ALCOHOL PRICES, CONSUMPTION, AND TRAFFIC FATALITIES

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Abstract

We examine the relationships among alcohol prices, consumption and traffic fatalities using data across U.S. states from 1982-2000. Some previous studies have found large, negative associations between alcohol *taxes* and fatalities. However, commonly-used price data suggest little or no connection between alcohol *prices* and fatalities. These apparently conflicting findings may result from measurement error and/or endogeneity in the price data, which biases ordinary least squares estimators toward a finding of no price effects. Using alcohol taxes as instrumental variables, fatalities are found to be negatively related to prices. In addition, alcohol consumption is strongly positively related to fatalities.

I. Introduction

Traffic fatalities are a leading cause of premature death, particularly among people under thirty-five years of age.[1] Alcohol is involved in about thirty percent of all traffic fatalities, and hence alcohol policies - particularly those focused on drinking and driving - have the potential to significantly reduce fatality rates.[2] Indeed, the proportion of traffic fatalities that involve alcohol has diminished by about one quarter in the last 20 years, as state and Federal governments have toughened penalties for drunk driving, raised the legal drinking age, stepped up enforcement of existing laws, and implemented educational programs aimed both at making the pitfalls of drinking and driving clear, and to change attitudes ("tastes").

This paper focuses on the links between alcohol prices, consumption, and traffic fatalities. The fundamental question is, how does the price of alcohol affect traffic fatalities? Price is an important policy variable, since it is affected by taxes and other measures, and - in some states for some beverages - price is actually set via the operation of alcohol control authorities. Economic theory predicts that alcohol consumption will be negatively related to price, and thus increases in price are expected, *ceteris paribus*, to reduce fatalities. Schematically, the hypothesized relationships are: Tax => Price => Consumption => Fatalities.

While there is little dispute about the qualitative nature of these relationships, there is a wide range of quantitative estimates of the magnitudes involved at each step, and a further question about whether, taken together, the estimated magnitudes make sense. Some researchers, for example, have estimated reduced form relationships based on tax and fatality data, ignoring

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[1] http://www.cdc.gov/nchs/data/nvsr/nvsr49/nvsr49_08.pdf Table 10

[2] http://www.niaaa.nih.gov/databases/crash01.txt April 25, 2003

the intermediate relationships between taxes and prices, prices and consumption, and consumption and fatalities. Even these studies have produced markedly different estimates.[3] There are relatively few studies taking a structural approach. Young and Bielinska-Kwapisz (2002) find that beverage prices rise more than one for one with alcohol taxes, suggesting that taxes may indeed have substantial impacts on consumption and fatalities. However, the few studies that estimated a price - fatality relationship yielded inconsistent results.[4]

A key empirical concern is the quality of the price data that is typically employed in analyses of consumption, fatalities and other behaviors. Many studies have employed beer, wine and spirits prices collected by ACCRA – formerly known as the American Chamber of Commerce Researchers Association.[5] These data have a number of defects. The beverage definitions have changed over time, requiring adjustments to create a consistent time series. The data may also be inconsistent across time and space, because members of local chambers of commerce are responsible for collection and reporting. Beer and wine price data are only available since 1982, and there are significant gaps in the data for various states and years. In addition, beverage prices may be endogenous in the sense that higher demand may result in

[3] For examples, Cook (1981), Chaloupka, et al. (1993), and Ruhm (1996) find large, negative relationships between beer taxes and fatalities, while Dee (1999), Mast et al. (1999), and Young and Likens (2000) find little or no relationship.

[4] Sloan et al. (1994) 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 time fixed effects. Price effects in Young and Likens (2000) are small, negative, and statistically insignificant.

[5] The ACCRA data have been used in studies of alcohol consumption by Nelson (2003), Grossman et al. (1998), Beard et al. (1997), Manning et al. (1995), Kenkel (1993) and Gruenewald et al. (1993); traffic accidents, homicides, suicides and other deaths by Sloan et al. (1994); spouse abuse by Markowitz (2000); alcohol-related motor vehicle fatalities by Young and Likens (2000); sales tax incidence by Besley and Rosen (1999); and suicides by Markowitz et al. (2002), among others.

higher market prices.[6]

Measurement error in the price data implies that the ordinary least squares (OLS) estimator is biased and inconsistent. Similarly, endogeneity of prices also renders the OLS estimator biased and inconsistent. In simple models, both problems bias the estimated price elasticity away from negative values. That is, OLS may substantially underestimate how much higher prices discourage consumption and traffic fatalities.

An alternative to the ACCRA data is to use excise taxes as measures of the price of alcohol. However, taxes do not accurately measure prices either. One reason is that combined state and Federal excise taxes average only about 11 percent (beer) to 16 percent (spirits) of retail beverage prices.[7] In addition, spirits and wine taxes are themselves difficult to measure accurately. In eighteen "control" states liquor is sold through state stores and is subject to ad valorem markups and/or excise taxes. In these states, the markup is in part a tax, because the government receives the revenue from the markup, but it is difficult to determine the implicit tax rate from the normal costs of wholesaling and retailing liquor. The remaining "license" states levy a per unit excise tax.[8] Tax rates also vary according to alcohol content, place or volume of production, size of container, place purchased (on- or off-premise), and there may be case or bottle handling fees.

These problems with price data in general and spirits and wine taxes in particular have

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[6] This point has been made by Manning et al. (1995), p. 126, and others.

[7] Average retail prices and state taxes are reported in Young and Bielinska-Kwapisz (2002). Federal taxes are available from the U.S. Bureau of Alcohol, Tobacco, and Firearms http://www.ttb.gov/alcohol/stats/index.htm .

[8] A similar but less severe situation occurs with wine: Five states "control" wine sales, while the remainder levy per unit excise taxes.

led some researchers to conclude that beer taxes are the best available indicator of the cost of alcohol.[9] However, Young and Bielinska-Kwapisz (2002) show that beer taxes alone are not highly correlated with either the ACCRA price data or national trends in the detailed CPI for alcohol. But a broader set of tax variables, including not just beer taxes but also liquor and wine per unit excise taxes, percentage excise taxes, and state markups, provides a set of instrumental variables which, in principle, can resolve the problems with the price data. That is, a set of alcohol tax variables appears to satisfy the conditions for use as instruments: They are, as a group, significantly correlated with true alcohol prices, and uncorrelated with the measurement error.[10]

Young and Bielinska-Kwapisz (2003) apply these methods to an analysis of alcohol consumption. Using data across U.S. states over the years 1982-97, they first test for endogeneity and/or measurement error in the ACCRA price data using a Hausman test. The null hypothesis of exogeneity is strongly rejected, and the authors proceed to estimate alcohol demand using instrumental variable methods. The IV estimates are substantially larger in absolute value than ordinary least squares estimates, which sometimes are not significantly different from zero or even positive.

