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SLIPPERY WHEN WET: THE EFFECTS OF LOCAL ALCOHOL ACCESS LAWS ON HIGHWAY SAFETY

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Abstract

This paper examines 237 instances of policy changes related to alcohol sales and consumption enacted in Texas communities between 1975 and 1996 to determine their effect on the incidence of alcohol-related motor vehicle accidents. These policies are categorized by location where the alcohol is consumed after sale (on the premises or off) and the type of alcohol available for consumption (beer and wine or hard liquor). After controlling for both county and year fixed effects, we find evidence that: (i) the sale of alcohol for consumption on the premises (in bars and restaurants) is associated with a sizeable increase in alcohol-related motor vehicle accidents, (ii) the sale of alcohol (in liquor stores) for consumption off the premises may actually decrease expected accidents, and (iii) the sale of higher proof alcohol (hard liquor) presents greater risk to highway safety.

> **"**Why should I drive 20 miles out of my way to Florence to buy a reasonable priced bottle of wine for dinner guests?' (Dara Florek, resident of Grant County) asked, contending that the nearest liquor stores in Kenton County, a wet oasis to the north, were not only fueling Grant County's rate of drunken driving but price gouging as well…drunk driving rates were higher in Grant County than in three neighboring wet counties."
>
> ["Woman Forces Area to Vote on Wet-or-Dry Issue"
> July 20, 2000, *The New York Times*]

I. Introduction

In the past 30 years, a major goal of public policy in the United States has been to reduce the health and safety risks associated with alcohol abuse. Among these risks, motor vehicle accidents caused by drunk driving are the subject of particularly intense scrutiny. A number of policies exist that are designed to restrict the consumption of alcohol. Some, such as the minimum legal drinking age (MLDA) and drunk driving laws,[1] have become noticeably more stringent in the past 20 years, and a number of empirical studies (Dee 1999; Ruhm 1996; Figlio 1995; Saffer and Grossman 1987b) conclude that these law changes reduced alcohol-related accident rates.

Curiously, at the same time that these laws were being tightened, alcohol control policies at city and county levels were relaxed in many parts of the country. Because they generally increase the availability of alcohol, one might expect these types of policy changes to increase the number of alcohol-related motor vehicle accidents. However, these law changes not only increase availability but also reduce the travel distance required to obtain the alcohol, changed where the alcohol is consumed and/or changed the type of alcohol consumed. The overall effect of local alcohol access policies is ambiguous.

This paper attempts to resolve the ambiguity using detailed information on 237 alcohol policy changes in the state of Texas, between 1975 and 1996. The changes that occurred in local jurisdictions of Texas vary in terms of where alcohol may be consumed (on- or off-premise) and what type of alcohol (beer, wine or hard alcohol) may be purchased. While the existing literature focuses on whether local jurisdictions are wet (that is, allows any sales of alcohol) or dry, we exploit the details. In particular, we evaluate whether the effects of local access laws vary by the type of restrictions. Allowing for heterogeneity in the effect of access policies seems essential. Arguably, the effect of on-premise consumption will differ from off-premise consumption. Likewise, the effects of legalizing the sale of beer and wine may differ from legalizing the sale of hard alcohol. Certainly, the federal excise tax system distinguishes among liquor with different alcohol content by taxing $0.58 per gallon for beer, $1.07 per gallon for wine, and $13.50 per proof gallon for distilled spirits (ATF 2000). Many states, including Illinois, New York, and California, also have differential excise tax rates on liquor based upon its percentage alcohol content.

A primary concern in evaluating the effects of local access laws on highway safety is that local regulations are not randomly selected. To the contrary, local regulations are likely to be endogenously determined. Using the panel nature of the data, we explicitly account for nonrandom selection of local alcohol access laws. In particular, the basic specification includes both county and time fixed effects. Thus, the model is identified if the unobserved factors influencing the local regulations are either county or time specific. If, however, there are time-varying country specific factors that influence local access, the simple fixed effect model may not be identified. To evaluate this possibility, we estimate a model using several instrumental

variables. In particular, we assume that variation in oil, gas, coal, and petroleum production all affect a county's decision to become wet or remain dry, but do not directly affect highway safety.

Using the fixed effects model, we find that the effect of increasing the availability of alcoholic beverages on the number of alcohol-related motor vehicle accidents is heterogeneous, depending both on the type of alcohol and on whether the alcohol is consumed off-premise or on-premise. The sale of higher alcohol-content liquor presents somewhat greater risk to highway safety than the sale of beer or wine. However, the most striking result is in regards to on- and off-premise restrictions. While allowing bars and restaurants to serve mixed beverages substantially increases the expected number of alcohol-related accidents, allowing liquor stores does not appreciably change the number of alcohol-related accidents. In fact, our results suggest that off-premise policies may actually decrease the number of alcohol-related accidents. Apparently, the type of local regulation influence both the magnitude and the sign of the effect of local access laws on highway safety.

Section two reviews the existing literature on alcohol policy and highway safety outcomes. In the third and fourth sections, we describe the analytical framework and the unique data set being used. The fifth section presents results of our estimation and, finally, we conclude by discussing these results, how they relate to past findings, and their implications for future policy.

II. Previous Research

A first set of studies evaluating the effects of alcohol policies on highway safety use ordinary least squares regression and find large and statistically significant effects of alcohol policy instruments on motor vehicle fatalities. These studies consistently find a strong

association with highway safety and alcohol control policies.[2] States and local government that control access and restrict behavior have much lower fatality rates that those with more liberal policies. Of course, assessing the effects of alcohol control policies on highway safety is complicated by the potential interrelationship between these behaviors. These estimates will be biased if a state or county's alcohol policy is positively correlated with unobservable or uncontrolled factors (i.e., cultural values, urbanicity) that also influence its traffic fatality rate.

