ALCOHOL CONSUMPTION, BEVERAGE PRICES AND MEASUREMENT ERROR

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**Abstract**

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We estimate the demand for alcohol from pooled data across U.S. states and the years 1982-97. A number of problems with the available price data suggest that they may contain substantial measurement error and/or be endogenous. Using state and Federal alcohol taxes as instrumental variables, formal tests confirm the hypothesis. As expected, instrumental variable estimates of the price elasticity of demand are substantially larger in absolute value than ordinary least squares estimates. The estimates are also sensitive to the inclusion of state dummy variables. Estimates of the price elasticity of demand for alcohol range from -.53 to -1.24. The 1991 increase in Federal excise taxes on alcohol reduced consumption between 2.5 and 6 percent.
I. Introduction

Alcohol taxes raise beverage prices and thus discourage consumption. How much consumption declines depends on the extent to which taxes are passed on to prices, and the extent to which consumers respond by decreasing consumption. In an earlier paper, we examined the relationship between alcohol taxes and beverage prices (Young and Bielinska-Kwapisz, 2001). The central purpose of this paper is to provide estimates of the price elasticity of demand for beverages containing alcohol, and thus to calculate the effects of changes in alcohol taxes on alcohol consumption. We employ pooled data across U.S. states over the years 1982-97.

There are several difficulties in obtaining reliable estimates of the price elasticity of demand. One of these is the quality of the available price data, which may contain substantial measurement error and/or be endogenous.¹ The American Chamber of Commerce Research Association (ACCRA) reports retail prices for beer, wine and spirits as part of their cost of living surveys. However, the beverage definitions have changed over time, requiring adjustments to create a consistent time series. The data may not be consistent across states and over time 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 higher market prices.²

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¹ As early as 1983, Ornstein and Levy concluded that the available data were poor in many cases, “especially with regard to price indices” (p. 344). Leung and Phelps (1993) suggest that there has not been much improvement in the price data or econometric technique since then (p. 24).

² Despite their problems, the ACCRA data have been widely used in studies of alcohol consumption by Nelson (2000), Beard et al. (1997), Kenkel (1993) and Gruenewald et al.(1993), an analysis of traffic accidents, homicides, suicides and other deaths by Sloan et al. (1994b) , and in a study on alcohol-related fatalities by Young and Likens (2000), among others.
An alternative to the ACCRA data is to use excise taxes as measures of the price of alcohol. However, taxes are also measured with error, particularly taxes on spirits. In eighteen states liquor is sold through state stores and is subject to ad valorem markup and/or excise taxes. In these “control” states, the markup is in part a tax, because the state stores earn a profit, 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. \(^3\) 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 led some researchers to conclude that beer taxes are the best available indicator of the cost of alcohol.\(^4\) However, Young and Bielińska-Kwapisz (2001) 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.

Measurement error in the price data imply 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 would tend to result in an estimated price elasticity that is

\(^3\) A similar but less severe situation occurs with wine: Five states “control” wine sales, while the remainder levy per unit excise taxes.

too small in absolute value (or even positive). That is, OLS may substantially underestimate how much consumers decrease consumption in response to an increase in price. To deal with these problems, we first test for endogeneity and/or measurement error using a Hausman test. The null hypothesis of exogeneity is strongly rejected, and we proceed to estimate alcohol demand using instrumental variable methods. State and Federal taxes on beer, wine and spirits are used as instrumental variables.