This paper applies the same techniques to the estimation of the price - fatalities and consumption - fatalities linkages. The results echo those from Young and Bielinska-Kwapisz (2003): There is substantial evidence of measurement error and/or endogeneity in both the price and consumption data, and IV estimates of price and consumption effects on fatalities are

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[9] See Chaloupka et al. (1993) p. 169 and Freeman (2000) p. 329.

[10] As described below, however, alcohol taxes may be correlated with unobserved factors which affect consumption, which invalidates their use as instruments. See Section II.

substantially larger and more significant than those from OLS.

II. Methods

We estimate regression models that express fatality rates as functions of alcohol prices (or consumption), socioeconomic characteristics, the legal environment, and state and year fixed effects.

$$y_{it} = \ln P_{it}\alpha + x_{it}\beta + u_i + v_t + w_{it}$$

The data include the contiguous states (i = 1,...,48) and the years 1982-2000 (t = 1,...,19), but price data are missing for various years in some states, so the total number of observations is 869. The dependent variable, y_{it}, is the logistic transformation of the fatality rate, r_{it} (i.e. fatalities per capita).[11]

$$y_{it} = \ln \frac{r_{it}}{1 - r_{it}}$$

The price of alcohol, P, is the Stone price index, a geometric weighted average of the prices of beer, wine and spirits, with weights equal to each beverage's share in total expenditure on alcohol.[12]

$$\ln P \equiv \sum_i w_i \ln p_i$$

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[11] The logistic transformation implies that the disturbance w_{it} is heteroskedastic. An asymptotically efficient estimation procedure described in Young and Likens (2000) is employed.

[12] The ACCRA data are reported quarterly for a varying number of cities in each state. We aggregate to the state level by computing simple averages of the city-quarter data.

The coefficient, α , on the price variable is approximately the elasticity of fatalities with respect to the price of alcohol.[13] For example, a coefficient of minus .1 implies that a ten percent increase in alcohol prices is associated with a one percent decline in fatalities. Similarly, when the natural logarithm of per capita alcohol consumption is entered instead of price, the coefficient is approximately the elasticity of fatalities with respect to consumption.

The price variable may be correlated with the disturbance term because of measurement error or because price is endogenous in the sense that demand conditions affect prices. If beverage prices are measured with error, then the price index will be correlated with the disturbance term and the ordinary least squares estimator of the price coefficient is biased and inconsistent.[14] If there is only a single variable subject to classical measurement error, then the OLS estimator is biased toward zero (attenuated). Similarly, if price is endogenous, it is correlated with the disturbance term, and OLS estimates a weighted average of the demand (negative) and supply (positive) coefficients. Thus, endogeneity of prices will also bias the OLS estimator away from negative values.

A similar result applies when alcohol consumption replaces price as a right hand side variable. Consumption may be correlated with the disturbance term because of measurement error or because some unmeasured factors are common to both drinking and fatalities. For example, some youth engage in a number of risky behaviors which include drinking, reckless driving, and/or unprotected sex (Gruber, 2001, Dee and Evans, 2001). Alcohol consumption is then correlated with fatalities both because it is in fact a causal factor, and as a reflection of

[13] The elasticity is exactly equal to $(1\text{-r})\alpha$, which is very close to α, because $1\text{-r} \cong .999$.

[14] See Greene (2000) Section 9.5.2. The same result applies to weighted least squares used in this paper.

underlying attitudes toward risk. The latter correlation is spurious, in that a reduction in alcohol consumption - for example, as a result of higher prices - does not change attitudes toward risk.[15] These biases in ordinary least squares estimates of the effects of consumption on fatalities are likely to operate in opposite directions: Measurement error biases the estimator toward zero, while spurious correlation makes the estimator too positive.

The biases due to measurement error and endogeneity can be eliminated by standard two-stage estimation methods, if a set of proper instrumental variables can be found. There are two key properties of instrumental variables: They must be correlated with the true prices (or consumption), and uncorrelated with the disturbance term in the fatality equation. In asymptotic theory, any non-zero correlation with prices (or consumption) is "enough." However, in practical applications on finite samples, the correlation must be substantial. Young and Bielinska-Kwapisz (2002) show that state and Federal excise taxes and markups explain about thirty percent of the variation in alcohol prices in pooled cross-section time-series data similar to that employed in this study. These results suggest that the tax variables satisfy the first condition to be proper instruments.[16]

The second condition - uncorrelated with the disturbance term in the consumption equation - is likely to be satisfied in the case of measurement error, but may not be for endogeneity/spurious correlation. That is, there is no *a priori* reason to expect that measurement errors in prices or consumption are correlated with alcohol taxes. But state policies are likely to

[15] For example, Grossman et al. (2002) find that substance use, while strongly correlated with teen sexual behavior, is not causually related.

[16] Beer taxes by themselves explain only about 5 percent of alcohol price variation, and therefore are less adequate as instruments than employing the broader set of tax variables on spirits and wine, and including state markups and percentage taxes.

reflect (unmeasured) attitudes toward alcohol. In particular, taxes may be higher in states in which there is stronger anti-alcohol sentiment, or taxes may change over time in response to changes in attitudes toward alcohol. If this is the case, taxes are not proper instrumental variables.[17]

We conclude that state and Federal excise taxes and markups are likely to be good instrumental variables to deal with the measurement error problem, but may not be fully satisfactory to deal with endogeneity/spurious correlation. However, the latter problem is mitigated to the extent that the regressions include socio-economic variables, state dummies and/or time trends which control for sentiment toward alcohol and its evolution over the sample period.