To this end, a literature has begun to focus on ways to control for the non-random selection of the liquor laws. Several studies (e.g., Ruhm 1996; Dee 1999) perform a national-level panel analyses that include state fixed effects to control for correlation between states' unobservable characteristics that are fixed over time and their alcohol policies. Others studies (e.g., Saffer and Grossman 1987a; Brown, Jewell, and Richer 1996) exploit instrumental variables, such as local tourism revenue, which are assumed to exogenously affect state/local restrictions but do not affect the outcome of interest, namely highway safety. This recent literature has reached consensus that the nonrandom selection plays in important role. In particular, the standard cross-section estimates substantially overstate the benefits of alcohol control policies.

There is somewhat less consensus about the effects of legal restrictions. Different policies appear to have different affects. Using data from 1982 to 1988, Ruhm (1996) does not find a significant effect of the percentage of state residents in dry counties on traffic fatalities, although other policies have statistically significant effects on highway fatalities.[3] Dee's (1999) national panel analysis demonstrates that controlling for state fixed effects can change the estimated impact of policy on accident rates. He concludes that estimates of the effect of beer taxes on traffic accidents have been overstated in previous studies as the result of not including

state fixed effects. Saffer and Grossman (1987a) find state minimum drinking laws have significant effects on highway safety, while Brown, Jewell and Richer (1996) find that the county access laws have a significant effect on highway fatalities and accidents.

Focusing on county access laws in Texas, the study by Brown, Jewell and Richer (1996) is perhaps the most relevant study for our application. They effectively use a single cross section of data to evaluate whether allowing for the sale of alcoholic beverages affects highway safety. They do not exploit the panel data, nor do they allow for the effects of local access laws to vary by the type of restriction. These shortcomings are likely to bias their estimates. Without a county fixed effect, local tourism revenue will not be a valid instrument if unobserved determinants of local tourism revenue are also related to the unobserved factors influencing highway safety. Aggregating the various types of access laws into a single category—wet—may miss important variation in the effects of control polices. Allowing on-premise consumption is not the same as allowing off-premise consumption, yet this restriction is implicit in their work.

Our empirical work makes several improvements to the existing literature. First, we explicitly model the variation in access law, so that the effects off-premise and on-premise restrictions can differ as well as the effects of allowing beer and wine versus hard alcohol. Second, when considering less restrictive policies and policies that change an area from dry to wet, we include instruments for the possible endogeneity of the alcohol policy as well as exploit the panel data by accounting for fixed county and time effects. With country fixed effects, our instruments do not have to be orthogonal to the unobserved factors influencing highway safety. Rather, we only need to assume that changes in the factors influencing our instruments are unrelated to changes in highway safety. This is a much less restrictive assumption than imposed in past research.

III. Analytical Framework

The number of alcohol-related driving accidents is directly related to the number of miles driven under the influence of alcohol, which depends on: (i) the amount of alcohol consumed; (ii) the travel distance required to obtain the alcohol; (iii) where the alcohol is consumed; and (iv) what type of alcohol is consumed.

The policy changes in local jurisdictions of Texas varied along two dimensions: type of alcohol that can be consumed (beer, wine, and/or hard liquor) and where the alcohol can be consumed (on-premise in bars and restaurants and/or off-premise sold in liquor stores). While almost all of the policy changes decreased the cost of obtaining alcohol and are likely to increase the consumption of alcohol, this does not necessarily imply an increase in the number of alcohol-related driving accidents. Increasing the local availability of alcohol, for instance, may result in people drinking more, but driving shorter distances to obtain alcohol. Which effect dominates with respect to alcohol-related accidents is an empirical question and may depend on the specific type of law change.

Allowing on- and off-premise consumption or only off-premise consumption may have different effects on accident rates. For example, a jurisdiction that only allows off-premise consumption may actually experience a decrease in accidents if individuals are more likely to drink at home after purchasing alcohol from a liquor store, relative to a law that allows on-premise consumption at bars.[4]

The effect on accident rates may also depend on the type of liquor that can be sold. Allowing the sale of beverages with higher alcohol content, for example, may result in higher numbers of accidents relative to allowing the sale of products like beer and wine. This

hypothesis reflects the implicit assumption in federal and some state laws that hard liquor imposes a larger negative externality associated with driving under the influence and is therefore taxed at a higher rate than lower alcohol content beverages.

IV. Data Description

The data are a panel of observations on the 254 Texas counties over the period 1975 to 1996. Along with the local liquor law changes, this panel contains county-level information on alcohol-related accidents, registered vehicles, highway expenditures, police expenditures, religious affiliations, population, per capita income and vehicle miles driven. The data come from the Bureau of Economic Analysis, the Regional Economic Information System, the Texas Alcoholic Beverage Commission, the Texas Department of Public Safety, *Churches and Church Membership in the U.S.*, the Texas Transportation and Planning Division, the Texas Vehicle Titles and Registration Division, and the Texas Department of Public Safety. See Appendix Table 1 for additional details on data sources. The remainder of this section provides a detailed description of the alcohol-related policy changes by local jurisdictions in Texas and descriptive evidence on the number of alcohol-related accidents.

Liquor law referenda can be voted on at the county, justice precinct, city, or town level. Of the 568 local alcohol-related referenda that came up for vote over this 22 year period, 260 passed and were upheld by the courts as legal. We code these votes into four categories: dry, beer and wine[5], liquor sales—off-premise, and liquor sales—on- and off- premise. Seven of the 260 passing votes involve a change within a single category (for example, beer to beer and wine), and 16 were not explicitly identified in the data. Table 1 summarizes the remaining 237 changes. As Panel A shows, the majority of these votes made alcohol sales legal in a previously dry

region. Only one of the votes restricted alcohol availability. The remainder allowed sales of hard liquor in areas that had previously only permitted beer and/or wine sales or allowed on-premise consumption of hard liquor. Panel B breaks down the number of passing referenda by year.