A second problem is whether to include state-specific dummy variables, in order to control for unobserved differences across states which may bias estimates of price effects. For example, attitudes toward alcohol consumption differ markedly among religious and other groups, and these attitudes are likely to influence alcohol policy. Thus, states in which alcohol is viewed less favorably - and people are less inclined to drink anyway - may levy higher alcohol taxes and adopt other policies which increase the cost of alcohol, enact and enforce more restrictive legislation concerning drunk driving, have more extensive programs of alcohol education, etc. The data will then display a negative correlation between alcohol prices and consumption. But this correlation overstates the impact of prices themselves, unless there are variables included to control for “tastes” of the residents and for all of the policies that discourage alcohol consumption. Realistically, it is not feasible to have sufficient data to control for “all” the influences on alcohol consumption, and thus even instrumental variable estimators are likely to suffer from omitted variable bias.5

State-specific dummy variables provide effective controls for unobserved factors such as tastes or policies which differ across states but are constant over time, and thus reduce the problem of omitted

5 It is of course possible to control for religion and some other factors as we do below.
variable bias. However, including state-specific dummy variables also has a substantial cost: The cross-sectional variation in the data are effectively removed, and estimates are based only on the variation over time within states. In the data used here, 90 percent of the variation in alcohol consumption is explained by state-specific effects, and only 10 percent of the variation occurs over time.\(^6\) Thus, including state dummies substantially reduces the information on which estimates of the price elasticity and other parameters are based. This paper provides estimates both with and without state-specific dummies, and assesses the quality of each.

The rest of the paper is organized in the following way. The theoretical framework and data are discussed in Sections II and III. Parameter estimates and their implications for tax effects are presented in Section IV. Conclusions, policy implications, limitations of our work, and suggestions for further research are in the last section.

II. Theoretical and Econometric Framework

The consumers’ decision process is assumed to be done in two stages. In the first stage, consumers determine their total expenditure on alcoholic beverages. In the second stage, they divide this expenditure into specific beverages: beer, wine, and spirits. We assume that the consumer’s utility function is weakly separable with respect to alcohol and other goods and services. The assumption of weak separability ensures that this is a correct model and that a price index for alcohol can be constructed from information on the prices of beer, wine and spirits, without having to consider the

\(^6\) About 58 percent of the variation in price is explained by state effects, and 80 percent is explained when both state and year dummies are included.
prices of other goods.\footnote{Weak separability implies, for example, that the marginal rate of substitution between beer and wine is independent of the quantity of salmon. Using aggregate time series data from Australia, Clements et al. (1997) failed to reject weak separability of beer, wine and spirits from other goods.}

The first stage of the consumers’ decision process uses a composite demand equation for total alcohol as a function of price, income and other variables, \(Z\).

![Equation (1)](\begin{align*}
\ln \frac{M}{P} &= \delta_0 + \phi_1 \ln P + \phi_2 \ln Y + \phi_3 \ln Z + \epsilon \\
\end{align*})

where \(M = p_b q_b + p_w q_w + p_s q_s\) is total expenditure on beer, wine and spirits. 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.

![Equation (2)](\begin{align*}
\ln P &= \sum_i w_i \ln p_i \\
\end{align*})

![Equation (3)](\begin{align*}
w_i &= \frac{p_i q_i}{M}, \quad i = b, w, s \\
\end{align*})

The dependent variable, \(M/P\), is a composite index of real alcohol consumption. An alternative would be to compute a direct measure of total alcohol consumption from the quantities of beer, spirits and wine, weighting each by their respective alcohol content. In practice, the two measures are almost identical: The correlation between the composite index and the direct measure of alcohol consumption is .999.

We interpret equation (1) as a demand function for alcohol. One econometric problem associated with estimation of (1) is that price may be endogenous or measured with error. 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.\(^8\) 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.

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 (1993): The (logarithm of) price is first regressed on all the other right hand side variables and a set of instrumental variables. We use state and Federal excise taxes and markups as instrumental variables. Composite demand is then re-estimated with the residual from the 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.\(^9\)

**III. Data**

The econometric analysis uses annual data for 49 states (excluding Hawaii, because price data are not available) and the District of Columbia over the time period 1982 - 1997. Data for consumption of beer, wine, and spirits are from the Brewers Almanac. They are computed as shipments of beer, wine, and spirits divided by the total population. Quantities of beer, wine and spirits are multiplied by

\(^8\) See Greene (2000) Section 9.5.2.