Hausman (1978) established a general test for correlation between a right hand side variable and the disturbance term. We employ a version due to Davidson and MacKinnon (1989, 1993): The (logarithm of) price is first regressed on all the other right hand side variables in equation (1) and a set of instrumental variables which measure state and Federal tax rates. Composite demand is then estimated with the residual from this price regression as an additional regressor. If the estimated coefficient of the residual is significantly different from zero, then the null hypothesis of exogenous prices is rejected.

[17]See Manning et al. (1995), footnote 4. Kubik and Moran (2003), using state election cycles as instruments, provide evidence that changes in beer taxes are endogenous. Brown et al. (1996) find that county-level prohibitions on alcohol sales are endogenous.

III. Data

Separate regressions are estimated for fatalities in the total population and the population aged 16-20, which we term "teen" fatalities. As Table 1a indicates, teen fatality rates are about twice those of the total population.[18] Both fatality rates display a significant downward trend since the early 1980's, declining by about one quarter in each case (Figure 1).[19]

Separate fatality rates are also computed based on the accident day and time. Thus, Weekend Night (WN) fatalities, which are most likely to involve alcohol, occur between 6 PM Friday and 6 AM Saturday, and between 6 PM Saturday and 6 AM Sunday.[20] Fatalities occurring between 6 AM and 6 PM Monday through Friday, plus those occurring 6 PM Sunday to 6 AM Monday , are much less likely to involve alcohol. We term these fatalities Other Times (OT).[21] As Table 1a indicates, weekend night fatalities account for one-fourth to one-third of fatalities, even though these times account for only one-seventh of the week. For the results to "make sense," these weekend-night fatalities should be more closely related to alcohol prices or consumption than are fatalities at other times.

Alcohol consumption declined steadily from the early 1980s to mid 1990s before leveling

[18] Fatality data were provided by NHTSA from the FARS data base (http://www.nhtsa.dot.gov/).

[19] Trends are the estimated year specific coefficients from regressions of the fatality rates on state and year dummies. Regressions are weighted by population.

[20] An alternative approach is use NHTSA's measures of alcohol-related fatalities. However, these data are imputations based on samples of drivers who were actually tested for alcohol, and these samples varied greatly over time and across states http://www.niaaa.nih.gov/databases/crash06.txt . Selection bias may be significant: Drivers were more likely to be tested if beer cans were found in the back seat. The current method was used by Dee (1999).

[21] There were three instances of zero fatalities in the original data for teens during Other Times: North Dakota in 2000 and Rhode Island in 1993 and 1994. Since the logistic transformation can not be computed with a zero fatality rate, we assumed that one fatality occurred in each instance.

off at about 2.2 gallons of pure ethanol per capita (Figure 2).[22] The real price of alcohol generally declined until 1991, when increases in Federal excise taxes took effect.[23] The declining trend resumed after 1991, and over the entire sample period, the price decline amounted to about seven percent. The overall decline of about 20 percent in alcohol consumption is therefore not attributable to price.[24] Changes in the age distribution played a role as a smaller fraction of the population was concentrated in the heavy-drinking 18-29 year old group (Nelson, 1997).

Extensive educational efforts and legal changes in the last two decades also may have affected drinking and fatalities. Seat belt laws were eventually adopted by every state, and numerous studies have concluded that fatalities declined as a result. The effects of many other laws are harder to measure, in part because states often changed several laws simultaneously, stepped up hard-to-measure enforcement, and developed educational programs. We form an index of the legal environment by summing a series of dummy variables indicating whether or not a state has: an open container law, a preliminary breath test law, a dram shop law, an illegal per se BAC level of at least .1, mandatory licensing action upon first conviction for DWI, and an administrative per se law.[25] Two more recent legal innovations are included as separate variables,

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[22] Based on population aged 14 and over. Data from 1982-99 from Nephew et al., (2002). Extended to 2000 using data from the Beer Institute. Consumption estimates are based on shipment data. Thus the upward blip in 1990 may represent stockpiling in anticipation of the 1991 tax and price increases. Such effects are eliminated from the regressions by time dummies.

[23] The price of alcohol is adjusted for national inflation using the CPI and expressed relative to the overall ACCRA cost of living in each state. It therefore represents the cost of alcohol relative to other goods, expressed in dollars of 2000 purchasing power. National averages of ACCRA prices closely follow the CPI price index for alcohol “at home.” The price of alcohol “away from home” has increased faster. See Young and Bielinska-Kwapisz (2002).

[24] Cook and Moore (2001) reach the same conclusion regarding teen drinking. Teen drinking is closely related to overall consumption, but the determinants of the latter are only partially understood.

[25] Data from NHTSA, Digest of Highway Safety Legislation, various years.

in order to provide evidence on their effectiveness: An illegal per se BAC level of .08 or less, and a server training law.[26] In addition, teen fatality regressions include several laws directed specifically at this age group: the legal drinking age, keg registration, and the existence of a separate (lower) BAC level for teens.[27]

Alcohol use and risk taking are affected by socio-economic factors other than price and legal restrictions. Thus, several additional variables are included in the fatality regressions which use price as a right hand side variable. Specifically, the percentages of the population that are Catholic, Mormon and Southern Baptist, the percentage of the population over age 65, and a tourism variable measuring the percentage of Gross State Product from the Hotel and Restaurant industry.[28] In addition to an indirect effect on fatalities via alcohol consumption, these factors may also have a direct affect on fatalities, and the relationships may sometimes be conflicting. For example, the population over 65 tends to drink less, but are more likely to be involved in fatal accidents.[29]

Part b of Table 1 displays descriptive statistics on the tax measures used as instruments for prices and consumption. All states employ per unit excise taxes on beer, wine and spirits. In addition, control states levy taxes and/or markups based on the wholesale prices of spirits and wine. Each fatality equation is estimated by a two-step procedure. First, the right hand side

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[26] Data on the .08 law is from NHTSA's *Digest*. Server training data provided by Alexander C. Wagenaar, Alcohol Epidemiology Program, University of Minnesota, School of Public Health.

[27] Drinking age from Chaloupka (1988), keg registration and youth BAC from Wagenaar, Ibid.

[28] Religion variables are interpolations/extrapolations based on Bradley et al. (1990) and Quinn et al. (1980). Age data from US Bureau of the Census. Tourism data from US Bureau of Economic Analysis http://www.bea.doc.gov/bea/regional/gsp/ .

