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ALCOHOL CONTROL POLICIES AND MOTOR VEHICLE FATALITIES

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ABSTRACT

The purpose of this study is to estimate the effects of drunk driving deterrents and other alcohol related policies on drunk driving. The data set employed is an annual time-series of state cross-sections for the 48 contiguous states of the U.S. from 1982 through 1988. Total and alterative alcohol involved motor vehicle fatality rates, for the general population and for 18 to 20 year olds, are used as measures of drunk driving. The results indicate that the most effective policies are increased beer taxes and mandatory administrative license actions. Maintaining the beer tax at its real 1951 value would have reduced fatalities by 11.5 percent annually, on average, during the sample period. A mandatory administrative license sanction of one year would have reduced fatalities by 9 percent. The next most effective policies are a 21 year old legal drinking age, preliminary breath test and dram shop laws and relatively large mandatory fines. These policies each reduce total fatalities by about 5 to 6 percent. No plea bargaining provisions and mandatory license sanctions upon conviction are also found to have some deterrent effect. Other drunk driving laws tested include mandatory jail sentences and community service options, illegal per se laws, and open container laws. None of these were found to have a deterrent effect on drunk driving.

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I. Introduction

Since the mid-1970's, the Federal and various state and local governments have campaigned to reduce motor vehicle fatalities by discouraging alcohol abuse. One part of this campaign was the Alcohol Traffic Safety Act of 1983. This act provides financial incentives for states to enact and enforce new, more stringent drunk driving laws. These measures include certain and more severe penalties upon conviction for drunken driving, an easing of the standards required for conviction, and the increased allocation of resources for the apprehension of drunken drivers. A second part of this campaign was the Federal Uniform Drinking Age Act of 1984. This act pressured all states into raising the minimum legal drinking age to 21 for all alcoholic beverages. States that were slow to respond were penalized by having part of their federal highway funding withheld. Ross (1990) reports that between 1980 and 1990 over 500 new drunk driving laws were passed in the United States.

These new drunk driving laws are intended to both punish and deter. The deterrence effect depends on the assumption of rational behavior. While driving when drunk may not be rational, the joint decision to drink and then drive can be modeled as a rational decision. Becker (1968), assuming rational behavior, describes the deterrent effect of legislation in a model of expected utility. Becker shows that the number of offenses committed by an individual is negatively related to the cost of each offense. The cost of each offense is a positive function of the probabilities of arrest and conviction and the severity of punishment if convicted.

The purpose of this study is to estimate the effects of drunk driving deterrence laws and other alcohol control policies on drunk driving. Prior research does not provide an unambiguous assessment of the effects of these laws. Many early studies used interrupted time series analysis which may not be the most appropriate method for studying the effects of drunk driving laws. Also, most of these studies consider only one law. This study is important because the effects of all major drunk driving laws, as well as those of minimum legal drinking ages and alcohol excise taxes, are estimated simultaneously. The second novel aspect of this study is the use of an estimated alcohol involved driver fatality rate. This variable was constructed using information on the blood alcohol concentration of drivers

killed in fatal crashes. An annual time-series of state cross-sections is used to estimate these models. This type of data set is important since it allows for estimation of more subtle effects than can be detected with a univariate time series.

Several recent studies have examined the effects of various drunk driving laws. Ross (1985) reviews a number of these studies and concludes that laws which increase the perceived certainty of punishment have a short term effectiveness. However, he concludes that the laws have little impact in the long run due to a decline in the public's perception that the laws will be enforced. Ross (1984) also reviews research on deterrents in the United Kingdom, France, the Netherlands, Canada, New Zealand and Australia. He finds that there is evidence of a deterrence effect in these countries, the magnitude of which varies with the perception that the laws will be enforced.

Moskowitz (1989) also reviews several studies of drunk driving deterrence laws and concludes that the deterrence approach has little effect on behavior. Drunk driving laws, according to Moskowitz, are useful to the extent that they communicate the community's concern about the problem.

Evans, et. al. (1989) use a cross sectional time series data set for 48 states over the period from 1975 to 1986 in their study of seven anti-drunk driving laws. They examine preliminary breath tests, sobriety checkpoints, no plea bargaining provisions, mandatory jail sentences, illegal per se and open container laws, and administrative license sanctions. None of these measures, with the possible exception of breath tests and sobriety check points, are found to have any effect on motor vehicle fatalities. However, they defined all drunk driving deterrence laws as dichotomous variables and only estimate fixed effects models. The resulting collinearity between state and time dummies and their dichotomous law indicators may mask the effects of the laws.

Zador, et al. (1988) study the effect of per se laws, administrative license action laws, and mandatory jail or community service laws using cross sectional time series data for the 48 states from 1978 to 1985. All three laws are found to have a significant negative effect on highway fatalities.

Saffer and Chaloupka (1989) use a cross sectional time series data set for 48 states over the period from 1980 to 1985 to examine the effects of preliminary breath test laws.

Using a variety of fatality rates and specifications, they find that the preliminary breath test significantly reduces motor vehicle fatality rates.

Kenkel (1990) studies the effects of preliminary breath tests, mandatory penalties, administrative per se laws and no plea bargaining laws, using a micro data set taken from the 1985 Health Interview Survey. The outcome measures are self-reported alcohol consumption and self-reported drunk driving. He finds evidence that these laws, with the exception of the no plea bargaining law, deter heavy drinking. However, holding the effect of the laws on heavy drinking constant, no independent effect on drunk driving is observed. Kenkel's results also lend some support to the notion that is the joint decision to drink and then drive which can be modeled as a rational behavior.

II. Empirical Specification

The empirical model is derived from a theoretical model consisting of two equations. The first equation is a production function relating the probability a fatal motor vehicle accident (π) to an individual's alcohol consumption shortly before or while driving (y) and a vector of additional variables (z).

$$\pi = \pi(y,z) \tag{1}$$

The z vector includes variables which measure traffic density, roadway conditions, vehicle quality and other motor vehicle safety measures. The second equation is the demand for alcohol shortly before or while driving:

$$y = y(p, a, c, f, l) \tag{2}$$

which is a function of the price of alcohol (p), the probabilities of apprehension (a) and conviction (c) for drunk driving, a vector of the penalties associated with apprehension and conviction (f), and a vector of other variables affecting alcohol demand (l). The vector l includes income, the prices of alcohol complements and substitutes, laws affecting the availability of alcohol, alcohol sentiment and other measures of taste.

Substituting the alcohol demand equation into the probability of a motor vehicle fatality equation yields a reduced form probability equation:

$$\pi = \pi(p, a, c, f, l, z) \tag{3}$$

which can be aggregated across individuals to yield an empirically estimable probability of

a motor vehicle accident fatality equation.

III. Data

The data set employed in this study is a time series of state cross sections for the 48 contiguous states of the U.S. covering the years from 1982 through 1988.[1] Means and summary definitions of all variables are found in Table 1.

Motor vehicle fatality rates are the best empirical measures of drunk driving available.[2] While not all motor vehicle fatalities are the result of drunk driving, there is a strong correlation between the two measures. Several alternative fatality rates, based on the information contained in the National Highway Traffic Safety Administration's (NHTSA) Fatal Accident Reporting System (FARS), are employed to measure drunk driving. The FARS contains data on all motor vehicle accident fatalities by state of occurrence.

The first fatality rate includes all motor vehicle accident fatalities and is called the total fatality rate. In an attempt to focus on alcohol involvement in motor vehicle fatalities and to isolate the impact of the DUI laws on driver behavior, two additional, driver specific fatality rates are defined. The first driver specific fatality rate is limited to drivers who died between 12:00 a.m. and 3:59 a.m., and is called the night driver fatality rate. The NHTSA estimates that 75-90% of these drivers had been drinking.

The second driver specific fatality rate uses the information contained in the FARS on the blood alcohol concentration of drivers killed in fatal crashes. No other study of drunk driving employs a fatality rate constructed from these BAC data. Since the BAC data is not collected for all drivers killed in a fatal accident, the alcohol involved driver fatality rate was estimated. This fatality rate is based on the fraction of the dead drivers tested and the fraction of those tested with BAC's of at least 0.05%, based on most states definition of alcohol involvement.

In addition, three similar, age specific fatality rates are defined for youths ages 18

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[1] Alaska and Hawaii were omitted from the data set because several important variables were missing for these two states. The District of Columbia is excluded because its size and nature make it likely that many of its motor vehicle accidents involve nonresidents.

[2] Fatality data is preferred to accident data due to the variability in reporting standards across states for accident data.

years to 20 years.[3] Alcohol involvement in motor vehicle accidents is estimated to be three times higher in the 18 to 20 year old group than it is in the overall population. It is, therefore, particularly important to examine the effects of alcohol regulations on this age group.