Because referenda may take place on sub-county level, it is possible for policies to vary within a county. The Texas Alcoholic Beverage Commission's Annual Report officially codes county liquor law status each August. The following seven county-level status designations take into account the fact that liquor sales may be legal in either all or part of a county:[6]

- **Dry** – Sales of alcoholic beverages are prohibited everywhere in a county.
- **Beer** – Alcoholic beverages with less than 4 percent alcohol can be purchased in all or part of a county.[7]
- **Beer/Wine** – Alcoholic beverages with less than 14 percent alcohol can be purchased in all or part of a county.
- **Partial Hard Liquor**– Alcoholic beverages with greater than 14 percent alcohol can be purchased in *certain* parts of a county for off-premise consumption only.
- **Hard Liquor**– Alcoholic beverages with greater than 14 percent alcohol can be purchased in *all* parts of a county for off-premise consumption only.
- **Partial Mixed Beverages** – Alcoholic beverages with greater than 14 percent alcohol can be purchased in *certain* parts of a county for on- and off-premise consumption.
- **Mixed Beverages** – Alcoholic beverages with greater than 14 percent alcohol can be purchased in *all* parts of a county for on- and off-premise consumption.

By not differentiating based on geographic area (partial versus entire county) and grouping the statuses in a similar manner as the votes, we condense the seven status categories into four: Dry, Beer/Wine, Liquor Sales for Off-Premise Consumption, and Liquor Sales for On- and Off-Premise Consumption. Panel A of Table 2 describes the changes in county liquor

law status observed between 1975 and 1996. Note that there were many more passing referenda than actual changes in county-level liquor status; many of these referenda simply legalized sales for a town or justice precinct in a county that already allowed sales elsewhere within its borders. Panel B of Table 2 graphs the yearly number of county status changes between 1975 and 1996. The number of dry counties falls during this period, and the largest growth is in the number of counties allowing sales of hard liquor for off-premise consumption only. Corresponding to the pattern of passing referenda, the majority of changes took place before 1985. In total, 87 of the 254 counties in Texas were dry at the start of this period, and 33 of these legalized some type of alcohol sales by 1996. There were 32 other changes observed in which already non-dry counties further relaxed alcohol control policies. Figure 1 depicts the distribution of county status across years.

In addition to the law change data, we also have annual data on the total number of alcohol-related motor vehicle accidents, for each of the 254 counties.[8] Figure 2 depicts the trend in these accidents per capita for counties based on their liquor status. Several state-level changes in the classification of alcohol-related accidents contribute to the volatility in trends.[9] Two things stand out in Figure 2: (i) on average, dry counties have fewer accidents per capita and counties allowing the sale of hard liquor for on- and off-premise consumption have the greatest number of accidents per capita; and (ii) there has been a gradual decrease in the number of accidents per capita beginning in the mid-1980s.

V. Regression Results

Our strategy is to first replicate the earlier research, which pooled all data and classified counties only by wet and dry. We then extend the analysis to exploit the panel data and account for heterogeneity in local access laws.

Replicating Previous Research

The baseline model is a straightforward OLS regression, treating our panel data as a series of pooled cross sections:

$$Y_{it} = \alpha_t + \beta_1 (WET)_{it} + \beta_2 X_{it} + \varepsilon_{it} \qquad (1)$$

where Y_{it} is the observed number of alcohol-related accidents for county *i* in year *t*, *WET* is a dummy variable that equals one if county *i* allows any sales of alcoholic beverages in year *t* and *X* is the observed vector of other county level variables that are likely to influence the number of alcohol-related accidents. These include the number of registered vehicles, highway expenditures, police expenditures, percent of residents that are Catholic, percent of residents that are Baptist, population, per capita income, vehicle miles driven on highways and total vehicle miles driven. See Appendix Table A-1 for descriptive statistics of the variables. Unobserved factors influencing alcohol fatalities are included in ε_{it} For now, assume that ε_{it} is mean independent of the observed variables *X* and *WET*. Finally, the coefficients α_t, β_1, and β_2 are unobserved, with α_t being a year fixed effect.

The first column of Table 3 contains the least-squares estimates from this model. Consistent with previous research (for example, Winn and Giacopassi1993; Brown, Jewell, and Richer 1996), we find that a county being wet has a strong positive effect on the number of alcohol-related accidents observed. Removing prohibition of alcohol sales is associated with an

additional 6.71 accidents per year per county, all else equal. Given the mean number of accidents is 131 per year, this represents a 5 percent increase over the mean. Other county characteristics generally have the expected effect. For example, an additional 100,000 miles driven is associated with 2.57 more accidents per year and a $1 million increase in police spending is associated with 6.03 fewer accidents per year.

To control for unobserved county characteristics that might be fixed over time, yet correlated with both policy and accident rates, we add county fixed effects, C_i, in our next specification:

$$Y_{it} = \alpha_t + C_i + \beta_1 (WET)_{it} + \beta_2 X_{it} + \varepsilon_{it}. \qquad (2)$$

As the second column of Table 3 shows, controlling for county fixed effects reduces the magnitude of being wet to less than a third of what is was without the fixed effects (an increase of 2.12 accidents) and the effect is no longer statistically significant. These results suggest that ignoring these unobservable factors, as some previous studies have done, leads to substantially different results. In the fixed effects model, miles driven, population and police and highway expenditures continue to have statistically and economically significant effects on accidents.