[29] A regression of fatality rates on state and time dummies, and the proportions of the population 18-29 and over 65, shows significant positive relationships with each of the latter two variables.

endogenous variable - alcohol price or consumption - is regressed on all of the exogenous variables including the taxes and state and time fixed effects, and the fitted values are retained. In the second step, the fatality equation is estimated using the fitted value of price (or consumption) as an instrumental variable.[30] The squared correlations between the fitted and actual values for price and consumption are, respectively, .90 and .98. The lower R-squared for price is consistent with a larger amount of measurement error in that variable.

[30] See Greene (1998), Section 17.3.9 for details.

IV. Results

Tests for measurement error and/or endogeneity of prices are displayed in Table 2a. The null hypothesis of exogeneity is rejected at the one percent level for five of the six fatality rates. As the last two columns indicate, correcting for measurement error/endogeneity has a profound impact on the estimated price effects. Ordinary least squares (OLS) estimates are positive for five of the six fatality rates, and three of the estimates are statistically significant. Taken at face value, these estimates imply that increases in alcohol prices are positively associated with traffic fatalities. However, the instrumental variables (IV) estimates imply quite the opposite: All six of the estimates are negative, and five of the six are significant at the five percent level.

The estimated magnitudes suggest substantial effects of prices on fatalities. A ten percent increase in alcohol prices is predicted to reduce total fatalities by 5.8 percent. The estimated effect is somewhat larger for weekend night fatalities (6.9 percent), and smaller for other times (3.9 percent). The estimated impact on all youth fatalities (9 percent) is larger than for the total population. Less plausibly, the estimated impact on weekend night fatalities among youth (3.5 percent) is smaller and statistically insignificant than the impact on youth at other times (9.3 percent).

The results using alcohol consumption in place of price are broadly similar. Exogeneity is rejected at the 10 percent significance level or less for five of the six fatality rates, and instrumental variable estimates indicate larger effects than do OLS estimates. For example, using OLS, a 10 percent increase in per capita alcohol consumption is associated with a 9.9 percent increase in fatalities, while the IV estimate is 11.3 percent. The other estimated effects range from 10.2 percent to 14.1 percent. Somewhat implausibly, the estimated effects are smaller on weekend night fatalities than on fatalities at other times, particularly for youth. Also, the estimated effects on youth are larger than those on adults.

The regressions also provide evidence on a number of other determinants of fatalities. Among the total population (Table 3), income, vehicle miles traveled, and the population 18-29 are positively and significantly related to fatalities in most specifications. Seat belt laws reduce fatalities four to six percent. The evidence is less strong for the legal environment index, which is negative for five of six fatality rates, but not always statistically significant .[31] The percentage of the population living in dry counties has no effect on fatalities, conditional on the price of alcohol. However, percentage living in dry counties is positively related to fatalities, conditional on alcohol consumption. This is consistent with the hypothesis that dry counties have a mixed relationship with fatalities: (1) More people living in dry counties is associated with a lower demand for alcohol and on that account fewer fatalities. (2) At the same time, people who do drink may be more likely to drive to obtain alcohol and on that account result in more fatalities.[32]

There is little evidence that .08 laws or server training are effective in reducing fatalities. The coefficients of the .08 law variable mostly indicate a positive relationship with both total and teen fatalities, although they are seldom statistically significant. The server training coefficients are negative in about 2/3 of the specifications, but never statistically significant.

Membership in the Catholic church is negatively related to fatalities, significantly so in two of three equations. The percentage Mormon is not significant, while fatalities are positively

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[31] Entering the components of the index as separate variables results in about half negative and half positive coefficients, many of which are not significant. It appears that the data are not sufficiently strong to distinguish among the effects of the large number of legal initiatives that states have implemented.

[32] See Baughman et al. (2001).

and significantly related to Southern Baptist membership. The latter relationship is unexpected, because many Southern Baptists preach abstinence. Fatalities are positively related to the population aged 65 and above, apparently because fatality rates are higher for this group. Tourism is not significantly related to fatalities.

Results for teenagers (age 16-20) are broadly similar (Table 4). Income and vehicle miles traveled are positively and significantly related to fatalities, while a seat belt law reduces fatalities. Increasing the drinking age by one year is estimated to reduce teen fatalities by one to three percent, with the largest estimated impact on weekend night fatalities. There is little evidence that the legal environment, population in dry counties, .08 law, or server training are related to fatalities. There is some evidence that Catholicism and Mormonism are associated with fewer teen fatalities, while membership in the Southern Baptist church is positively associated with fatalities. There is some evidence that keg registration is associated with lower teen fatalities, but not on weekend nights. A youth BAC law is not significantly related to fatalities.

V. Discussion

There is strong evidence of measurement error and/or endogeneity in the ACCRA price data for alcohol, which biases conventional (OLS) estimators toward a finding of little or no effect of prices on traffic fatalities. Using state and Federal tax rates as instrumental variables, there is strong evidence that fatalities are in fact negatively and significantly related to the price of alcohol, *ceteris paribus*. Qualitatively similar results hold for the relationship between alcohol consumption and fatalities: Estimates based on instrumental variable techniques are larger than those from OLS.

Are the partial reduced form estimates of the price-fatality relationship consistent with structural estimates of the effects of price on consumption and consumption on fatalities? By definition, the elasticity of fatalities with respect to the price of alcohol, E_{fp} say, is equal to the product of the price-consumption elasticity, E_{cp}, and the consumption-fatality elasticity, E_{fc}. Our point estimates for total fatalities are $E_{fp} = -.58$ and $E_{fc} = 1.13$. The two are consistent if the price-consumption elasticity is $E_{cp} = -.58/1.13 = -.51$. This value is within the range of price elasticities for aggregate alcohol consumption estimated in previous work (Leung and Phelps, 1993, Young and Bielinska-Kwapisz, 2003).