Each fatality rate is computed as the relevant number of motor vehicle accident deaths divided by the relevant state population. The fatality equation is specified as a logistic equation. The logistic functional form is ideal since it constrains the fatality rate to lie between zero and one. The logistic specification is obtained by transforming the fatality rate to ln[M/(1-M)], where M is the fatality rate and ln is the natural logarithm. Maddala (1983) shows that weighted least squares should be used with this logistic transformation. The weight is $[nM(1-M)]^{\frac{1}{2}}$, where n is the relevant state population.

An extensive set of variables are included as indicators of the various state laws related to alcohol use and/or driving under the influence of alcohol. These laws include: implied consent laws; illegal and administrative per se laws; minimum legal drinking ages for alcoholic beverages; preliminary breath test laws; open container laws; no plea bargaining laws; laws specifying mandatory minimum penalties for conviction of driving under the influence; and dram shop statutes or case laws. These laws represent all important DUI legislation.[4] All law variables were constructed from the information provided in the NHTSA's annual compilation A Digest of State Alcohol-Highway Safety Related Legislation.

An implied consent law presumes that an individual with a driver's license agrees to be tested for alcohol and other drugs upon request or face a license suspension or revocation. This law is modeled with two variables: a dichotomous indicator of whether or not a state has a statute calling for a minimum driver license suspension or revocation upon first refusal to submit to a blood, breath, or urine test for alcohol; and the length, in days,

[3] Several other fatality rates were also constructed from the FARS data. Results for these can be found in Grossman, Saffer, and Chaloupka (1991).

[4] An additional measure used in other studies which represents an increase in the probability of arrest is the use of roadside sobriety checkpoints. Based on conversations with the NHTSA, the roadside checkpoints can not be captured in the data employed in this study due to the use of sobriety checkpoints in all states and the lack of data on how extensively checkpoints are used within a state.

of the mandatory license suspension or revocation associated with the first refusal (zero for states without a first refusal implied consent law). Through 1988, 38 states and the District of Columbia had implied consent laws with suspensions or revocations from 30 days to one year.

Illegal per se laws make it an offense to operate a motor vehicle with a BAC at or above some specified level. Under these laws, a BAC at or above the specified level is sufficient proof to convict an individual for drunk driving. The only relevant rebuttable evidence is that the test was administered incorrectly. Through 1988, all but 6 states had illegal per se laws for BAC levels ranging from 0.08 percent to 0.12 percent. Three dichotomous variables are defined to capture these laws. The first is one if a state has an illegal per se BAC of 0.08 percent, and is zero otherwise. Similar variables are defined for a BAC of 0.10 percent, the most common, and for a BAC of over 0.10 percent. The omitted category is states with no illegal per se laws.

Some states have also enacted administrative per se laws which may require the state licensing agency to suspend or revoke an individual's license after arrest for DUI. In many states, this action is mandatory when the individual's BAC exceeds a specified level (generally 0.10 percent). The administrative action is independent of any later court penalty. Two variables are defined to capture these administrative license actions. The first is a dichotomous indicator equal to one in states requiring an administrative license suspension or revocation for the first arrest for DUI, and is zero otherwise (including states allowing discretionary administrative sanctions). The second is the mandatory minimum license action, in days, associated with the law (zero for states with no mandatory administrative sanctions). Through 1988, 15 states had mandatory, administrative license sanctions of 10 to 180 days, effective at BAC levels ranging from 0.08 percent to 0.13 percent.

The state minimum legal purchase age for beer, alcohol content greater than 3.2 percent, is included in all estimated equations. By the end of the sample period, all states had minimum ages of 21 for all alcoholic beverages. However, many enacted grandfather clauses when raising their drinking ages, exempting state residents of legal age prior to the

increase. The drinking age measure employed in this study accounts for these clauses.[5] Finally, if a state raised its legal age during the year, the drinking age variable is the weighted average of the ages in effect during the year.[6]

The preliminary breath test variable is a dichotomous indicator equal to one if a state has a law authorizing the pre-arrest use of a preliminary breath test to establish probable cause for arrest for DUI, and is equal to zero otherwise. These laws allow the police to administer the breath test without the assistance of medical personnel. Through 1988, 25 states had statutes allowing the use of a preliminary breath test.

In several states, it is an offense to have an open container of an alcoholic beverage in the passenger compartment of a motor vehicle. Open container laws are modeled by including a dichotomous variable equal to one if a state has an open container law and equal to zero otherwise. At the end of 1988, 21 states had open container laws.

In the past, an individual charged with DUI might negotiate a plea bargain to reduce the charge to a non alcohol-related offense, such as reckless operation, carrying a less severe penalty. To eliminate plea bargains, some states now require prosecutors to try an individual for DUI if they are arrested for DUI, unless a written statement is filed indicating why the charge should be reduced. This is modeled by a dichotomous variable which is one if the state has a no plea bargaining law and is zero otherwise. Through 1988, twelve states restricted the use of plea bargaining in DUI cases.

Additionally, several states have dram shop laws which allow a person injured by an intoxicated individual to bring suit against the person or establishment serving the alcoholic beverages. This variable is one if the state has either a statute or case law clearly authorizing such a lawsuit and is equal to zero otherwise. 35 states had such statutes at the end of 1988, with case laws in an additional 4 states and the District of Columbia.

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[5] This was done by taking a weighted average of the daily effective drinking age in the state. For example, in a state raising its drinking age from 20 to 21 on January 1st, but grandfathers individuals 20 years of age prior to January 1st, the average drinking age for the year would be: $20+(\sum_{i=1}^{365} i)/365^2$.

[6] Saffer and Grossman (1987a,b) find that drinking age related youth border crossing is an important determinant of youth motor vehicle fatality rates from 1975 through 1981. Similar variables were included in the equations presented below. However, these had little impact in this sample, probably due to the uniformity of drinking ages and the fact that the grandfather clauses pertain to state residents only.

At the end of 1988, 35 states and the District of Columbia had laws calling for mandatory minimum penalties to be imposed upon the first conviction for DUI. These include dollar fines, driver license suspension or revocation, and jail sentences. In some states, more than one penalty may be imposed. Additionally, some states allow an individual to engage in a minimum amount of court approved community service in lieu of a jail sentence. Eight variables were defined to capture these mandatory sanctions. Separate, dichotomous indicators were defined as one in states requiring a mandatory minimum fine, license action, or jail sentence upon first conviction for DUI. An additional dichotomous indicator was defined for states allowing community service in lieu of jail. Finally, four continuous variables were defined for the mandatory minimum penalties: the fine, in 1967 dollars; the license sanction, in days; the jail sentence, in days; and the community service, in hours. These variables are zero for states which do not require the relevant mandatory penalty. Through 1988, 16 states had mandatory fines for the first conviction ranging from $50 to $500. Similarly, 24 states and the District of Columbia either suspended or revoked an individual's driver license from 15 days up to 1 year. Finally, 15 states mandated a jail sentence of from 1 to 3 days, with 9 of these allowing from 8 to 100 hours of community service in lieu of the jail term.

Ideally, the impact of penalties for drunken driving would be modeled empirically by three variables:

$$\pi_j = \alpha_0 + \alpha_1 D_j + \alpha_2 D_j S_j^M + \alpha_3 (1-D_j) S_j^D \qquad (4)$$

where π_j is the fatality rate in state j, D_j is the dichotomous indicator of a mandatory minimum sanction in state j, S_j^M is the mandatory minimum sanction in state j, and S_j^D is the discretionary average sanction in states with no mandatory minimum penalties. Thus, the impact of the sanction is shown by α_2 and α_3, with the effect allowed to differ depending on the nature of the sanction. The impact of requiring a mandatory penalty, implying greater certainty of punishment, is shown by α_1. Comparing the average fatality rate in states with a mandatory minimum penalty (π^M) to that in states imposing discretionary rather than mandatory penalties (π^D):

$$\pi^M = \alpha_0 + \alpha_1 + \alpha_2 \bar{S}^M \qquad (5)$$

$$\pi^D = \alpha_0 + \alpha_3 \bar{S}^D \qquad (6)$$

where $\bar{S}^M$ and $\bar{S}^D$ are the average penalties imposed in each type of state. Hence,

$$\pi^M - \pi^D = \alpha_1 + \alpha_2\bar{S}^M - \alpha_3\bar{S}^D. \quad (7)$$

The problem, however, with estimating equation (4) is that no data is available on the average penalties imposed in states with no mandatory minimum penalties. Assuming that average penalties in states without mandatory minimums do not vary, unbiased estimates of α_2 can be obtained from:

$$\pi_j = \beta_0 + \beta_1 D_j + \alpha_2 D_j S_j^M. \quad (8)$$

where $\beta_0 = \alpha_0 + \alpha_3\bar{S}^D$ and $\beta_1 = \alpha_1 - \alpha_3\bar{S}^D$. Thus, the impact of more severe mandatory minimum penalties can be found directly from α_2, but the effect of having a mandatory minimum penalty can not be found without information on the average penalties imposed in states without mandatory penalties. If more severe mandatory minimum penalties act as deterrents, as expected, α_2 will be negative. However, the sign on β_1, the coefficient on the indicator of a mandatory penalty, is ambiguous. α_1 is expected to be negative, since having a mandatory penalty increases the probability of a penalty and, as a result, the expected cost of drunken driving. α_3, though, is also expected to be negative, since increased average penalties for drunken driving are expected to deter individuals from driving drunk.