As Table 1 shows, coding only county level changes from wet to dry ignores 32 of the 65 status changes because so many occur from one wet status to another less restrictive status. To capture this variation, we estimate the following regression:

$$Y_{it} = \alpha_t + C_i + \beta_1 (LessRestrictive)_{it} + \beta_2 X_{it} + \varepsilon_{it}. \qquad (3)$$

LessRestrictive is a cumulative (across years) indicator variable that records any change in alcohol policy that is less restrictive than the previous policy. The third column of Table 3 shows that moving to a less restrictive policy is positively correlated with the number of alcohol-related accidents. However, the coefficient is still not statistically different than zero at standard levels.

Using data from the 237 passing *votes* captures, on an even finer level, marginal changes in access to alcoholic beverages within a county and provides more variation in policy. Table 4 presents results for the same set of models run with votes as the independent policy variable of interest. We measure votes as the total cumulative (across years) number of legal and passing referenda that changed a region within a county from dry to wet. In the single case where a vote results in a change from wet to dry, we code a decrease in the number of votes. The first column of Table 4 shows that, ignoring county-level fixed effects, the coefficient on the vote variable is negative (-0.305) and statistically significant (s.e.=1.23). Based on the results without fixed effects in Table 3 (column 1), we expect this negative coefficient: most of the counties that actually had no or few votes were wet since 1975 and those counties have more alcohol-related accidents than the other counties.

When we control for county fixed effects and look at within county changes, shown in column 2 of Table 4, the effect of a vote from dry to wet is an increase of 7.38 alcohol-related accidents. This coefficient is statistically significant (s.e.=1.78) at the 1 percent level. In column 3 we recode the policy variable to reflect any votes that made the alcohol policy less restrictive. This specification accounts for the 27 cases where the votes further relaxed the restrictions on alcohol sales in wet counties. Like the results in column 2, we find that relaxing restrictions on alcohol within a county are correlated with statistically and economically significant increases (coefficient = 7.85, s.e. =1.68) in alcohol-related accidents.

Our results thus far indicate that controlling for fixed effects changes the estimated effects. However, like the previous research, relaxing restrictions on alcohol policy appears to substantially increase alcohol-related accidents.

Time Varying Endogeniety

A potential criticism of the results in Table 4 is that our estimates of the effect of alcohol control policy change are biased because they are endogenously determined with highway safety outcomes. For example, perhaps votes to loosen alcohol restrictions only occur when accident rates are low. In addition, if unobservable county characteristics (such as cultural values) vary over time, then a fixed effects estimator does not remove the bias in our estimates.

To address this issue, we combine the fixed effects model with instrumental variables measuring annual oil, coal and petroleum production for each county in each year. Oil booms represent large exogenous shocks to the local economy based on the size of the county's oil reserves, and thus are ideal instruments (Black, McKinnish, and Sanders 1999). In the first stage of this analysis we predict which counties have a passing vote from dry to wet (column 1 of Table 5) or a passing vote to a less restrictive policy (column 3 of Table 5) using the three instrumental variables. We use the predicted value in the second stage regression. In both Columns 1 and 3, the oil and gas production coefficient and the petroleum coefficient are statistically significant in the first stage predicting equation. As columns 2 and 4 of Table 5 show, we find that a passing vote from dry to wet or to a less restrictive policy has positive, but economically small (coefficient = 0.158 and coefficient = 0.376) and statistically insignificant (s.e. = 0.870 and s.e. = 0.817) effects on alcohol-related accidents. These results suggest that the coefficient estimates associated with liquor law policy in Tables 3 and 4 are biased upward.

Variation in Access Policies

In our conceptual framework we argued that moving to a less restrictive policy does not imply an increase in accidents. Thus far, the analysis suggests that access does, in fact, increase accidents. Yet, we have not exploited the variation in policy. In particular, changes in on-

premise versus off-premise consumption may have differential effects on accidents. In addition, different types of alcohol may have differential effects on alcohol-related accidents. The previous models impose the restriction that all access laws have the same affect on highway safety. To test these hypotheses, we include dummies for the specific type of passing vote as independent variables. We continue to control for fixed time and county effects so our results can be interpreted as within county changes.[10]

In fact, we find evidence that alcohol-related accidents may actually decline if counties allow alcohol for consumption in their homes, or more generally, off-premise. As Table 6 shows, a within county vote from dry to beer and wine (primarily off-premise) is negatively correlated with accidents (coefficient=-6.19) and statistically significant (s.e.=3.72) at the 10 percent level. The coefficient (-1.59, s.e. = 3.49) on votes from dry to alcohol off-premise is also negative, although we cannot reject the hypothesis that switching from dry to alcohol off-premise has no effect on alcohol-related accidents at standard significance levels.

Economically, these coefficients also suggest that allowing beer and wine is not the same as allowing alcohol. The absolute value of the coefficient on dry to alcohol off-premise is approximately one-fourth the coefficient on dry to beer and wine, although at standard significance levels, we cannot reject that these coefficients are statistically different ($F[1,5298]=0.73$).

In contrast to the negative coefficients on the votes to off-premise consumption, the coefficient estimates on a vote from dry to alcohol on- and off-premise (coefficient = 32.00, s.e. = 3.94) and on a vote from alcohol off-premise to alcohol on- and off-premise (coefficient = 39.97, s.e. = 9.26), suggest that allowing on-premise consumption results in more frequent drinking and driving, despite not having to drive as far to drink on-premise. We cannot

reject that these two effects are statistically different from one another (F[1,5298]=0.59). However, we can reject that they are statistically different from the effect of the votes from dry to beer and wine (F[1,5298]=39.26 and F[1,5298]=21.99) and dry to off-premise alcohol (F[1,5298]=38.26 and F[1,5298]=17.64), implying that where the alcohol can be consumed influences the overall effect on accident rates.