\(^9\) The test relies on the assumption that taxes are exogenous. In fact, taxes may also reflect (unmeasured) sentiment toward alcohol and therefore be correlated with the disturbance in equation (2), thereby rendering the test invalid. However, no clearly superior alternative exists.
their average alcohol content (respectively, 4.5%, 11%, and 40%) and expressed as gallons of pure ethanol per capita. As Table 1 indicates, beer accounts for 55% of total alcohol consumption, wine 11%, and spirits 34%.

Beverage prices are from the American Chamber of Commerce Researchers Association (ACCRA), which gathers price data for its quarterly survey of the cost of living in various cities around the U.S. The surveys report retail prices, exclusive of sales taxes, for specific beverages.\(^\text{10}\) Annual, state level data are calculated by averaging the quarterly figures from one or more cities within each state.\(^\text{11}\) We modify the state average prices in three ways. First, the prices are expressed per gallon of pure ethanol, in the same manner as consumption. Second, the state average prices are divided by the ACCRA cost of living index for each state, so that the resulting series measures the price of alcohol relative to other goods.\(^\text{12}\) Thirdly, prices have been converted to fourth quarter 1997 dollars using the consumer price index for all urban consumers. In these data, wine has the lowest price per unit of alcohol and spirits the highest, but this is partly a function of the specific beverages whose prices are tracked by ACCRA.\(^\text{13}\)

Data on state beer, wine, and spirits taxes are from the Distilled Spirits Council of the United

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\(^\text{10}\) Currently the beverages are a six pack of Budweiser or Miller-Lite in 12 oz. containers, a 750 ml bottle of J&B Scotch, and a 1.5 liter bottle of Gallo or Livingston Cellars Chablis. However, the beverage definitions have changed over time. See Young and Bielinska-Kwapisz (2001) for details.

\(^\text{11}\) There are significant gaps in the data for various states in various years, reducing the sample size to 761.

\(^\text{12}\) We use the ACCRA COLI excluding housing. In earlier work we found that the ACCRA COLI including housing is sensitive to exactly which cities are included in any particular sample. Excluding housing the series is much more consistent over time.

\(^\text{13}\) J&B Scotch is a fairly high quality spirits beverage, while Gallo Sauvignon Blanc is not of the same standing among wines. CPI data - based on “all malt beverages” for beer, vodka for spirits, and “table” wine - reverse the ordering: Spirits are the cheapest, then beer, and finally wine.
States (1999). Federal excise tax data come from the US Bureau of Alcohol, Tobacco, and Firearms. Federal excise taxes have been added to the state taxes, and total taxes are adjusted for alcohol content, the state cost of living, and national inflation in exactly the same manner as the price data. As Table 1 indicates, combined state and Federal excise taxes on beer and wine average about 10 percent of beverage prices, while excise taxes on spirits average about 16 percent of price.

“Control” states may levy percentage markups or excise taxes based on value instead of or in addition to per unit excise taxes. Data on these taxes are included as well for the states and years in which they occur.

Income is measured as per capita personal income, deflated by the state COLI and the national CPI. Two variables, the percent of population aged 18-29 and percent of population over age 65, control for the life cycle pattern of alcohol consumption. The legal drinking age for beer increased from 18 in some states to 21 in all states during the sample period, and previous research concluded that youth drinking declined (Coate and Grossman, 1988). Whether there is a measurable impact on total consumption remains to be seen. Religious variables and the percentage of population residing in dry counties for beer capture sentiments toward drinking. The percentages of Catholic, Mormon, Southern Baptist, and (any) Other Religion were linearly interpolated and extrapolated from 1980 and 1990 data from the National Council of Churches (Bradley et al. (1990), Quinn et al. (1980)). Tourism is also related to alcohol consumption. It is measured by the percentage of hotel and lodging value

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14 http://www.atf.treasury.gov/alcohol/stats/historical.htm

Johnson and Oksanen (1977) also found that income had little or no effect on the demand for alcohol. One explanation is that increases in income may primarily affect the quality of the beverages consumed, rather than the alcohol content.