This model applies to the mandatory minimum fine, license sanction, and jail sentence variables. In addition, the estimation of equation (8) for an implied consent law provides both the impact of having an implied consent law and the effect of the mandatory minimum penalties associated with the law, since states without implied consent laws impose no penalties upon refusal to submit to tests. Finally, a slightly more complicated version of this model applies to administrative per se laws.

In all equations, the price of alcohol is measured by the excise tax rate on beer. Excise tax data are the most reliable price data available. Beer tax data were chosen since beer is the most popular alcoholic beverage in the U.S. and because meaningful wine and distilled spirits taxes are only available for states which permit the sale of all alcoholic beverages in licensed establishments. The beer tax variable is defined as the sum of the Federal and state excise tax rates on a case of 24-12 ounce containers of beer, in 1967 dollars. The Federal tax had been fixed at 64 cents from 1951 until recently when it was doubled as part of a deficit reduction package. State excise tax rates were obtained from

the U.S. Brewers Association's annual Brewers Almanac. If a state raised its tax during the year, the tax is computed as the weighted average of the rates in effect throughout the year.

Five other alcohol related variables are included in all equations as measures of unobserved exogenous sentiment towards alcohol. For example, anti-alcohol sentiment should be relatively widespread in states in which religious groups opposing alcohol are prevalent or in states in which a higher than average fraction of the population reside in counties prohibiting the sale of alcohol. Thus, variables are defined for the percentages of the state population who are Mormons, Southern Baptists, other Protestants, and Catholics. These data were available from the National Council of Churches for 1971 and 1980 only. Estimates for 1982 through 1988 were computed by logarithmic trend. The final sentiment variable is the percentage of the state population residing in "dry" counties, taken from the Brewers Almanac.

Failing to control for sentiment may bias coefficients on the deterrence measures and the other determinants of alcohol demand. For example, states with strong anti-drinking sentiment may enact high alcohol taxes and drunk driving deterrent measures as part of the political process. Thus, if sentiment is excluded from the fatality equations, the estimated coefficients on taxes and the drunk driving laws overstate the effects of these variables. Alternatively, states with pro-drinking sentiment might enact higher taxes on alcohol, since these are a good source of revenues. If this is the case, then the estimated tax coefficients understate the true effects of taxes when sentiment is excluded.

Real per capita personal income and the state unemployment rate are also included in all equations. Income should be positively related to the demand for alcohol and health, as well as to the quality and condition of motor vehicles. Thus, the predicted effect of income on fatality rates is ambiguous. Unemployment may be a stress factor increasing alcohol consumption, but may reduce driving because of reduced work related travel, as well as lead to less drinking away from home. The unemployment data are taken from the Bureau of Labor Statistics' Geographical Profile of Employment and Unemployment.

Additionally, five variables are used to control for the probability of a fatal motor vehicle accident. They are the percentage of highway traffic exceeding 65 miles per hour, the number of vehicle miles traveled in 100,000's of miles per licensed driver, the fraction

of licensed drivers ages 24 years and under, a dichotomous indicator for states requiring annual safety inspections of all motor vehicles, and a dichotomous indicator of a mandatory seat belt use law. The first three of these variables were computed using data from the Federal Highway Administration's Highway Statistics, and unpublished data provided by the FHA. The safety inspection indicator was taken from the American Automobile Association's Digest of Motor Laws. Finally, information on mandatory seat belt use laws was obtained from communications with the NHTSA.

Vehicle miles per driver reflect motor vehicle use and traffic density and should be positively related to fatality rates. According to Peltzman (1975), because young drivers have a higher demand for risky driving, they are more likely to have an accident than older drivers. Thus, an increase in the fraction of young drivers should have a positive effect on fatality rates. Similarly, vehicle speed should also have a positive effect on fatality rates, with deviation from the average speed also having a positive effect (Lave, 1985). Thus, an increase in the percentage of drivers exceeding 65 mph on highways should lead to higher fatality rates. Likewise, mandatory safety inspections should result in safer vehicles and, as a result, lower fatal accident rates. Lastly, increased seat belt use resulting from the mandatory seat belt use laws should reduce the probability of a fatal accident.

Finally, temporal variation in unmeasured variables and other time trends are modeled by a set of dichotomous variables for each of the years from 1982 through 1987.

IV. Regression Results

A. Introduction

The empirical specifications are designed primarily to address problems associated with an extensive list of potential independent variables. There are 11 drunk driving laws that have been identified by NHTSA as important legislation. Several of these laws must be modeled with two or more empirical variables. Also, many of these laws were enacted at the same time. The number of variables and the simultaneous enactment of the laws can create collinearity in the data set. Collinearity problems may be reduced by limiting the number of variables in the models. The exclusion of correlated variables, however, can cause omitted variable bias in the coefficients of the included variables. One approach to these two problems is the estimation of several specifications using different combinations

of drunk driving laws. The estimation of three fairly different sets of specifications provides the means to judge the robustness of the results with respect to the problems of collinearity and omitted variables. There are six regressions in each specification set. In each set, the regressions have different dependent variables but the same independent variables. The results are presented in Tables 2 through 7.[7]

The first set of specifications includes only one drunk driving law along with the control variables. These specifications are presented in Tables 2 and 3, and are labeled Single Law Specification. Each panel in these tables represents a separate regression in which only the coefficient(s) for the drunk driving law is presented. There is no collinearity between the drunk driving laws since only one law is included in each regression. However, collinearity between the included drunk driving law and other alcohol control policies could still be a problem. Also, excluding the other drunk driving laws may create an omitted variables bias.

The second specification includes all drunk driving laws. These results are presented in Tables 4 and 5, and are labeled Extended Specification. These models are important since they minimize omitted variables bias. They are, however, subject to collinearity since many of these laws are enacted jointly.

The third specification includes the control variables and a limited set of drunk driving laws. The results are presented in Tables 6 and 7, which are labeled Limited Specification. These specifications attempt to provide a balanced solution to the problems of collinearity and omitted variables. These models reduce collinearity since they include fewer drunk driving laws than are included in the Extended Specification. The laws included in the Limited Specification were those that consistently matched a priori expectations in the prior specifications. The drunk driving laws included are the preliminary breath test, no plea bargaining, dram shop, administrative per se, and mandatory fine and license sanction laws. These models also reduce the problem of omitted variable bias relative to the Single Law

[7] Of the other specifications tested, one set merits some additional attention. Attempts were made to estimate fixed effects models by including dummy variables for all but one of the states in the sample, as well as an adaptation of Searle's (1971) procedure provided by Willard Manning. Colinearity made it impossible to obtain meaningful results from these alternative specifications.

Specification since they include six drunk driving laws.

An important advantage of these regression models over previous research is the inclusion of variables representing a wide variety of alcohol control policies. This allows for comparisons of the effectiveness of each policy. However, computation of elasticities is not appropriate for policies which are modeled with dichotomous variables or with several variables. An alternative method of assessing the relative effects of the various alcohol control policies is to simulate the number of lives that might have been saved by these policies.

Simulations of alternative policies using the regression coefficients from the Limited Specifications were performed by first predicting the actual number of fatalities in the 48 contiguous states of the U.S. from 1982 through 1988. The total number of fatalities is then re-estimated changing the appropriate independent variable(s) to reflect the policy being simulated and compared to actual fatalities. Finally, for the drunk driving deterrence laws, the number of fatalities averted as a result of existing laws is also estimated by re-estimating total fatalities in the absence of the law being examined.

Tables 8 and 9 contain the results of these simulations for the three total and age-specific fatality rates, respectively. The first value, in each cell, is the average annual predicted reduction in fatalities due to the policy being simulated. The second represents the percentage reduction in fatalities resulting from the simulated policy. For the drunk driving laws, each cell contains two additional values: the number of fatalities averted by existing laws and the percentage reduction in fatalities this represents (compared to the estimated fatalities in the absence of the law under consideration). The estimated number of fatalities which could be averted by the policy being simulated depends on both the regression coefficients and the number of states that had the policy in effect from 1982 through 1988. This increases as the absolute value of the coefficient increases and decreases as the number of states with the policy increases. The full impact of each deterrence measure can be compared by summing the number of fatalities averted if all states had a law with the number of fatalities averted by the laws already in effect.