What do these estimates imply about the impact of alcohol taxes on traffic fatalities? The answer depends on the degree to which alcohol taxes are shifted forward to retail prices, and on how important taxes are as a share of retail prices. Young and Bielinska-Kwapisz (2002) find that spirits, beer and wine taxes are over-shifted: Retail prices rise more than one-for-one with an increase in taxes. Specifically, beer prices rise \$1.71 for each dollar increase in the beer tax, spirits prices rise \$1.60 for each dollar increase in spirits taxes, and wine prices rise \$1.24 for a dollar increase in wine taxes. However, excise taxes are only 11-18 percent of retail prices.[33] Thus, the 1991 increase in Federal excise taxes, which doubled the beer tax (from 16 cents per six pack to 32 cents) and increased the wine tax six-fold, apparently increased retail prices by only about six percent (see Figure 2). Based on a price-fatality elasticity of .58, the predicted decline in total fatalities is about three and one-half percent.

These results can also be expressed as a tax-fatality elasticity. Ignoring the increase in the wine tax for simplicity, the implied elasticity of fatalities with respect to the beer tax is .06. That is, the 16 cent increase in the Federal tax amounted to a 56 percent increase in combined state and Federal excise taxes, that - when passed through to price - is predicted to have reduced fatalities by 3.5 percent (3.5/56=.06). This figure is about one-quarter lower than Evans et al.'s (1991) estimate of .08, and about one-half of Ruhm's (1996, Table 2) estimate of .11. Chaloupka et al. (1993, p. 181) estimated that doubling the Federal beer tax would have reduced fatalities by a slightly larger 3.9 percent.

The estimated tax elasticity for teen fatalities is about half again as large (.09), because the teen price elasticity of fatalities is estimated to be that much larger (Tables 2 and 4). A higher elasticity for teens could in principle result from either (or both) of two factors: Teen drinking could be more responsive to price than drinking among the general population, and/or alcohol consumption may have a larger effect on teen fatalities than it does in the general population. In any case, a tax elasticity of .09 is substantially smaller than some previous estimates. For example, Ruhm's (1996, Table 4) tax elasticity for 18-20 year olds is twice as high (.17-.21). Chaloupka et al. (1993, p. 181) report that doubling the Federal beer tax would reduce fatalities

[33] Based on 1997 data. See Young and Bielinska-Kwapisz (2002).

among 18-20 year olds by 11.8 percent, implying an even larger tax elasticity of .21 (=11.8/56).

These estimates should be regarded with caution, however. One reason is that the pattern of price and consumption effects across the different fatality measures is sometimes counter-intuitive. For example, teen fatalities on weekend nights are apparently less responsive to the price of alcohol than are fatalities at other times. Similarly, total fatalities on weekend nights are apparently less responsive to alcohol consumption than fatalities at other times. Both of these results are unexpected, because alcohol plays a greater role on weekend nights than at other times. Dee (1999) and Dee and Evans (2001) obtain similar results. As Cook and Moore (2001, p. 421) point out, efforts to empirically assess the impact of alcohol taxes have been hampered by the limited variation in the data, i.e. "small and infrequent changes in state excise taxes."

Another concern is the very mixed results for alcohol policies other than price. Although the effectiveness of seat belt laws and the legal drinking age is confirmed, other aspects of the legal environment - including .08 laws, server training, keg registration and a youth BAC - do not display strong relationships with fatalities. In part this may result from multicollinearity - state policy changes are simply too highly correlated - and in part it may reflect weakness in the underlying data.[34]

A related concern is that alcohol taxes and other policies may reflect underlying attitudes toward alcohol, or be correlated with other policy measures intended to curb fatalities, and thus be improper instrumental variables. Concern about and awareness of alcohol abuse has risen substantially in the last 20 years, resulting in much tougher and more visible enforcement of

[34] For example, the principal source of these data, NHTSA's *Digest*, indicates that Montana had an open container law for several years in the early 1980s. In fact, it has never had one.

existing laws on driving and drinking. Many states also increased drug and alcohol education in the schools. These factors were very likely important 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 which 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. On the other hand, states may enact alcohol control policies in response to high fatality rates, creating a spurious positive association between policy measures and fatalities. Thus the estimated effects of policies could, in principle, be biased in either direction.

REFERENCES

American Chamber of Commerce Researchers Association (ACCRA). 1982-2000 *ACCRA cost of living index, quarterly reports.* Louisville, KY.

Baughman, Reagan, Michael Conlin, Stacy Dickert-Conlin, and John Pepper 2001 Slippery when wet: the effects of local alcohol access laws o highway safety. *Journal of Health Economic*s 20:1089-1096.

Beard, T. Randolph, Paula A. Gant, Richard. P. Saba. 1997 Border-Crossing Sales, Tax Avoidance, and State Tax Policies: An Application to Alcohol. *Southern Economic Journal* 641: 293-306.

Beer Institute. 2000. *Brewers almanac.* Washington, DC,.

Besley, Timothy J. and Harvey S. Rosen. 1999 Sales Taxes and Prices: An Empirical Analysis *National Tax Journal,* June, 157-178.

Bradley, Martin B., Norman M. Green Jr., Dale E. Jones, Mac Lynn, and Lou McNeil. 1990 *Churches and church membership in the United States 1990.* Atlanta: Glemnary Research Center.

Brown, Robert, R. Todd Jewell, and Jerell Richer. 1996. Endogenous Alcohol Prohibition and Drunk Driving. *Southern Economic Journal* 62-4: 1043-53.

Chaloupka, F.J., H. Saffer, and M. Grossman. 1993 Alcohol control policies and motor-vehicle fatalities. *Journal of Legal Studies 22-1* (January): 161-86.

Cook, Phillip J. 1981 The Effect of Liquor Taxes on Drinking, Cirrhosis, and Auto Fatalities. In Moore and Gerstein (eds.) *Alcohol and Public Policy: Beyond the Shadow of Prohibition* 255-285. Washington, DC, National Academy Press.

Cook, Philip J. and Michael J. Moore 2001. Environment and Persistence in Youthful Drinking Patterns. In Jonathon Gruber (ed.) *Risky Behavior Among Youths*. The University of Chicago Press. Chicago.

Davidson, Russell and James G. MacKinnon. 1989 Testing for Consistency using Artificial Regressions *Econometric Theory* 5: 3 63-3 8 4.

Davidson, Russell and James G. MacKinnon. 1993 *Estimation and Inference in Econometrics* Oxford University Press.