III. Findings

Estimates of equation (1), the composite demand for alcohol, are presented in Table 2. The first column presents ordinary least squares estimates, with state dummy variables excluded. The estimated price elasticity of demand is -.345 and significantly different from zero. However, measurement error and/or endogeneity, if present, are likely to bias the estimated coefficient toward zero. As indicated in the first row of Table 3, a Hausman test strongly rejects exogeneity in favor of endogeneity and/or measurement error.

Column 2 of Table 2 presents two stage least squares estimates of the composite demand, using the tax variables as instruments for the price variable. As expected, the estimated price elasticity of demand is larger than in column 1: A one percent increase in alcohol prices is estimated to reduce consumption by 1.24 percent.

Most of the other coefficient estimates also conform to theoretical expectations. The estimated income elasticity is positive, although only about .1.\textsuperscript{16} A one percent increase in the population aged 18-29 is estimated to increase per capita alcohol consumption by about 3 percent. A one percent increase in the population over age 65 is estimated to reduce consumption by about one-half of one percent, and increasing the legal drinking age by one year is estimated to reduce consumption by one percent, although neither of these estimates is statistically significant. The population in dry counties and the

\textsuperscript{16}Johnson and Oksanen (1977) also found that income had little or no effect on the demand for alcohol. One explanation is that increases in income may primarily affect the quality of the beverages consumed, rather than the alcohol content.
religion variables are each negatively and significantly related to consumption. The largest effect comes from Mormonism: A one percent increase in the population that is Mormon is estimated to reduce alcohol consumption by one percent. Finally, tourism has a significant and large relationship with consumption - an increase of one percent in the hotel and lodging share of Gross State Product is associated with an increase of 4.5 percent in alcohol consumption.\(^17\)

Column 3 of Table 2 displays OLS estimates of the composite demand for alcohol when state-specific dummy variables are included. As expected, the R-squared increases markedly, but the estimated price elasticity is small in magnitude and not statistically different from zero. We again perform the Hausman test for endogeneity/measurement error, this time including the state dummies among the instruments. As indicated in row 2 of Table 3, the null hypothesis of exogeneity is even more strongly rejected, implying that the OLS estimates are biased and inconsistent.

The fourth column of Table 1 presents two stage least squares estimates with the state dummies included. The estimated price elasticity is statistically significant and again much larger in absolute value than using OLS: A one percent increase in the price of alcohol is estimated to reduce consumption by about three-fourths of one percent.

The estimated coefficients of some of the control variables, however, display unexpected signs when state dummies are included. Income and population age 18-25 still have statistically significant and positive effects on consumption, and Other Religion has a significant negative effect. But population over age 65, Catholic, and Southern Baptist now have significant positive associations with alcohol consumption.

\(^{17}\) The two “states” with the highest alcohol consumption are Washington DC and Nevada, both of which have large tourism industries.
consumption. The legal drinking age and tourism have also changed signs, and Mormonism is smaller in magnitude and statistically insignificant.

There is a simple explanation for these sign reversals and general lack of significance: With state-specific dummy variables included, parameter estimates are based solely on the variation within states over time - the variation across states is entirely absorbed in the coefficients of the state dummies.\(^{18}\) Apparently, there is insufficient within state variation in the control variables to provide reliable estimates.

The last column of Table 2 therefore displays estimates of the composite demand with only price, income, and the state and time dummies included. The adjusted R-squared falls by only .01, confirming that the excluded control variables are not important when state dummies are included. The estimated price elasticity continues to be statistically significant with a magnitude of about minus one-half.

In 1991 the federal government raised excise taxes on alcohol. The beer tax was doubled from $9 to $18 per barrel, the spirits tax was increased from $10 to $10.80 per 80 proof gallon, and the wine tax was increased from $0.17 to $1.07 per wine gallon.\(^{19}\) We now calculate the estimated effects of the tax changes on total alcohol consumption. The calculation involves several steps: Recently, Young and Bielinska-Kwapisz (2001) investigated the relationship between alcohol taxes and prices

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\(^{18}\) More precisely, with year dummies also included, estimates are based solely on the variation within states over time that is distinct from national trends.