B. Drunk Driving and Alcohol Related Policy Variables

The preliminary breath test law is negative and significant in all but one of the models

presented.[8] A comparison of fatality rates generally reveals the expected pattern of larger coefficients for the more alcohol involved fatality rates. There is generally no difference in the magnitude of the coefficients across the three alternative specifications or among 18 to 20 year olds. Clearly, states with a preliminary breath test law have significantly lower motor vehicle accident fatality rates than states without this law. The simulations predict that if all states had a preliminary breath test during the sample period, average annual fatalities would have been reduced by approximately 3.4 percent, with about 20 percent of this reduction taking place among 18 to 20 year olds. As expected, about 90 percent of the total reduction would have occurred among alcohol involved drivers. Existing preliminary breath test laws are estimated to have saved approximately 1,067 lives each year. Thus, the marginal effect of going from no breath test laws to every state enacting a breath test law is estimated to be 2,579 lives per year.

The indicator for laws limiting the use of plea bargaining in drunk driving cases is negative and significant in 13 of the 18 models. A comparison of fatality rates reveals a pattern of larger coefficients for the nighttime driver fatality rates than for the others, while little difference is observed between the results for 18 to 20 year olds and the full sample. Also, larger coefficients are observed in the Extended specification relative to the Single and Limited specifications. The empirical results provide evidence of a negative effect of a no plea bargaining law on drunk driving fatality rates. Simulations indicate that a national no plea bargaining law would have reduced night driver fatalities (where it was most significant) by approximately 7.9 percent. About 16 percent of all fatalities averted by this law would have been in the 18 to 20 year old group. An estimated 543 fewer night driver fatalities were predicted when comparing the national no plea bargaining law simulation to that where no state had a law.

The administrative per se law is significant in 12 of the models. Most of these significant estimates are in the total fatality regressions including more than one law. There is very little variation in the magnitude of the significant coefficients. Simulations imposing

[8] All statement concerning significance are based on tests done at the ten-percent significance level. These tests are one-tailed t-tests for laws modeled with one variable and are F-tests of joint significance for laws modeled with more than one variable.

a mandatory license sanction of one year (the most severe penalty in place in 1988) suggest that administrative per se laws can significantly deter drunken driving as long as relatively severe sanctions are imposed. Existing laws, with relatively weak penalties, are found to have no deterrent effect. However, imposing a mandatory one year administrative sanction in all states would have reduced total fatalities by 4,202, with about 19 percent of the reduction occurring in the 18 to 20 year old group.

Mandatory minimum fines are found to be significant in 10 of the 18 alternative specifications. All of the significant estimates occur in the models using the night driver or alcohol involved driver fatality rate as the dependent variable. This is a reasonable result since the effects of the deterrents are expected to be more obvious in the more alcohol involved regressions. Also, a comparison of the 18 to 20 age group with the full sample reveals somewhat smaller and less significant coefficients for youths. No systematic difference in the magnitude of the coefficients is observed among the three alternative specifications. These results suggest that mandatory fines do deter drunk driving although the effect on young drivers may be weaker. Again, the simulations indicate that the effectiveness of the mandatory fines appears to depend on relatively large fines being imposed. Uniformly imposing a mandatory nominal fine of $500 would have reduced alcohol involved driver fatalities by 2,738 per year, about 19 percent of these fatalities, with about 12 percent of the reduction taking place among 18 to 20 year olds. The marginal effect on alcohol involved drivers of going from no states with a mandatory minimum fine to all states imposing mandatory fines of $500 is estimated to be 2,916 lives.

The deterrent effect of a mandatory license action was found to be significant in 5 of the models presented. However, the signs of the coefficients on the two variables capturing these penalties were consistent with a deterrent effect in all but one of the models presented. Again, the significant effects were observed only in the models using a dependent variable representing greater alcohol involvement. The results were also significant in specifications using all ages. These results indicate that the impact of a mandatory license sanction is limited to older drivers. Simulating the impact of a national mandatory license sanction of one year indicates that approximately 647 fewer alcohol involved driver fatalities would have occurred in each year when compared to the situation where no states imposed

this type of mandatory penalty. As before, the estimated impact of the relatively weak existing mandatory license sanctions indicates that these penalties must be fairly severe to have any deterrence effect.

The dram shop law is negative and significant in all but one of the models presented. As expected, a comparison of fatality rates generally reveals a pattern of larger coefficients for the more alcohol involved fatality rates. Also, a comparison of the 18 to 20 age group with the full sample reveals a clear pattern of smaller and less significant coefficients for youths. This result is not surprising since, during the period examined, the minimum legal drinking age was 21 in many states. Young people would, therefore, have difficulty receiving service in the on-premise drinking establishments where the dram shop laws are expected to have the greatest impact. Simulations indicate that the enactment of a dram shop law in those states without one during the 1982 to 1988 period would have reduced total fatalities by 852 per year. About 62 percent of the fatalities averted by this policy would have been in the alcohol involved driver group. A relatively low proportion of this reduction would have occurred among 18 to 20 year olds. Comparing the national dram shop law case to the situation where no state has a dram shop law indicates that the marginal effect of this law is 2,436 lives per year, a reduction in total fatalities of 5.3 percent.

The real beer tax coefficients are negative and significant at the one percent level in all specifications reported. A comparison of fatality rates generally reveals a pattern of larger coefficients for the more alcohol involved fatality rates. Also, a comparison of the 18 to 20 age group with the full sample reveals a clear pattern of larger coefficients for the younger age group. Finally, a comparison of the Extended specification and Limited specification reveals generally that the magnitude of the coefficients are larger in the Extended specifications. These results suggest that beer taxes have a negative effect on drunk driving and that this effect is larger for young driver than for older drivers. Collinearity may be a problem in the Extended specification.

Three alternative increases in the beer tax are simulated. The first is an increase in the nominal beer tax so that the real beer tax in effect in 1951 is maintained. This is an increase in the beer tax from 16 cents to 71.6 cents per six-pack and represents a 447 percent increase in the federal beer tax in 1988. The simulations predict that this policy

would have reduced total fatalities per year, on average, by 5,174 or about 11.5 percent of all fatalities. This policy would have reduced fatalities in the 18 to 20 year old group by 1,660, about 32 percent of all fatalities in this group.

The second tax simulation is an increase in the beer tax which equates the tax on the pure alcohol in beer to the tax on the pure alcohol in distilled spirits. This is an increase in the beer tax to 78.4 cents and represents a 490 percent increase in the federal beer tax in 1988. The simulations predict that this policy would have reduced total fatalities per year by 5,771, or approximately 12.8 percent of all fatalities. This policy would have reduced fatalities in the 18 to 20 year old group by 1,822 which is about 35.2 percent of all fatalities in this group.

The final tax policy simulated is the doubling of the tax to 32 cents per six-pack called for in the deficit reduction package of 1990. The simulations predict that this policy would have reduced total fatalities per year by 1,744 which is about 3.9 percent of all fatalities. This policy would have reduced fatalities in the 18 to 20 year old group by 611 which is about 11.8 percent of all fatalities in this group.

For each of the tax policies, a comparison of fatality rates shows that the magnitude of the effect increases with the degree of alcohol involvement. About 75 percent of the fatalities averted by these policies would be in the alcohol involved driver group. A comparison of fatality rates for 18 to 20 year olds also shows that the magnitude of this effect increases with the degree of alcohol involvement. About 32 percent of all fatalities averted, of all ages, would have been in the 18 to 20 year old group.

The elasticity of the beer tax with respect to total fatalities was estimated for both the 18 to 20 year old group and for all ages. The younger group was expected to be more price responsive than the overall population. The elasticity of the beer tax with respect to total fatalities in the 18 to 20 year old age group is estimated to be -0.21, and for all ages to be -0.07. These estimates are consistent with those obtained in other recent studies. Saffer and Grossman (1987a) estimated this elasticity for the 18 to 20 year old group to be –0.17. Evans et. al. (1989) estimated this elasticity for all ages to be –0.11.

The results indicate that the effect of a minimum legal drinking age law is limited to 18 through 20 year olds. The drinking age is negative and significant in all models using

fatality rates for 18 to 20 year olds, while it attains significance in only the more alcohol involved measures for the full sample. A comparison of the 18 through 20 year old fatality rates generally reveals a pattern of larger coefficients for the more alcohol involved fatality rates. The effects of a 21 year old minimum legal purchase age in all states during the sample period is simulated. The simulations predict that this policy would have reduced fatalities in the 18 to 20 year old group by 166 per year. This is a small number since most states had a 21 year old minimum legal drinking age during the sample period. About 83 percent of the total fatalities averted would have been in the alcohol involved driver category. To gain some further understanding of the overall impact of legal drinking ages, the effects of an 18 year old minimum purchase age in all states is also simulated. The simulations predict that this policy would have increased fatalities in the 18 to 20 year old group by 498 per year, with most of the increased fatalities in the alcohol involved driver category. The marginal effect of going from an 18 to a 21 year old minimum legal purchase age in all states is thus estimated at 664 lives.