One counterintuitive finding is that votes from beer and wine to alcohol off- and on-premise are associated with declines (coefficient = -21.76, s.e. = 10.82) in alcohol-related accidents at economically and statistically significant levels. This appears inconsistent with our other findings that allowing hard alcohol on- and off-premise increases accidents. This negative coefficient might reflect the fact that private clubs, which are allowed to serve mixed beverages, are more common in rural areas of Texas. The average county population where the 11 votes from beer/wine to alcohol on- and off-premise occurred was 660,000 at the times of the elections. The average county population where the 71 votes, from dry to alcohol on- and off-premise or from alcohol off-premise to alcohol on- and off-premise, occurred was 2,550,000 at the times of the elections. Therefore, these rural areas that change from beer/wine to alcohol for off- and on-premise consumption may actually only be moving from private clubs to bars. The negative coefficient may simply suggest that the number of miles driven under the influence of alcohol is likely to be greater when private clubs exist in the area rather than bars.[11]

VI. Conclusion

Our empirical analysis differs from the existing empirical literature by classifying alcohol policy in greater detail than simply wet and dry. Our data allow us to discriminate among policies that change where the alcohol may be consumed and what type of alcohol may be

consumed. We make two main conclusions. First, the sales of alcohol for on-premise consumption is associated with a sizeable increase in alcohol-related motor vehicle accidents while the sale for off-premise consumption may actually decrease expected accidents. Second, the sale of higher alcohol-content liquor presents greater risk to highway safety. These results suggest that it may be appropriate to differentiate between types of liquor sales, such as the federal excise tax does, when designing policies to improve highway safety outcomes.

Endnotes

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1. Examples include what blood alcohol level defines DUI and DWI, open container laws, and mandatory sentencing guidelines.

2. Exploiting policy variation among U.S. states Saffer and Grossman (1987b) and Saffer, Grossman, and Chaloupka (1993) estimate a large and significant reduction in highway mortality rates associated with a broad set of state-level alcohol control policies, including a number of laws relating to drunk driving. At the intra-state level, Winn and Giacopassi (1993), find that counties in Kentucky that prohibit alcohol sales have substantially fewer fatal accidents than those that allow sales at one or more locations within the county.

3. Ruhm also finds that laws that hold restaurant and bar owners responsible for the actions of patrons and laws that suspend or revoke and individual's license after a DUI arrest are statistically correlated with highway fatalities. A higher minimum legal drinking age reduces highway fatalities, but only among the aged 18 to 20 population. Beer taxes have a much broader impact.

4. This could be especially important under Texas' open container law which stipulates that, although drivers cannot, passengers in an automobile can have an open container of alcohol.

5. Discussions with the Texas Alcohol and Beverage Commission and a review of the revenue obtained from different establishments that sell beer and/or wine suggests that the majority involve off-premise consumption only. We group the sale of beer and the sale of beer and wine for off- and/or on- premise consumption into one classification. We do this because the majority of these changes involve the off-premise consumption of beer, we do not expect the effect on alcohol-related accidents to vary substantially across these groupings and, in some cases, we cannot identify whether consumption occurs off- and/or on-premise.

6. A county's liquor law status does not account for the existence of private clubs (including the VFW, American Legion and other fraternal organizations) that may serve alcohol,

because clubs are not considered retail locations. An otherwise dry county that allows clubs to serve beer, wine and mixed beverages is still classified as "Dry." A county classified as serving beer and wine may also have private clubs that serve mixed beverages.

7. The Beer and Beer/Wine classifications do not distinguish between on- and off-premise consumption.

8. All accidents are classified as fatal, injury and non-injury. Analysis on fatal accidents is qualitatively similar to the total accident analysis.

9. For example, the property damage limits for reportable traffic accidents has increased in certain years. Any alcohol-related accident where the property damage is below the limit is not included in our accident count.

10. We also estimate the specification where the independent variables of interest reflect the six specific changes in county liquor status (for example, from dry to off-premise consumption). Given the small sample sizes in each of the categories, we are not surprised to find that none of the coefficients of interest are statistically significant at standard levels.

11. Because we have only three instrumental variables, we are unable to control for the possible endogeneity of the six different types of policy changes. Based on the results in Table 5, if the policy changes are endogenous, we expect the coefficients in Table 6, associated with these policy changes, to be biased upward.

Table 1. Panel A: Passing Referenda by Type of Vote, 1975-96
(237 total)

	To			
From	**Dry**	**Bear and Wine Sales**	**Liquor Sales-Off Premises**	**Liquor Sales-On and Off Premises**
Dry	-	73	78	58
Beer and Wine Sales	1	-	3	11
Liquor Sales – Off Premise	0	0	-	13
Liquor Sales – On and Off Premise	0	0	0	-

Panel (B) : Passing Referenda By Year, 1975-96
(237 total)