\(^{19}\) This was the first excise tax rate increase since 1951 for beer and wine. The spirits excise tax was $8.40 from 1951-1984, $8.80 in 1985, and $10 from 1986-1990 per 80 proof gallon. The relatively small increase for spirits had the effect of more nearly equalizing the tax per unit of pure ethanol.
and found significant over-shifting of alcohol taxes. Specifically, beer prices rise $1.71 for each dollar increase in the beer tax, spirits prices rise $1.60 for each $1 increase in spirits taxes, and wine prices rise $1.24 for a $1 increase in wine taxes. Converting all values to the 1997 dollars per gallon of pure ethanol used in this study, and evaluating percentage changes at the means of the data, the estimated effect was to increase the price of beer by 7.4%, spirits by 1.6%, and wine by 8.3%. The composite price index for pure ethanol rose by 5.0%. Based on the range of price elasticities of demand presented in this paper, total alcohol consumption is estimated to have declined by between 2.5 and 6 percent.

IV. Summary and Conclusions

We have estimated the demand for alcohol using data pooled across U.S. states and over time. We tested for and confirmed the presence of measurement error and/or endogeneity in the price data. Using state and Federal tax rates as instrumental variables, we found that two stage least squares estimates of the demand for alcohol yield significantly larger estimates of the response to price than do ordinary least squares estimates.

Estimates are also sensitive to whether or not state-specific dummy variables are included in the demand equations. When state effects are included, the variation in alcohol consumption and other variables is substantially reduced, and estimated price elasticities are smaller in absolute value. Excluding state effects, however, runs the risk of biased estimates stemming from omitted variables that are correlated with both price and consumption.