The other DUI and alcohol related laws that were examined are the illegal per se, implied consent, and open container laws and the mandatory minimum jail sentences and community service penalties. The Single Law specifications and the Extended specifications produced mostly insignificant and positive coefficients or unstable coefficients for these laws. The results suggest that these laws do not have a deterrence effect and, as a result, were not included in the Limited specifications and no simulations were performed for them.

C. Alcohol Sentiment Measures

The variable measuring the percentage of the state population in dry counties is negative and significant in only a few of the specifications presented. This may be due to the fact that alcohol could be easily purchased in nearby counties. Thus, these results suggest that local limits on the sale of alcoholic beverages have little impact on drunk driving.

The Southern Baptist variable is never negative and significant, contrary to expectations. The coefficients on the remaining religion variables are generally negative and significant. A comparison of fatality rates with respect to alcohol involvement reveals no particular pattern. Also, a comparison of the 18 to 20 age group with the full sample reveals

a general pattern of smaller coefficients for the younger age group. These results suggest that religious participation ia associated with reduced alcohol abuse.

D. Highway Conditions

The percentage of drivers exceeding 65 miles per hour is positive and significant in all specifications reported, as expected. Total vehicle miles driven per licensed driver was expected to have a positive impact on fatality rates, since increased driving should increase the probability of an accident. However, this variable was generally negative and insignificant in the estimated equations. All motor vehicle fatality rates were found to be positively and significantly affected by the percentage of drivers ages 15 through 24 in all estimated specifications. Mandatory safety inspections are expected to improve the quality of motor vehicles and, as a result, lower motor vehicle fatality rates. This variable is negative and significant in all total fatality regressions, but is insignificant in all other regressions. Mandatory seat belt use laws are expected to increase seat belt use, thereby lowering the probability of a fatality in a motor vehicle accident. This variable is negative and significant in most of the equations estimated. With the exception of the inspection indicator, a comparison of these results across fatality rates generally reveals a pattern of larger coefficients for the more alcohol involved fatality rates. The only differences observed between 18 to 20 year olds and the full sample are for the seat belt use laws which are estimated to have a larger impact on youths.

E. Economic Variables

Since both health and alcohol are normal goods, the effect of income on alcohol demand is uncertain. However, real income is negative and significant in all specifications reported. This suggests that the impact of income on health exceeds that of income on alcohol consumption and drunken driving. A comparison of fatality rates generally reveals a pattern of larger coefficients for the more alcohol involved fatality rates, while no differences are observed by age. The unemployment rate is negative and significant in all specifications reported, indicating that unemployed individuals do less driving and less drinking away from home. A comparison of total fatality, nighttime fatality and alcohol involved fatality rates for the full sample and for 18 to 20 year olds shows no particular pattern for these variables with respect to either alcohol involvement or age.

V. CONCLUSIONS

Based on the regression and simulation results, the relative effectiveness of all major drunk driving legislation, beer taxes and the minimum legal drinking age can be compared. In several cases these comparisons depend on how severe a policy is assumed, since sanctions can be set at relatively low or relatively high levels. The most severe mandatory minimum sanction in effect in any state, in 1988, is used in the simulations. Simulations using less severe penalties, which were not presented, implied that sanctions have to be severe to be effective.

The most effective policies are the beer tax and the relatively severe administrative license action of one year. An increase in the beer tax to its real value in 1951 would decrease fatalities by 11.5 percent. A mandatory minimum administrative penalty of one year decrease fatalities by about nine percent. However, the relatively weak administrative penalties currently in place have little, if any, deterrent effect.

The next most effective policies are a 21 year old minimum legal drinking age, a preliminary breath test law, a dram shop law, and the relatively high mandatory minimum fine of $500. These policies each reduce total motor vehicle fatalities by about five to six percent.[9] Finally, the no plea bargaining law and the mandatory minimum license action of one year each reduce total fatalities by about one percent.[10]

The other deterrent laws, which include mandatory jail sentences, community service laws, and open container laws were not found to act as deterrents to drunk driving.

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[9] An 18 year old drinking age is assumed as the alternative drinking age. The five percent estimate is based on the number of 18 to 20 year old fatalities averted as a percent of total faralities. Also, the alternative drunk driving policies are no law to be in effect in any state.

[10] The estimate for the no plea bargaining law was computed using the number of night driver fatalities averted as a percent of total fatalities.

Table 1
Definitions and Means of Variables*

Variable	Definition and Mean
Total Fatality Rate	Total motor vehicle fatalities per 100,000 population. μ=18.840
Night Driver Fatality Rate	Total driver deaths occurring between 12:00 a.m. and 3:59 a.m. in motor vehicle accidents per 100,000 population. μ=2.271
Alcohol Involved Driver Fatality Rate	Estimated alcohol involved, driver deaths in motor vehicle accidents per 100,000 population. μ=5.950
Youth Fatality Rate	Total 18 to 20 year old deaths in motor vehicle accidents per 100,000 population ages 18 to 20. μ=54.472
Youth Night Driver Fatality Rate	Total driver deaths, ages 18 to 20 years, occurring between 12:00 a.m. and 3:59 a.m. in motor vehicle accidents per 100,000 population ages 18 to 20. μ=9.991
Youth Alcohol Involved Driver Fatality Rate	Estimated alcohol involved driver deaths, ages 18 to 20 years, in motor vehicle accidents per 100,000 population ages 18 to 20. μ=18.870
Implied Consent Law	Dichotomous indicator of state law requiring a license sanction upon refusal to submit to a chemical test for alcohol. μ=0.626
Mandatory Minimum Implied Consent Penalty	Mandatory minimum license suspension or revocation, in days, for refusal to submit to a chemical test for alcohol. μ=125.134
Per Se BAC=0.08%	Dichotomous indicator that equals one if the state has an illegal per se law which applies at a BAC of 0.08%. μ=0.018
Per Se BAC=0.10%	Dichotomous indicator that equals one if the state has an illegal per se law which applies at a BAC of 0.10%. μ=0.784
Per Se BAC above 0.10%	Dichotomous indicator that equals one if the state has an illegal per se law which applies at BACs greater than 0.10%. μ=0.045
Mandatory Administrative Per Se Law	Dichotomous indicator that equals one if the state has a law calling for a mandatory administrative driver license suspension or revocation after first arrest for DUI. μ=0.115
Mandatory Minimum Administrative Penalty	Mandatory minimum administrative driver license suspension or revocation, in days, after first arrest for DUI. μ=10.609
Minimum Legal Drinking Age	Minimum legal drinking age, in years, for the purchase and consumption of beer with an alcohol content of more than 3.2%, adjusted for grandfather clauses. μ=20.258
Preliminary Breath Test	Dichotomous indicator that equals one if the state has a law which authorizes the police to administer a pre-arrest breath test for alcohol. μ=0.427
Open Container	Dichotomous indicator that equals one if the state has a law making it an offense to have an open container of an alcoholic beverage in the passenger compartment of a motor vehicle. μ=0.386
No Plea Bargaining	Dichotomous indicator that equals one if the state has a law requiring prosecutors to try an individual for DUI if arrested for DUI. μ=0.217
Mandatory Fine	Dichotomous indicator that equals one if the state has a law requiring a minimum fine upon first conviction for DUI. μ=0.314
Real Mandatory Minimum Fine	Mandatory minimum fine, in dollars, for first conviction for DUI, divided by the Consumer Price Index (1967=100). μ=0.296
Mandatory License Action	Dichotomous indicator that equals one if the state has a law requiring a minimum license suspension or revocation upon first conviction for DUI. μ=0.295
Mandatory Minimum License Action	Mandatory minimum driver license suspension or revocation, in days, upon first conviction for DUI. μ=27.081
Mandatory Jail Sentence	Dichotomous indicator that equals one if the state has a law requiring a minimum jail sentence upon first conviction for DUI. μ=0.164