Dee, Thomas S. 1999. State alcohol policies, teen drinking and traffic fatalities. *Journal of*

Public Economics 72: 289-315

Dee, Thomas S. and William N. Evans 2001 Teens and Traffic Safety in Jonathon Gruber (ed.) *Risky Behavior Among Youths*. The University of Chicago Press. Chicago.

Distilled Spirits Council of the U.S. (DISCUS). 2000 *History of beverage alcohol tax changes.* Washington, DC.

Evans, W. N., Neville, D., and Graham, J. 1991. General deterrence of drunk driving: evaluation of recent American policies. *Risk Analysis* 11: 279-89.

Freeman, Donald G. 2000 Alternative Panel Estimates of Alcohol Demand, Taxation and the Business Cycle., *Southern Economic Journal 67(2):* 325-44.

Greene, William H. 1998 *LIMDEP Version 7.0 User's Manual* Econometric Software, Inc. Plainview, New York.

Greene, William H. 2000 *Econometric Analysis* Fourth Ed. Prentice Hall, NJ.

Grossman, Michael, Frank J. Chaloupka, and Ismail Sirtalan. 1998 An Empirical Analysis of Alcohol Addiction: Results from the *Monitoring the* Future Panels. *Economic Inquiry* XXXVI. (1): 39-48.

Grossman, Michael, Robert Kaestner, and Sara Markowitz (2002) Get High and Get Stupid: The Effect of Alcohol and Marijuana Use on Teen Sexual Behavior. National Bureau of Economic Research Working Paper 9216.

Gruber, Jonathon (2001) "Introduction" in Jonathon Gruber (ed.) *Risky Behavior Among Youths*. The University of Chicago Press. Chicago.

Gruenewald, P.J., Ponicki, W.R., and Holder, H.D. 1993 The relationship of outlet densities to alcohol consumption: A time series cross-sectional analysis. *Alcoholism: Clinical and Experimental Research* 17(l): 38-47.

Hausman, J. 1978. Specification Tests in Econometrics. *Econometrica 46*: 1251-1271

Kenkel, Donald S. 1993 Drinking, Driving and Deterrence: The Effectiveness and Social Costs of Alternative Policies. *Journal of Law and Economics* 36 (2):861-876.

Kubik, Jeffrey D. and John R. Moran (2003) Can Policy Changes Be Treated as Natural Experiments? Evidence from State Excise Taxes. Working Paper. Department of Economics Syracuse University.

Leung, S.F. and C. E. Phelps. 1993 "My Kingdom for a Drink ... ?": A Review of Estimates of the Price Sensitivity of Demand for Alcoholic Beverages in Hilton, M.E. and G. Bloss eds. *Economics and the Prevention of Alcohol-Related Problems: Proceedings of a Workshop on Economic and Socioeconomic Issues in the Prevention of A1cohol-Related Problems, October* 10-11, 1991 Bethesda, MD NIAAA Research Monograph No. 25 1-31.

Manning, Willard G., Linda Blumberg, and Lawrence H. Moulton. 1995 The demand for alcohol: The differential response to price *Journal of Health Economics* 14:123-148.

Markowitz, Sara. 2000 The Price of Alcohol, Wife Abuse, and Husband Abuse. *Southern Economic Journal* 67(2):279-303.

Markowitz, S., P. Chatterji, R. Kaestner, and D. Dave. 2002. Substance use and suicidal behaviors among young adults. *NBER Working Paper 8810*

Mast, Brent D.; Benson, Bruce L.; Rasmussen, David W. 1999. Beer Taxation and Alcohol-Related Fatalities. *Southern Economic Journal v66, n2* (October): 214-49

Nelson, J. P. 2003. Advertising Bans, Monopoly, and Alcohol Demand: Testing for Substitution Effects using State Panel Data. *Review of Industrial Organization 22*: 1-25.

Nelson, J. P. 1997. Economic and Demographic Factors in U.S. Alcohol Demand: A Growth Accounting Analysis. *Empirical Economics* 22:83-102.

Nephew, T.M.; Williams, G.D.; Yi, H.; Hoy, A.K.; Stinson, F.S., and Dufour, M.C. (2002) NHTSA Surveillance Report #59: Apparent Per Capita Alcohol Consumption: National, State, and Regional Trends, 1970-99. Rockville, MD: National Institute on Alcohol Abuse and Alcoholism, Division of Biometry and Epidemiology.

Quinn, Bernard, Herman Anderson, Martin Bradley, Paul Goetting, and Peggy Shriver 1980 *Churches and church membership in the United States 1980.* Atlanta: Glenmary Research Center.

Ruhm C., 1996. Alcohol policies and highway vehicle fatalities. *Journal of Health Economics* 15: 435-454.

Sloan, F. A., B. A. Reilly, and C. M. Schenzler. 1994 Effects of Prices, Civil and Criminal Sanctions, and Law Enforcement on Alcohol-Related Mortality *Journal of Studies on Alcohol* July, 454-465.

U.S. Bureau of Labor Statistics. 1998 *CPI detailed report.* (January), Young, D. J., and T. W. Likens. 2000. Alcohol regulation and auto fatalities. *International Review of Law and Economics 20:* 107-126.

Young, D. J., and A. Bielinska-Kwapisz 2002. Alcohol taxes and beverage prices. *National Tax Journal LV-1* :57-73.

Young, D. J., and A. Bielinska-Kwapisz 2003. Alcohol consumption, Beverage Prices and Measurement Error. *Journal of Studies on Alcohol 64(2)*: 235-238