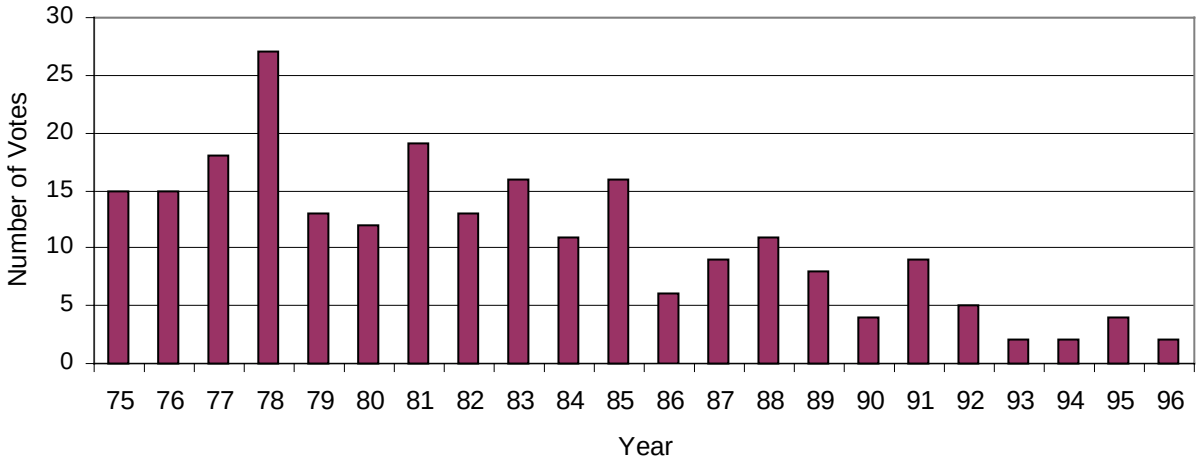


Table 2. Panel A: Changes in County Legal Status by Type of Change, 1975-96 (65 total)

	To			
From	**Dry**	**Bear and Wine Sales**	**Liquor Sales-Off Premises**	**Liquor Sales-On and Off Premises**
Dry	-	10	22	1
Beer and Wine Sales	0	-	5	5
Liquor Sales – Off Premise	0	0	-	22
Liquor Sales – On and Off Premise	0	0	0	-

Panel (B): Changes in County Legal Status By Year, 1975-96 (65 total)

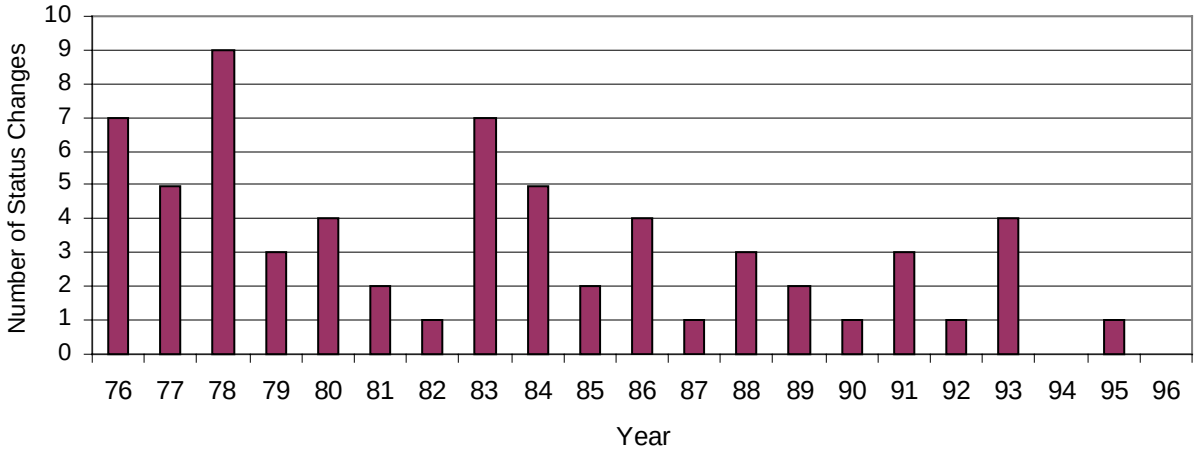


Table 3. Results for County Level Liquor Law Status[a]
(Dependent Variable is Alcohol-Related Motor Vehicle Accidents)

	OLS	County Fixed Effects	County Fixed Effects
County Status Less Restrictive			3.67
			(4.13)
County Status Wet	6.71**	2.12	
	(3.30)	(6.01)	
Registered Vehicles	-0.001	0.002	0.002
	(0.011)	(0.008)	(0.008)
Highway Expenditures	-0.286	4.16***	4.16***
	(0.271)	(0.20)	(0.20)
Police Expenditures	-6.03***	-3.30***	-3.30***
	(0.25)	(0.22)	(0.22)
Percent Population Catholic	26.14***	24.06	24.67
	(8.68)	(15.84)	(15.80)
Percent Population Baptist	-21.48**	-4.86	-4.03
	(10.69)	(17.30)	(17.31)
Population	175.49***	21.89***	21.96***
	(3.37)	(8.51)	(8.51)
Per Capita Income	97.89*	90.66	91.66
	(52.29)	(60.69)	(60.64)
Vehicle Miles – Highway	1.34***	1.52***	1.52***
	(0.37)	(0.33)	(0.33)
Vehicle Miles – Total	2.57***	1.04***	1.04***
	(0.38)	(0.30)	(0.30)
Year Fixed Effects	Yes	Yes	Yes
County Fixed Effects	No	Yes	Yes
R^2	0.951	0.979	0.979
Number of Observations	5,588	5,588	5,588

[a]Standard error in parentheses. Registered vehicles, population, per capita income and vehicle miles are measured in units of 100,000. Highway and police expenditures are in millions of dollars.

*Statistically significant at the .10 percent level.