Mandatory Minimum Jail Sentence	Mandatory minimum jail sentence, in days, upon first conviction for DUI. μ=0.307
Community Service in Lieu of Jail	Dichotomous indicator that equals one if the state allows community service in lieu of a mandatory jail sentence upon first conviction for DUI. μ=0.142
Minimum Community Service	Minimum community service, in hours, in lieu of jail sentence upon first conviction for DUI. μ=7.126
Dram Shop	Dichotomous indicator that equals one if the state has either a statute or case law authorizing parties injured by an intoxicated individual to file a lawsuit against the server of the alcoholic beverages. μ=0.674
Real Beer Tax	Sum of Federal and state excise taxes, in dollars, on a 24-unit case of 12-ounce containers of beer divided by the CPI. μ=0.00339
Real Income	Per capita money personal income divided by the CPI. μ=36.977
Unemployment Rate	Annual average state unemployment rate. μ=7.444
Mormon	Percentage of the state population who are Mormons. μ=1.233
Southern Baptist	Percentage of the state population who are Southern Baptists. μ=7.163
Catholic	Percentage of the state population who are Catholic. μ=20.588
Protestant	Percentage of the state population who are Protestant, excluding Mormons and Southern Baptists. μ=20.852
Percent Dry	Percentage of the state population living in counties prohibiting the sale of alcoholic beverages. μ=4.513
Vehicle Miles	Vehicle miles traveled, in hundred thousands of miles per licensed driver. μ=0.019
Young Drivers	Fraction of licensed drivers ages 24 years and under. μ=0.181
Inspections	Dichotomous variable that equals one if a safety inspection of motor vehicles is required every year. μ=0.444
Seat Belt Use	Dichotomous variable that equals one if the state has a mandatory seat belt use law. μ=0.398
Percent Over 65 mph	Percentage of highway traffic exceeding 65 miles per hour. μ=9.812

* All means are weighted by the total state population except for the age specific fatality rates which are weighted by the relevant age specific state population. All data are for the 48 contiguous states of the U.S. from 1982 through 1988.

Table 2: Single Law Specification, All Ages*

Independent Variable	Total	Nighttime Driver	Alcohol Involved Driver
Panel A: Preliminary Breath Test			
Preliminary Breath Test	-0.072***	-0.109***	-0.193***
	(-3.99)	(-4.20)	(-5.98)
Panel B: No Plea Bargaining			
No Plea Bargaining	-0.028	-0.146***	-0.100**
	(-1.22)	(-4.43)	(-2.29)
Panel C: Dram Shop			
Dram Shop	-0.065***	-0.074***	-0.125***
	(-3.50)	(-2.75)	(-3.61)
Panel D: Administrative Per Se Laws			
Mandatory Administrative Per Se Law	0.105***	-0.033	-0.120
	(3.24)	(-0.67)	(-1.90)
Mandatory Minimum Administrative Penalty	-0.001***	0.00002	0.0002
	(-2.50)	(0.06)	(0.48)
Panel E: Fines			
Mandatory Fine	0.007	0.095**	0.204**
	(0.12)	(1.22)	(2.07)
Real Mandatory Minimum Fine	-0.016	-0.163**	-0.255**
	(-0.27)	(-2.03)	(-2.46)
Panel F: License Suspension or Revocation			
Mandatory License Action	0.002	0.074*	0.058
	(0.08)	(2.27)	(1.37)
Mandatory Minimum License Action	-0.00001	-0.0003*	-0.0003
	(-0.05)	(-1.85)	(-1.41)
Panel G: Per Se Laws			
Per Se BAC=0.08%	0.042***	-0.267***	-0.042
	(0.64)	(-2.47)	(-0.32)
Per Se BAC=0.10%	0.060***	0.034***	0.071
	(2.60)	(1.05)	(1.64)
Per Se BAC above 0.10%	-0.082***	-0.104***	-0.061
	(-1.90)	(-1.66)	(-0.75)
Panel H: Implied Consent Laws			
Implied Consent Law	-0.042***	-0.177***	-0.117**
	(-1.60)	(-4.79)	(-2.41)
Mandatory Minimum Implied Consent Penalty	0.0004***	0.001***	0.0001**
	(3.70)	(3.84)	(0.66)
Panel I: Open Container			
Open Container	0.015	-0.024	-0.030
	(0.81)	(-0.87)	(-0.83)
Panel J: Jail Sentences			
Mandatory Jail Sentence	0.210***	0.124*	-0.118***
	(3.43)	(1.42)	(-1.09)
Mandatory Minimum Jail Sentence	-0.084***	-0.026*	0.141***
	(-2.82)	(-0.61)	(2.79)
Panel K: Community Service			
Community Service in Lieu of Jail	0.080***	-0.054***	0.243***
	(1.54)	(-0.68)	(2.48)
Minimum Community Service	0.0004***	0.002***	0.007***
	(0.48)	(1.91)	(4.18)

* All equations include the control variables described above. t-ratios are in parentheses. ***, **, and * represent statistically significant coefficients at the one, five, and ten percent significance levels, respectively. When examining the laws modeled by more than one variable, the significance level indicated is based on an F-test of the joint significance of the variables capturing the law in question. Finally, the F statistic is significant at the one percent significance level in all equations.

Table 3: Single Law Specification, 18-20*

Independent Variable	Total	Nighttime Driver	Alcohol Involved Driver
Panel A: Preliminary Breath Test			
Preliminary Breath Test	-0.113***	-0.097***	-0.199***
	(-5.30)	(-2.77)	(-5.66)
Panel B: No Plea Bargaining			
No Plea Bargaining	-0.053**	-0.151***	-0.127***
	(-1.92)	(-3.41)	(-2.71)
Panel C: Dram Shop			
Dram Shop	-0.058***	-0.058*	-0.079**
	(-2.59)	(-1.62)	(-2.07)
Panel D: Administrative Per Se Laws			
Mandatory Administrative Per Se Law	0.069**	0.005	-0.082
	(1.73)	(0.07)	(-1.18)
Mandatory Minimum Administrative Penalty	-0.001**	0.0004	-0.0003
	(-2.62)	(-0.82)	(-0.53)
Panel E: Fines			
Mandatory Fine	-0.031	-0.021**	0.151**
	(-1.47)	(-0.21)	(1.44)
Real Mandatory Minimum Fine	0.035	-0.087**	-0.232**
	(0.52)	(-0.83)	(-2.11)
Panel F: License Suspension or Revocation			
Mandatory License Action	0.017	-0.006	0.054
	(0.64)	(-0.13)	(1.19)
Mandatory Minimum License Action	-0.00004	-0.0001	-0.0001
	(-0.29)	(-0.36)	(-0.66)
Panel G: Per Se Laws			
Per Se BAC=0.08%	0.058*	-0.365**	0.020**
	(0.73)	(-2.34)	(0.14)
Per Se BAC=0.10%	0.041*	0.019**	0.102**
	(1.49)	(0.45)	(2.24)
Per Se BAC above 0.10%	-0.075*	-0.097**	-0.054**
	(-1.43)	(-1.16)	(-0.61)
Panel H: Implied Consent Laws			
Implied Consent Law	0.023**	-0.053	-0.055
	(0.74)	(-1.04)	(-1.04)
Mandatory Minimum Implied Consent Penalty	0.0002**	0.00003	-0.0001
	(1.19)	(0.12)	(-0.45)
Panel I: Open Container			
Open Container	0.005	-0.028	-0.053*
	(0.20)	(-0.76)	(-1.35)
Panel J: Jail Sentences			
Mandatory Jail Sentence	0.246***	0.095	0.049***
	(3.47)	(0.80)	(0.42)
Mandatory Minimum Jail Sentence	-0.081***	-0.008	0.071***
	(-2.35)	(-0.14)	(1.31)
Panel K: Community Service			
Community Service In Lieu of Jail	-0.034***	-0.165**	-0.324***
	(-0.55)	(-1.53)	(-3.06)
Minimum Community Service	0.002***	0.004**	0.008***
	(1.89)	(2.47)	(4.52)

* See note to Table 2.