Figure 1: Fatality Rates

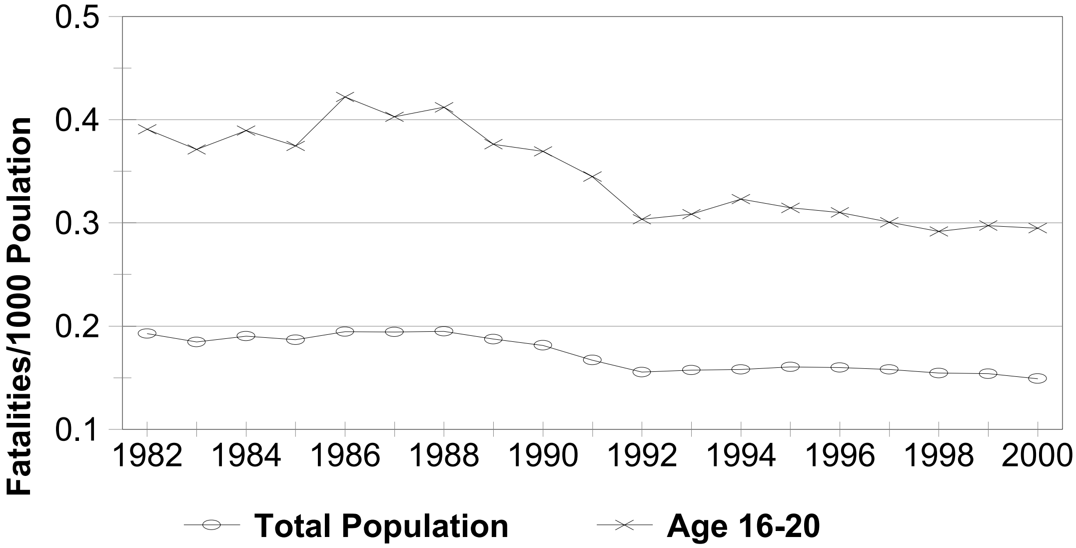

Figure 2: Price and Consumption

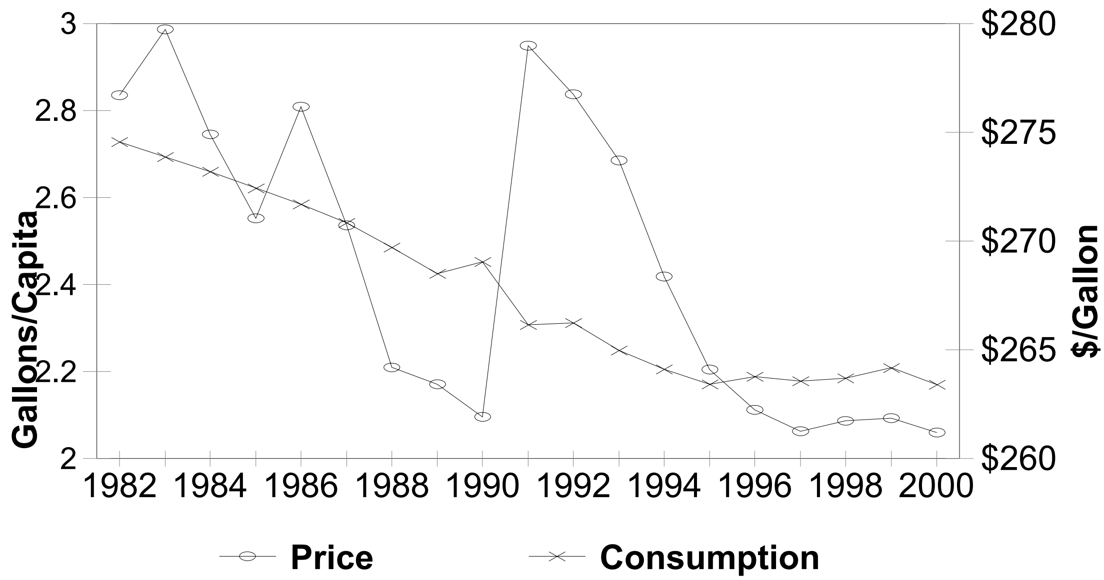

Table 1a. Descriptive Statistics

Variable	Definition	Mean	Std Dev	Min	Max
	<u>Fatality Rates</u> (per 1000 pop'n)				
TOTAL	All Ages, All Times	.172	.051	.066	.423
TOTALWN	All Ages, Weekend Nights	.042	.015	.011	.138
TOTALOT	All Ages, Other Times	.087	.027	.029	.240
TEEN	Ages 16-20, All Times	.346	.106	.132	.937
TEENWN	Ages 16-20 Weekend Nights	.115	.045	.022	.342
TEENOT	Ages 16-20 Other Times	.138	.048	.020	.511
	<u>RHS Endogenous Variables</u>				
ACON	Ethanol Consumption (gal/capita)	2.37	.430	1.24	5.26
APRICE	Ethanol Price ($/gal)	269.3	25.0	212.6	337.8
	<u>RHS Exogenous Variables</u>				
SBELT	Seat Belt Law =1	.760	.427	0.0	1.0
LEGALENV	Legal Environment Index	3.27	1.07	1.0	6.0
ILLPER08	Illegal Per Se .08	.180	.384	0.0	1.0
SERVTRAN	Server Training Law	.237	.422	0.0	1.0
INCOME	Income per Capita ($ 000's)	25.3	3.12	15.3	36.7
VMTLIC	Vehicle Miles Traveled (000's/ Driver)	12.9	2.09	7.75	22.4
DRY	Population Living in Dry Areas (%)	4.28	8.49	0.0	46.4
POP1829	Population Ages 18-29 (%)	18.72	2.30	13.82	24.0
DRINKAGE	Legal Drinking Age	20.7	.749	18.0	21.0
KEGREG	Keg Registration	.110	.312	0.0	1.0
YOUTHBAC	Lower BAC for Youth = 1	.420	.485	0.0	1.0
CATHOLIC	Catholic (%)	21.1	12.3	1.74	63.5
MORMON	Mormon (%)	1.51	6.51	0.1	76.2
SBAPTIST	Southern Baptist (%)	7.96	10.1	0.0	37.4
POP65	Population Ages 65+ (%)	12.4	2.04	7.6	18.6
TOURISM	Share of GSP from Hotels/Rest's (%)	0.76	1.03	0.27	15.1

Table 1b. Instrumental Variables

Variable	Definition	Mean	Std Dev	Min	Max
BTAX	Beer Excise Tax ($/gal)	18.86	6.64	8.57	52.95
WTAX	Wine Excise Tax ($/gal)	11.69	6.91	1.55	31.78
STAX	Spirits Excise Tax ($/gal)	40.58	7.46	22.6	66.4
STAXPERC	Spirits Excise Tax (%)	3.72	9.52	0.0	56.0
SMARKUP	Spirits Markup (%)	12.7	22.4	0.0	113.
WTAXPER	Wine Excise Tax (%)	1.06	4.10	0.0	35.0
WMARKUP	Wine Markup (%)	2.61	10.0	0.0	84.2

Note: Means and Standard Deviations are weighted by state population. N =869.