**Statistically significant at the .05 percent level.

***Statistically significant at the .01 percent level.

Table 4. Results for Legal and Passing Referenda Votes[a]
(Dependent Variable is Alcohol-Related Motor Vehicle Accidents)

	OLS	County Fixed Effects	County Fixed Effects
Within County Vote(s) to Less Restrictive			7.859***
			(1.68)
Within County Vote(s) from Dry to Wet	-3.05**	7.38***	
	(1.23)	(1.78)	
Registered Vehicles	-0.002	0.002	0.002
	(0.011)	(0.008)	(0.008)
Highway Expenditures	-0.248	4.12***	4.106***
	(0.272)	(0.20)	(0.20)
Police Expenditures	-6.13***	-3.21***	-3.223***
	(0.25)	(0.22)	(0.22)
Percent Population Catholic	26.40***	25.55	25.40
	(8.66)	(15.72)	(15.71)
Percent Population Baptist	-26.11**	2.61	4.74
	(10.53)	(17.33)	(17.35)
Population	174.63***	16.54*	16.83**
	(3.38)	(8.59)	(8.56)
Per Capita Income	92.20*	92.93	93.29
	(52.19)	(60.55)	(60.52)
Vehicle Miles – Highway	1.59***	1.39***	1.37***
	(0.38)	(0.33)	(0.33)
Vehicle Miles – Total	2.52***	1.11***	1.12***
	(0.38)	(0.30)	(0.30)
Year Fixed Effects	Yes	Yes	Yes
County Fixed Effects	No	Yes	Yes
R^2	0.951	0.979	0.979
Number of Observations	5,588	5,588	5,588

[a]Standard error in parentheses. Registered vehicles, population, per capita income and vehicle miles are measured in units of 100,000. Highway and police expenditures are in millions of dollars.

*Statistically significant at the .10 percent level.

**Statistically significant at the .05 percent level.

***Statistically significant at the .01 percent level.

Table 5. Results for Instrumental Variables Model on Votes[a]

	Stage 1 Dependent Variable = Wet	Stage 2 Dependent Variable = Alcohol-Related Accidents	Stage 1 Dependent Variable = Less Restrictive	Stage2 Dependent Variable = Alcohol-Related Accidents
Less Restrictive				0.376
				(0.817)
Wet		0.158		
		(0.870)		
Registered Cars	-0.001	0.001	-0.001	0.001
	(0.001)	(0.007)	(0.001)	(0.007)
Highway Expenditures	-0.019	2.29***	-0.011	2.26***
	(0.021)	(0.23)	(0.023)	(0.23)
Police Expenditures	-0.045*	-2.02***	-0.001	--2.00***
	(0.023)	(0.26)	(0.025)	(0.25)
Percent Population Catholic	-3.03**	23.35	-2.43	23.91
	(1.45)	(16.49)	(1.54)	(16.36)
Percent Population Baptist	-11.88***	-17.61	-13.98***	-14.08
	(1.60)	(20.94)	(1.71)	(21.51)
Population	9.97***	-20.11	8.87***	-22.02*
	(0.87)	(13.15)	(0.93)	(12.29)
Per Capita Income	07.26	152.45**	-8.70	154.22**
	(5.64)	(63.28)	(6.01)	(63.27)
Vehicle Miles (S)	0.198***	3.57***	0.215***	3.52***
	(0.031)	(0.38)	(0.033)	(0.39)
Vehicles Miles (T)	-0.075***	0.415	-0.087***	0.452
	(0.029)	(0.338)	(0.031)	(0.341)
Oil and Gas Production	-16.13***		-18.29***	
	(1.51)		(1.61)	
Coal Production	-40.19		-6.18	
	(50.77)		(54.10)	
Petroleum Production	-20.84**		-20.84**	
	(9.02)		(9.02)	
Year Fixed Effects	YES	YES	YES	YES
County Fixed Effects	YES	YES	YES	YES
R^2	0.84	0.98	0.84	0.98
Number of Observations	5,080	5,080	5,080	5,080

[a]Standard error in parentheses. Registered vehicles, population, per capita income and vehicle miles are measured in units of 100,000. Highway and police expenditures are in millions of dollars.

*Statistically significant at the .10 percent level.

**Statistically significant at the .05 percent level.

***Statistically significant at the .01 percent level.

Table 6. Results for Differential Changes on Status and Votes[a]
(Dependent Variable is Alcohol-Related Motor Vehicle Accidents)

	Within County VOTES
Dry to Beer/Wine	-6.19*
	(3.72)
Dry to Alcohol Off-Premise	-1.59
	(3.49)
Dry to Alcohol Off- and On-Premise	32.00***
	(3.94)
Beer/Wine to Alcohol Off-Premise	9.31
	(20.30)
Beer/Wine to Alcohol Off- and On-Premise	-21.76**
	(10.82)
Alcohol Off-Premise to Alcohol Off- and On-Premise	39.97***
	(9.26)
Registered Vehicles	0.002
	(0.008)
Highway Expenditures	4.03***
	(0.20)
Police Expenditures	-3.37***
	(0.22)
Percent Population Catholic	18.74
	(15.64)
Percent Population Baptist	-3.44
	(17.35)
Population	20.09**
	(8.69)
Per Capita Income	102.6*
	(60.2)
Vehicle Miles – Highway	1.26***
	(0.33)
Vehicle Miles – total	1.14***
	(0.30)
Year Fixed Effects	YES
County Fixed Effects	YES
R^2	0.979
Number of Observations	5,588

[a]Standard error in parentheses. Registered vehicles, population, per capita income and vehicle miles are measured in units of 100,000. Highway and police expenditures are in millions of dollars.

*Statistically significant at the .10 percent level.
**Statistically significant at the .05 percent level.
***Statistically significant at the .01 percent level.