Table 4: Extended Specification, All Ages*

Independent Variable	Total	Nighttime Driver	Alcohol Involved Driver
Real Income	-0.035***	-0.040***	-0.061***
	(-9.80)	(-7.52)	(-8.66)
Percentage Exceeding 65 mph	0.014***	0.016***	0.023***
	(5.07)	(4.07)	(4.43)
Total Vehicle Miles Driven	-6.346	-0.251	-1.705
	(-1.24)	(-0.03)	(-0.18)
Percentage of Young Drivers	1.972***	2.593***	3.943***
	(4.41)	(4.06)	(4.65)
Safety Inspections	-0.092***	-0.026	0.029
	(-4.82)	(-0.95)	(0.78)
Seat Belt Law	-0.052***	-0.087***	-0.140***
	(-2.39)	(-2.71)	(-3.28)
Unemployment Rate	-0.044***	-0.027***	-0.046***
	(-8.57)	(-3.71)	(-4.84)
Dry	0.0001	-0.002	0.004*
	(0.06)	(-1.44)	(1.78)
Mormons	-0.011***	-0.012***	-0.021***
	(-6.07)	(-4.15)	(-5.49)
Southern Baptists	0.008***	0.007**	0.00004
	(3.83)	(2.47)	(0.01)
Catholics	-0.007***	-0.0004	-0.010***
	(-5.55)	(-0.26)	(-4.31)
Protestants	-0.010***	-0.004*	-0.012***
	(-7.27)	(-1.79)	(-4.40)
Minimum Legal Drinking Age	-0.012	-0.040***	-0.069***
	(-1.18)	(-2.67)	(-3.51)
Real Beer Tax	-42.073***	-69.953***	-91.123***
	(-4.85)	(-5.54)	(-5.57)
Preliminary Breath Test	-0.054***	-0.063**	-0.161***
	(-2.82)	(-2.28)	(-4.40)
No Plea Bargaining	-0.110***	-0.246***	-0.178***
	(-4.04)	(-6.15)	(-3.42)
Dram Shop	-0.056***	-0.084***	-0.092***
	(-3.17)	(-3.34)	(-2.76)
Mandatory Administrative Per Se Law	0.012***	-0.100***	-0.152***
	(0.36)	(-1.97)	(-2.30)
Mandatory Minimum Administrative Penalty	-0.001***	-0.001***	-0.0002***
	(-3.44)	(-1.67)	(-0.52)
Mandatory Fine	-0.031	0.013	0.255**
	(-0.61)	(0.18)	(2.80)
Real Mandatory Minimum Fine	0.003	-0.074	-0.250**
	(0.05)	(-0.97)	(-2.55)
Mandatory License Action	-0.030	0.056*	0.106**
	(-1.46)	(1.87)	(2.70)
Mandatory Minimum License Action	-0.00002	-0.0003*	-0.0005**
	(-0.21)	(-2.00)	(-2.38)
Per Se BAC=0.08%	0.099***	-0.048	0.005***
	(1.44)	(-0.44)	(0.04)
Per Se BAC=0.10%	0.049***	0.056	0.142***
	(2.89)	(1.87)	(3.55)
Per Se BAC above 0.10%	-0.086***	0.005	0.162***
	(-1.96)	(0.08)	(1.96)
Implied Consent Law	-0.062***	-0.210***	-0.136***
	(-3.16)	(-5.66)	(-2.81)
Mandatory Minimum Implied Consent Penalty	0.001***	0.001***	0.001***
	(7.31)	(7.19)	(3.16)
Open Container	-0.008	0.010	0.004
	(-0.39)	(0.33)	(0.11)
Mandatory Jail Sentence	0.053***	-0.022	-0.303**
	(0.78)	(-0.23)	(-2.44)
Mandatory Minimum Jail Sentence	-0.062***	-0.009	0.141**
	(-2.07)	(-0.23)	(2.68)
Community Service in Lieu of Jail	-0.003***	-0.150***	-0.248***
	(-0.86)	(-2.08)	(-2.67)
Minimum Community Service	0.003***	0.006***	0.009***
	(3.99)	(4.98)	(5.55)
R2	0.834	0.661	0.743
F	38.12	14.82	21.89

* See note to Table 2.

Table 5: Extended Specification, 18-20*

Independent Variable	Total	Nighttime Driver	Alcohol Involved Driver
Real Income	-0.039***	-0.045***	-0.059***
	(-8.44)	(-5.49)	(-7.55)
Percentage Exceeding 65 mph	0.016***	0.017***	0.018***
	(4.53)	(2.87)	(3.03)
Total Vehicle Miles Driven	-1.524	-10.276	-18.877*
	(-0.24)	(-0.93)	(-1.76)
Percentage of Young Drivers	2.149***	2.695***	3.693***
	(3.75)	(2.80)	(3.88)
Safety Inspections	-0.097***	-0.054*	-0.032
	(-3.98)	(-1.29)	(-0.80)
Seat Belt Law	-0.082***	-0.075*	-0.180***
	(-2.90)	(-1.52)	(-3.69)
Unemployment Rate	-0.047***	-0.047***	-0.057***
	(-7.30)	(-4.16)	(-5.38)
Dry	-0.0003	-0.003	0.001
	(-0.19)	(-1.38)	(0.42)
Mormons	-0.011***	-0.005	-0.010***
	(-4.69)	(-1.17)	(-2.61)
Southern Baptists	0.004*	0.006	0.006
	(1.84)	(1.41)	(1.54)
Catholics	-0.008***	-0.001	-0.005*
	(-4.99)	(-0.32)	(-1.82)
Protestants	-0.008***	0.001	-0.005*
	(-4.59)	(0.28)	(-1.65)
Minimum Legal Drinking Age	-0.044***	-0.054***	-0.085***
	(-3.38)	(-2.46)	(-3.93)
Real Beer Tax	-86.233***	-102.116***	-117.256***
	(-7.77)	(-5.35)	(-6.36)
Preliminary Breath Test	-0.069***	-0.029	-0.116***
	(-2.80)	(-0.70)	(-2.81)
No Plea Bargaining	-0.158***	-0.227***	-0.220***
	(-4.56)	(-3.80)	(-3.81)
Dram Shop	-0.032*	-0.048	-0.051*
	(-1.41)	(-1.26)	(-1.37)
Mandatory Administrative Per Se Law	-0.045***	-0.056**	-0.164***
	(-1.01)	(-0.72)	(-2.20)
Mandatory Minimum Administrative Penalty	-0.001***	-0.001**	0.0004***
	(-2.43)	(-1.53)	(-0.72)
Mandatory Fine	-0.095	-0.082*	0.133
	(-1.48)	(-0.76)	(1.30)
Real Mandatory Minimum Fine	0.082	-0.018*	-0.160
	(1.23)	(-0.16)	(-1.47)
Mandatory License Action	-0.022	-0.033	0.048
	(-0.81)	(-0.73)	(1.09)
Mandatory Minimum License Action	-0.00004	-0.0001	-0.0002
	(-0.38)	(-0.28)	(-1.21)
Per Se BAC=0.08%	0.131*	-0.315*	0.081***
	(1.49)	(-1.82)	(0.53)
Per Se BAC=0.10%	0.055*	0.049*	0.186***
	(2.06)	(1.09)	(4.26)
Per Se BAC above 0.10%	-0.043*	-0.006*	0.155***
	(-0.77)	(-0.06)	(1.66)
Implied Consent Law	-0.013***	-0.056**	-0.043
	(-0.41)	(-1.01)	(-0.80)
Mandatory Minimum Implied Consent Penalty	0.001***	0.001**	0.001
	(4.20)	(2.40)	(1.78)
Open Container	-0.038*	-0.046	-0.060*
	(-1.41)	(-1.01)	(-1.33)
Mandatory Jail Sentence	0.171**	0.111	0.025
	(2.00)	(0.76)	(0.18)
Mandatory Minimum Jail Sentence	-0.092**	-0.044	0.023
	(-2.44)	(-0.70)	(0.38)
Community Service in Lieu of Jail	-0.101***	-0.224***	-0.355***
	(-1.62)	(-2.00)	(-3.39)
Minimum Community Service	0.005***	0.007***	0.010***
	(4.36)	(3.62)	(5.44)
R2	0.832	0.697	0.790
F	37.61	17.34	28.28

* See note to Table 2.

Table 6: Limited Specification, All Ages*

Independent Variable	Total	Nighttime Driver	Alcohol Involved Driver
Real Income	-0.030***	-0.029***	-0.048***
	(-7.62)	(-5.25)	(-6.68)
Percentage exceeding 65 mph	0.015***	0.017***	0.025***
	(5.04)	(3.96)	(4.62)
Total Vehicle Miles Driven	-4.618	2.759	-8.755
	(-0.79)	(0.34)	(-0.85)
Percentage of Young Drivers	1.254***	1.941***	3.029***
	(2.58)	(2.89)	(3.49)
Safety Inspections	-0.056***	0.012	0.021
	(-2.79)	(0.43)	(0.59)
Seat Belt Law	-0.040*	-0.047*	-0.087**
	(-1.62)	(-1.36)	(-1.93)
Unemployment Rate	-0.042***	-0.022***	-0.040***
	(-7.49)	(-2.88)	(-4.09)
Dry	-0.0002	-0.003*	0.002
	(-0.18)	(-1.91)	(1.18)
Mormons	-0.010***	-0.011***	-0.019***
	(-5.36)	(-3.91)	(-5.01)
Southern Baptists	0.001	0.0003	-0.003
	(0.45)	(0.12)	(-0.83)
Catholics	-0.011***	-0.005***	-0.012***
	(-8.26)	(-2.83)	(-5.00)
Protestants	-0.011***	-0.001	-0.006**
	(-7.95)	(-0.69)	(-2.49)
Minimum Legal Drinking Age	0.001	-0.018	-0.054***
	(0.14)	(-1.24)	(-2.99)
Real Beer Tax	-19.69***	-43.235***	-50.525***
	(-2.73)	(-4.21)	(-3.96)
Preliminary Breath Test	-0.058***	-0.070***	-0.163***
	(-3.04)	(-2.64)	(-4.90)
No Plea Bargaining	0.008	-0.103***	-0.035
	(0.32)	(-2.93)	(-0.80)
Dram Shop	-0.054***	-0.073***	-0.103***
	(-2.78)	(-2.71)	(-2.98)
Mandatory Administrative Per Se Law	0.097***	-0.072	-0.144**
	(3.02)	(-1.52)	(-2.43)
Mandatory Minimum Administrative Penalty	-0.001***	0.0001	0.0002**
	(-2.34)	(0.31)	(0.59)
Mandatory Fine	0.018	0.068**	0.191**
	(0.32)	(0.92)	(2.04)
Real Mandatory Minimum Fine	-0.035	-0.134**	-0.262**
	(-0.62)	(-1.72)	(-2.66)
Mandatory License Action	0.013	0.089**	0.088*
	(0.57)	(2.86)	(2.20)
Mandatory Minimum License Action	0.00002	-0.0003**	-0.0004*
	(-0.13)	(-2.08)	(-1.79)
R2	0.759	0.543	0.672
F	33.31	12.56	21.63

* See note to Table 2.