Table 2a. Tests for Endogeneity and/or Measurement Error in Prices

Fatality Rate	F-value (Significance Level)	Price Coefficient |t-ratio|	
		OLS	IV
All Ages All Times	28.4 (.00)	.16 2.2	-.58 3.4
All Ages Weekend Nights	17.3 (.00)	.11 1.1	-.69 3.0
All Ages Other Times	12.6 (.00)	.29 3.5	-.39 2.1
Ages 16-20 All Times	15.3 (.00)	.08 .7	-.90 3.1
Ages 16-20 Weekend Nights	.4 (.52)	-.10 .5	-.35 .8
Ages 16-20 Other Times	12.7 (.00)	.44 2.6	-.93 2.2

Table 2b. Tests for Endogeneity and/or Measurement Error in Consumption

Fatality Rate	F-value (Significance Level)	Consumption Coefficient |t-ratio|	
		OLS	IV
All Ages All Times	10.7 (.00)	.99 16.8	1.13 14.4
All Ages Weekend Nights	3.1 (.08)	.99 12.4	1.08 9.5
All Ages Other Times	12.1 (.00)	.91 12.9	1.11 11.7
Ages 16-20 All Times	12.6 (.00)	.97 9.2	1.29 8.9
Ages 16-20 Weekend Nights	1.4 (.23)	.86 5.0	1.02 4.3
Ages 16-20 Other Times	13.8 (.00)	.85 5.3	1.41 6.3

Table 3. Fatality Regressions for Total Population (All Ages)

Dependent Variable: Logit of Fatality Rate

(Absolute values of t-statistics below parameter estimates)

	Alcohol Price			Alcohol Consumption		
Right Hand Side Variable	**All Times**	**Weekend Nights**	**Other Times**	**All Times**	**Weekend Nights**	**Other Times**
ln (Alcohol Price)	-.58 3.4	-.69 3.0	-.39 2.1			
Ln (Alcohol Consumption)				1.13 14.4	1.08 9.5	1.11 11.7
Income	.045 11.7	.040 7.7	.045 10.6	.017 5.6	.010 2.2	.022 5.9
VMTLIC	.022 5.4	.014 2.5	.022 5.0	.009 2.6	.003 .5	.010 2.3
Population 18-29 (%)	.051 7.2	.037 3.7	.055 7.0	.029 5.3	.023 2.8	.030 4.8
Seat Belt Law	-.038 3.1	-.045 2.8	-.041 3.1	-.043 4.3	-.055 3.8	-.046 3.8
Legal Environment	-.004 .8	-.011 1.8	.001 .2	-.008 2.1	-.017 3.1	-.002 .4
Pop in Dry Counties (%)	.001 .5	.005 1.5	-.002 .6	.009 3.9	.013 4.0	.005 1.8
BAC=.08	.027 2.2	.034 1.9	.010 .7	.008 .9	.008 .6	-.003 .3
Server Training	-.004 .4	.011 .7	-.009 .7	-.012 1.4	.006 .5	-.018 1.6
Catholic (%)	-.009 4.1	-.003 .9	-.013 5.1			
Mormon (%)	-.010 .8	.010 .5	-.021 1.5			
Southern Baptist (%)	.045 7.9	.055 7.0	.038 6.0			
Population 65+ (%)	.024 2.1	.026 1.7	.024 1.9			
Tourism (%)	-.021 1.0	-.028 1.0	-.015 .7			
Adjusted R^2	.94	.91	.92	.94	.93	.93

Notes: State and year dummies are included in every equation. Estimation is by 2SLS using combined state plus Federal excise taxes on beer, spirits, and wine, and for control states, the percentage excise taxes and/or markups on spirits and wine, as applicable. Price or consumption is treated as endogenous. N=869.

Table 4. Fatality Regressions for Teens (Age 16-20)

Dependent Variable: Logit of Fatality Rate

(Absolute values of t-statistics below parameter estimates)

Right Hand Side Variable	Alcohol Price: All Times	Alcohol Price: Weekend Nights	Alcohol Price: Other Times	Alcohol Consumption: All Times	Alcohol Consumption: Weekend Nights	Alcohol Consumption: Other Times
ln (Alcohol Price)	-.89 3.1	-.35 .8	-.93 2.2			
Ln (Alcohol Consumption				1.29 8.9	1.02 4.3	1.41 6.3
Income	.055 9.4	.041 4.5	.065 7.5	.023 4.3	.016 1.8	.033 4.0
VMTLIC	.031 5.0	.015 1.6	.041 4.5	.015 2.5	.008 .8	.022 2.3
Drinking Age	-.019 2.3	-.022 1.7	-.011 .8	-.023 3.0	-.028 2.3	-.014 1.2
Seat Belt Law	-.042 2.3	-.057 2.1	-.046 1.7	-.055 3.2	-.071 2.6	-.057 2.1
Legal Environment	-.002 .3	.010 1.0	-.012 1.2	-.008 1.2	.003 .3	-.016 1.6
Pop in Dry Counties (%)	-.005 1.2	-.000 .0	-.013 1.8	.004 .9	.005 .8	-.003 .4
BAC=.08	.078 4.0	.052 1.7	.041 1.4	-.040 2.4	.027 1.0	.005 .2
Server Training	-.006 .4	.021 .8	-.015 .6	-.006 .4	.023 .9	-.019 .8
Catholic (%)	-.008 2.3	-.003 .5	-.014 2.7			
Mormon (%)	-.023 1.3	-.037 1.1	-.046 1.9			
Southern Baptist (%)	.059 6.9	.058 4.4	.056 4.5			
Keg Registration	-.127 4.9	-.034 .8	-.182 4.8	-.039 1.6	.019 .5	-.091 2.5
Youth BAC	-.009 .5	-.019 .7	.013 .5	.006 .4	-.005 .2	.026 1.1
Adjusted R^2	.85	.79	.76	.87	.79	.77

Notes: State and year dummies are included in every equation. Estimation is by 2SLS using combined state plus Federal excise taxes on beer, spirits, and wine, and for control states, the percentage excise taxes and/or markups on spirits and wine, as applicable. Price or consumption is treated as endogenous. N=869.