Appendix Table A-1. Variables

Variable	Frequency	Year	Source	Mean (Standard Deviation)	Notes
Alcohol-related automobile accidents (fatal, injury and non-injury)	annual	1975-1987	TDPS	131 (447)	Several changes across years in the classification of non-injury accidents.
Liquor Law Status	annual	1970-1997	TABC		
Results of all alcohol policy referenda	Date of Referenda	1970-1997	TABC		Votes can be held at county, city, or justice precinct level.
Registered Vehicles	Annual	1974-1997	TVTR	2.11 (118)	
Highway Expenditures[a]	Every 5 years	1972-1992	TTP	4.4 (19.7)	
Police Expenditures[a]	Every 5 years	1972-1992	TDPS	4.3 (23.7)	
Religious Participation (Catholic, Baptist)[a]	Every 10 years	1970, 1980, 1990	CCM	Catholics: 0.24 (0.24) Baptists: 0.44 (0.19)	
Population	Annual	1974-1996	BEA, REIS	0.63 (2.28)	
Per Capita Income	Annual	1974-1996	BEA, REIS	0.12 (0.05)	
Vehicle Miles Driven	Annual	1975-1996	TTP	Highway: 10.0 (28.2) Total: 14.5 (50.6)	

[a]For variables not available at the annual level, we have filled in missing values, assuming a constant rate of growth across years.

Notation: BEA – Bureau of Economic Analysis; REIS – Regional Economic Informational System; TABC – Texas Alcoholic Beverage Commission; TDPS – Texas Department of Public Safety; CCM – Churches and Church Membership in the U.S., Glenmary Research Center; TTP – Texas Transportation and Planning Division; and TVTR – Texas Vehicle Titles and Registration Division.

Figure 1. Distribution of County Alcohol Policies

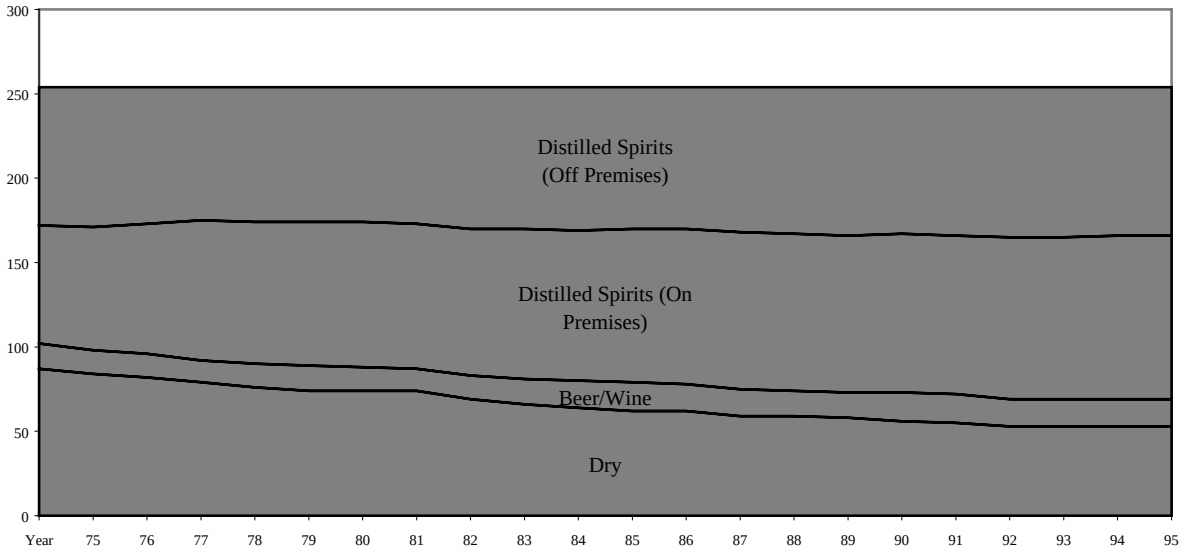
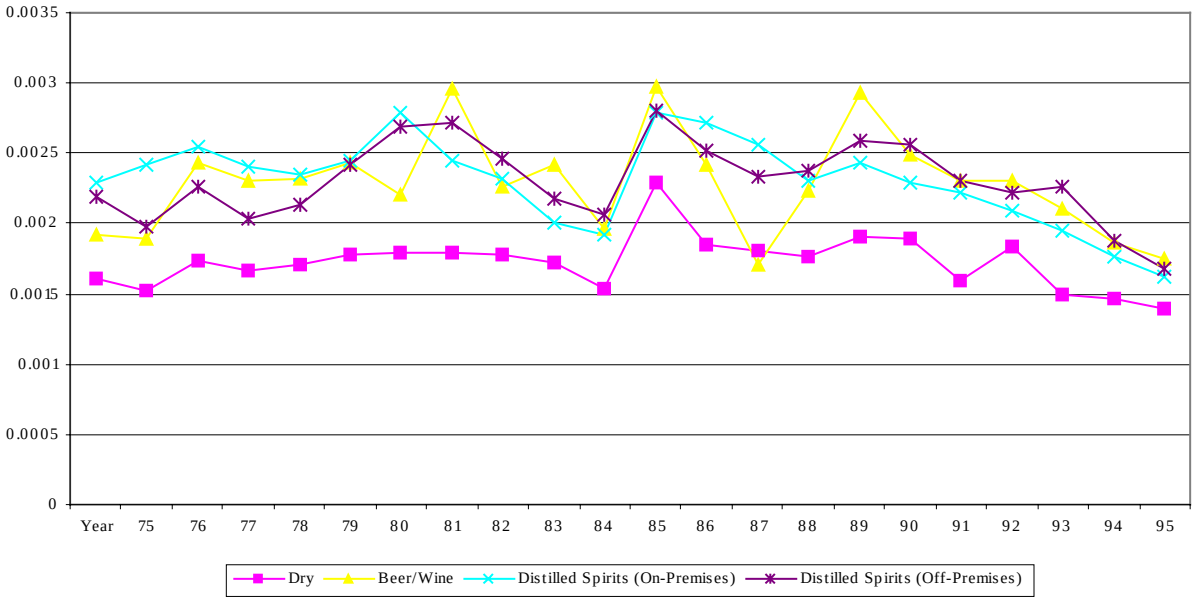


Figure 2. Average Total Accidents Per Capita By County Alcohol Policy



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