Table 7: Limited Specification, 18-20*

Independent Variable	Total	Nighttime Driver	Alcohol Involved Driver
Real Income	-0.032***	-0.038***	0.046***
	(-6.86)	(-4.84)	(-5.91)
percentage exceeding 65 mph	0.016***	0.017***	0.020***
	(4.50)	(2.94)	(3.32)
Total Vehicle Miles Driven	-0.745	-10.175	-25.118**
	(-0.11)	(-0.92)	(-2.24)
Percentage of Young Drivers	1.605***	2.471***	3.042***
	(2.79)	(2.68)	(3.22)
Safety Inspections	-0.053**	-0.014	-0.002
	(-2.24)	(-0.38)	(-0.04)
Seat Belt Law	-0.088***	-0.063*	-0.151***
	(-2.97)	(-1.28)	(-3.00)
Unemployment Rate	-0.043***	-0.043***	-0.045***
	(-6.54)	(-4.05)	(-4.22)
Dry	-0.002	-0.005**	-0.001
	(-1.23)	(-2.14)	(-0.61)
Mormons	-0.010***	-0.009**	-0.010***
	(-4.54)	(-2.24)	(-2.75)
Southern Baptists	-0.002	0.001	0.002
	(-0.69)	(0.29)	(0.41)
Catholics	-0.011***	-0.004t	-0.008***
	(-7.72)	(-1.68)	(-3.08)
Protestants	-0.008***	0.003	0.0005
	(-4.83)	(0.98)	(0.19)
Minimum Legal Drinking Age	-0.041***	-0.053***	-0.090***
	(-3.42)	(-2.71)	(-4.56)
Real Beer Tax	-62.280***	-79.953***	-83.395***
	(-7.20)	(-5.54)	(-5.92)
Preliminary Breath Test	-0.100***	-0.062**	-0.173***
	(-4.47)	(-1.70)	(-4.71)
No Plea Bargaining	-0.013	-0.093**	0.045
	(-0.43)	(-1.94)	(-0.94)
Dram Shop	-0.036*	-0.053*	-0.057*
	(-1.56)	(-1.43)	(-1.52)
Mandatory Administrative Per Se Law	0.055*	-0.040	-0.109**
	(1.41)	(-0.62)	(-1.65)
Mandatory Minimum Administrative Penalty	-0.001*	-0.0004	-0.0003**
	(-2.28)	(-0.76)	(-0.67)
Mandatory Fine	-0.037	-0.031**	0.131**
	(-0.58)	(-0.31)	(1.29)
Real Mandatory Minimum Fine	0.034	-0.073**	-0.221**
	(0.51)	(-0.69)	(-2.07)
Mandatory License Action	0.026	0.010	0.072
	(1.00)	(0.22)	(1.66)
Mandatory Minimum License Action	0.00003	-0.0001	-0.0002
	(-0.26)	(-0.44)	(-0.83)
R2	0.792	0.661	0.746
F	40.28	20.45	30.71

* See note to Table 2.

Table 8: Policy Simulations, All Ages*

Simulation	Total Fatalities	Nighttime Driver Fatalities	Alcohol Involved Driver Fatalities
Real Beer Tax Maintains 1951 value - increase nominal tax with CPI (71.6¢ per 6-pack in 1988)	-5,174*** -11.5%	-1,285*** -23.5%	-3,885*** -26.9%
Tax on Alcohol in Beer Equalized with Tax on Alcohol in Spirits (78.4¢ per 6-pack in 1988)	-5,771*** -12.8%	-1,420*** -26.0%	-4,280*** -29.7%
Deficit Reduction Tax Increase - Doubling of the beer tax to 32¢ per six-pack	-1,744*** -3.9%	-456*** -8.4%	-1,400*** -9.7%
21 year old minimum legal purchase age in all states	+50 +0.1%	-75* -1.4%	-625*** -4.3%
18 year old minimum legal purchase age in all states	-147 -0.3%	+218* +4.0%	+1,822*** +12.6%
preliminary breath test law in all states	-1,512*** -3.4% -1,067*** -2.3%	-223*** -4.1% -159*** -2.8%	-1,348*** -9.3% -976*** -6.3%
no plea bargaining law in all states	+282 +0.6% +74 +0.2%	-429*** -7.9% -114*** -2.0%	-398 -2.8% -105 -0.7%
dram shop law in all states	-852*** -1.9% -1,584*** -3.4%	-137*** -2.5% -265*** -4.6%	-530*** -3.7% -977*** -6.3%
mandatory minimum nominal fine in all states of $500 upon conviction for DUI	-1,463 -3.3% -200 -0.4%	-649** -11.9% -87** -1.6%	-2,738** -19.0% -178** -1.2%
mandatory minimum administrative per se penalty of 1 year license action	-4,202*** -9.4% +291*** +0.7%	-151 -2.8% -41 -0.8%	-565** -3.9% -222** -1.5%
mandatory minimum license action of 1 year upon conviction for DUI	+177 +0.4% +143 +0.3%	-250** -4.6% +91** +1.7%	-867* -6.0% +220* +1.5%

The policy simulations use the estimates from the limited variables models. Each cell contains estimates of the absolute change in fatalities per year, on average, of the simulated policy (first row) and the percentage change in the fatality rate resulting from the policy simulation (second row). In addition, the DUI law simulations include an estimate of the number of lives saved annually, on average, as a result of laws already in place (third row), and the estimated percentage reduction in the fatality rate from these existing laws (fourth row). ***, **, * represent simulations based on coefficients significant at the 1%, 5%, and 10% levels, respectively.

Table 9: Policy Simulations, 18 to 20 Year Olds

Simulation	Total Fatalities	Nighttime Driver Fatalities	Alcohol Involved Driver Fatalities
Real Beer Tax Maintains 1951 value - Increase nominal tax with CPI (71.6¢ per 6-pack in 1988)	-1,660*** -32.1%	-379*** -39.1%	-739*** -40.3%
Tax on Alcohol in Beer Equalized with Tax on Alcohol in Spirits (78.4¢ per 6-pack in 1988)	-1,822*** -35.2%	-413*** -42.6%	-804*** -43.9%
Deficit Reduction Tax Increase - Doubling of the beer tax to 32¢ per six-pack	-611*** -11.8%	-145*** -14.9%	-285*** -15.6%
21 year old minimum legal purchase age in all states	-166*** -3.2%	-42*** -4.4%	-138*** -7.5%
18 year old minimum legal purchase age in all states	+498*** +9.6%	+118*** +12.1%	+389*** +21.3%
preliminary breath test law in all states	-299*** -5.8% -215*** -4.0%	-35** -3.6% -25** -2.6%	-179*** -9.8% -133*** -6.8%
no plea bargaining law in all states	-51 -1.0% -13 -0.3%	-70** -7.2% -18** -1.8%	-65 -3.5% -17 -0.9%
dram shop law in all states	-66*** -1.3% -119*** -2.2%	-18* -1.8% -34* -3.3%	-37* -2.0% -68* -3.6%
mandatory minimum nominal fine in all states of $500 upon conviction for DUI	+94 +1.8% -10 -0.2%	-109** -11.2% -27** -2.7%	-334** -18.2% -34** -1.8%
mandatory minimum administrative per se penalty of 1 year license action	-815* -15.7% NC* NC	-145 -15.0% -8 -0.9%	-347** -19.0% -31** -1.7%
mandatory minimum license action of 1 year upon conviction for DUI	+41 +0.8% -215 -4.0%	-21 -2.2% NC NC	-10 -0.5% +29 +1.6%

See note to Table 8.

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