Estimates of the price elasticity of demand range from about minus one-half to minus 1.2, which is consistent with previous studies using aggregate data (Manning et al. 1995). The larger response to price is estimated when state dummy variables are excluded, and thus may be biased upward in
Further research is desired on the problems taken up in this paper. One extension is to allow for habit formation and/or “rational addiction” using Becker and Murphy’s (1988) framework (Grossman et al., 1998). More generally, the time series properties of consumption have been entirely ignored in this paper. Nor have we considered cross-border sales which may be induced by interstate price differentials (Beard et al., 1997). Another approach is to estimate disaggregated demands for beer, wine and spirits, in order to assess substitution effects. The 1991 Federal tax increases, for example, altered relative prices, and therefore are likely to have induced substitution among beverage types. Applications to micro data - for example, distinguishing moderate and “binge” drinking - are also possible (Manning, et al., 1995). The main point of this paper is that in any application using the ACCRA data, the problems of measurement error and endogeneity must and can be confronted using state and Federal taxes as instruments.
Table 1. Variables definitions and descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>bcon</td>
<td>Per capita consumption of malt beverages (gallons of pure alcohol)</td>
<td>1.06</td>
<td>.18</td>
<td>.57</td>
<td>1.82</td>
<td>800</td>
</tr>
<tr>
<td>wcon</td>
<td>Per capita consumption of wine (gallons of pure alcohol)</td>
<td>.21</td>
<td>.12</td>
<td>.05</td>
<td>.79</td>
<td>800</td>
</tr>
<tr>
<td>scon</td>
<td>Per capita consumption of distilled spirits (gallons of pure alcohol)</td>
<td>.65</td>
<td>.29</td>
<td>.28</td>
<td>2.28</td>
<td>800</td>
</tr>
<tr>
<td>bprice</td>
<td>Real beer price in 1997 dollars per gallon of alcohol, divided by state COLI</td>
<td>176.8</td>
<td>14.9</td>
<td>138.9</td>
<td>224.8</td>
<td>761</td>
</tr>
<tr>
<td>wprice</td>
<td>Real wine price in 1997 dollars per gallon of alcohol, divided by state COLI</td>
<td>143.3</td>
<td>21.6</td>
<td>82.1</td>
<td>222.9</td>
<td>761</td>
</tr>
<tr>
<td>sprice</td>
<td>Real spirits price in 1997 dollars per gallon of alcohol, divided by state COLI</td>
<td>242.9</td>
<td>25.6</td>
<td>166.4</td>
<td>323.7</td>
<td>761</td>
</tr>
<tr>
<td>btaxex</td>
<td>Sum of Federal and state excise taxes on beer, in 1997 dollars per gallon of alcohol, divided by state COLI</td>
<td>17.90</td>
<td>6.35</td>
<td>7.98</td>
<td>49.35</td>
<td>761</td>
</tr>
<tr>
<td>wtaxex</td>
<td>Sum of Federal and state excise taxes on wine, in 1997 dollars per gallon of alcohol, divided by state COLI</td>
<td>13.14</td>
<td>6.88</td>
<td>1.69</td>
<td>34.73</td>
<td>761</td>
</tr>
<tr>
<td>wtaxp</td>
<td>State percentage tax on wine</td>
<td>9.23</td>
<td>8.14</td>
<td>3.00</td>
<td>35.00</td>
<td>50</td>
</tr>
<tr>
<td>wmarkup</td>
<td>State markup on wine (%)</td>
<td>41.23</td>
<td>20.10</td>
<td>17.60</td>
<td>84.17</td>
<td>94</td>
</tr>
<tr>
<td>staxex</td>
<td>Sum of Federal and state excise taxes on spirits, in 1997 dollars per gallon of alcohol, divided by state COLI</td>
<td>39.49</td>
<td>7.07</td>
<td>25.16</td>
<td>63.55</td>
<td>761</td>
</tr>
<tr>
<td>staxp</td>
<td>State percentage tax on spirits</td>
<td>21.05</td>
<td>13.23</td>
<td>2.08</td>
<td>56.00</td>
<td>148</td>
</tr>
<tr>
<td>smarkup</td>
<td>State markup on spirits (%)</td>
<td>48.87</td>
<td>23.27</td>
<td>17.00</td>
<td>113.00</td>
<td>278</td>
</tr>
<tr>
<td>income</td>
<td>Per capita personal income in thousands of 1997 dollars, divided by the state COLI</td>
<td>21.63</td>
<td>3.09</td>
<td>13.87</td>
<td>32.06</td>
<td>761</td>
</tr>
<tr>
<td>Pop 18-29</td>
<td>Percent of population aged 18-19</td>
<td>19.11</td>
<td>2.31</td>
<td>14.25</td>
<td>26.11</td>
<td>800</td>
</tr>
<tr>
<td>Pop &gt; 65</td>
<td>Percent of population aged $ 65</td>
<td>12.26</td>
<td>2.16</td>
<td>2.96</td>
<td>18.56</td>
<td>800</td>
</tr>
</tbody>
</table>
Table 1. Variables definitions and descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Min</th>
<th>Max</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry</td>
<td>Percent of population residing in dry counties</td>
<td>4.19</td>
<td>9.63</td>
<td>0.00</td>
<td>46.36</td>
<td>800</td>
</tr>
<tr>
<td>Drink Age</td>
<td>Minimum legal age for purchase and consumption of beer &gt; 3.2%</td>
<td>20.69</td>
<td>.79</td>
<td>18.00</td>
<td>21.00</td>
<td>800</td>
</tr>
<tr>
<td>Cath</td>
<td>Percent of population that is Catholic</td>
<td>18.72</td>
<td>13.26</td>
<td>1.74</td>
<td>63.58</td>
<td>800</td>
</tr>
<tr>
<td>Mormon</td>
<td>Percent of population that is Mormon</td>
<td>3.10</td>
<td>10.59</td>
<td>.02</td>
<td>74.88</td>
<td>800</td>
</tr>
<tr>
<td>SBaptist</td>
<td>Percent of population that is Southern Baptist</td>
<td>7.66</td>
<td>10.43</td>
<td>.04</td>
<td>36.32</td>
<td>800</td>
</tr>
<tr>
<td>OtherRel</td>
<td>Percent of the population that is a member of any other religion</td>
<td>54.90</td>
<td>12.96</td>
<td>29.47</td>
<td>83.02</td>
<td>800</td>
</tr>
<tr>
<td>Tourism</td>
<td>Percent of GSP from hotels and lodging</td>
<td>1.01</td>
<td>1.92</td>
<td>.26</td>
<td>15.47</td>
<td>800</td>
</tr>
</tbody>
</table>
### Table 2. Composite Demand for Alcohol

Dependent Variable: Alcohol Consumption Index ln (M/P)  
(T-statistics below parameter estimates)

<table>
<thead>
<tr>
<th>Estimation Method</th>
<th>OLS</th>
<th>2SLS</th>
<th>OLS</th>
<th>2SLS</th>
<th>2SLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>State Dummies Included?</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ln (Alcohol Price)</td>
<td>-.345</td>
<td>-1.24</td>
<td>-.055</td>
<td>-.750</td>
<td>-.530</td>
</tr>
<tr>
<td>ln (Income per Capita)</td>
<td>.103</td>
<td>.138</td>
<td>.497</td>
<td>.764</td>
<td>.663</td>
</tr>
<tr>
<td>Pop Age 18-29 (%)</td>
<td>.049</td>
<td>.031</td>
<td>.022</td>
<td>.014</td>
<td></td>
</tr>
<tr>
<td>Pop Age &gt; 65 (%)</td>
<td>-.004</td>
<td>-.005</td>
<td>.018</td>
<td>.034</td>
<td></td>
</tr>
<tr>
<td>Legal Drinking Age</td>
<td>-.010</td>
<td>-.010</td>
<td>.003</td>
<td>.004</td>
<td></td>
</tr>
<tr>
<td>Pop in Dry Counties (%)</td>
<td>-.003</td>
<td>-.002</td>
<td>.001</td>
<td>-.001</td>
<td></td>
</tr>
<tr>
<td>Catholic (%)</td>
<td>-.000</td>
<td>-.001</td>
<td>.002</td>
<td>.011</td>
<td></td>
</tr>
<tr>
<td>Mormon (%)</td>
<td>-.012</td>
<td>-.010</td>
<td>-.016</td>
<td>-.004</td>
<td></td>
</tr>
<tr>
<td>Southern Baptist (%)</td>
<td>-.006</td>
<td>-.004</td>
<td>.036</td>
<td>.044</td>
<td></td>
</tr>
<tr>
<td>Other Religion (%)</td>
<td>-.006</td>
<td>-.004</td>
<td>-.005</td>
<td>-.008</td>
<td></td>
</tr>
<tr>
<td>Tourism (%)</td>
<td>.047</td>
<td>.045</td>
<td>-.020</td>
<td>-.014</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>1.68</td>
<td>6.49</td>
<td>-2.58</td>
<td>.066</td>
<td>1.11</td>
</tr>
<tr>
<td>Adjusted R(^2)</td>
<td>.67</td>
<td>.62</td>
<td>.98</td>
<td>.97</td>
<td>.96</td>
</tr>
</tbody>
</table>

Notes: Year dummies for 1982-96 are included in every equation; the base year is 1997. When state dummies are included, the base state is Alabama. Instruments for the 2SLS estimates include the 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 is treated as endogenous. N=761. Mean of the dependent variable = 0.601.
Table 3. Tests for Endogeneity and/or Measurement Error in Prices

<table>
<thead>
<tr>
<th>State Dummies Included?</th>
<th>F-value</th>
<th>Significance Level</th>
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</thead>
<tbody>
<tr>
<td>No</td>
<td>13.5</td>
<td>.0003</td>
</tr>
<tr>
<td>Yes</td>
<td>46.7</td>
<td>.0000</td>
</tr>
</tbody>
</table>
REFERENCES

American Chamber of Commerce Researchers Association (ACCRA). 1982-97. ACCRA cost of living index, quarterly reports. Louisville, KY.


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


