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Applied Econometrics and Time Series Analysis
Project Report
Group 1

Impact of Minimum Legal Drinking Age on Traffic Fatalities

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1. Introduction

Background

The possible impact of the minimum legal drinking age (MLDA) on public health and safety, particularly concerning road fatalities, has long been a topic of discussion and examination. The goal of enacting MLDA legislation was to lower the number of alcohol-related collisions involving young drivers. While some countries set the age at 18, others set it at 21. Policymakers, law enforcement organizations, and public health advocates must comprehend the connection between MLDA and traffic deaths to put into place efficient policies that emphasize road safety and lessen the dangers of underage alcohol use. In 1984, a federal law raised the Minimum Legal Drinking Age (MLDA) to 21 across the United States, intending to decrease alcohol-related accidents and deaths.

Objective

This paper examines the relationship between minimum legal drinking age (MLDA) legislation and traffic fatalities, looking for trends, patterns, and possible causes. This project aims to give insights that guide policy decisions and initiatives to reduce alcohol-related accidents and improve public health outcomes. We will synthesize previous research, analyze pertinent data, and explore various factors influencing road safety to achieve this. To throw light on potential policy implications and future research directions, this paper will review the literature that has already been written about the complex relationship between MLDA laws and traffic fatalities. It will also evaluate statistical data and provide insights into this relationship.

2. Literature Review

The study "The Effect of Minimum Drinking Age Legislation on Youthful Auto Fatalities, 1970-1977" by Philip J. Cook and George Tauchen looks into how minimum drinking age laws affected young people who were killed in automobile accidents between 1970 and 1977. The authors use a rigorous analytical approach to investigate the relationship between minimum drinking age legislation and road safety results. They consider several aspects, including changes in public attitudes toward alcohol consumption, demographic data, and the execution of these laws. This research investigates the impact of minimum drinking age laws on the number of young people who die in motor accidents by looking at past data and using statistical approaches. The findings provide insights on road safety and underage drinking behavior to stakeholders and policymakers, which broaden our understanding of the connection between alcohol policy and public health outcomes.

Another study, “The fatal toll of driving to drink: The effect of minimum legal drinking age evasion on traffic fatalities” by Michael F. Lovenheim and Joel Slemrod, adds to the body of research on the subject by examining the effect of avoiding the minimum legal drinking age (MLDA) on young drunk driving. Through the use of sophisticated GIS software and micro-data on fatal car accidents from 1977 to 2002, the study provides important new information by concentrating on states with different alcohol laws. It demonstrates that legislative limits on alcohol consumption do not reduce the involvement of minors in fatal accidents in counties that are situated within a 25-mile radius of a jurisdiction with a lower MLDA. There has been a noted rise in the number of fatal accidents involving drivers between the ages of 18 and 19. On the other hand, MLDA limitations show efficacy in lowering accident mortality in locations further away from such borders, which is consistent with other research findings. The estimations show that there was a significant decline in adolescent-related mortality during the 1970s and 1980s following the equalization of the state minimum legal drinking age (MLDA) at 21. More specifically, this equalization is anticipated to account for approximately 15 percent of the reduction for 19-year-olds and between 25 and 33 percent for 18-year-olds.

Additionally, the study finds that the consequences of MLDA alterations vary depending on how close a state's population is to its boundaries, which makes MLDA evasion possible. These results highlight the potential consequences of decreasing the MLDA in some jurisdictions, as Vermont proposes. This could result in a significant rise in the number of young drivers involved in fatal accidents as a result of circumventing state alcohol laws.

3. Data

A thorough dataset for examining road deaths in the US is provided by the "Fatalities" dataset, which can be found in the "AER" package in R. It includes details on 336 observations for 34 different variables. Important variables in the dataset consist of:

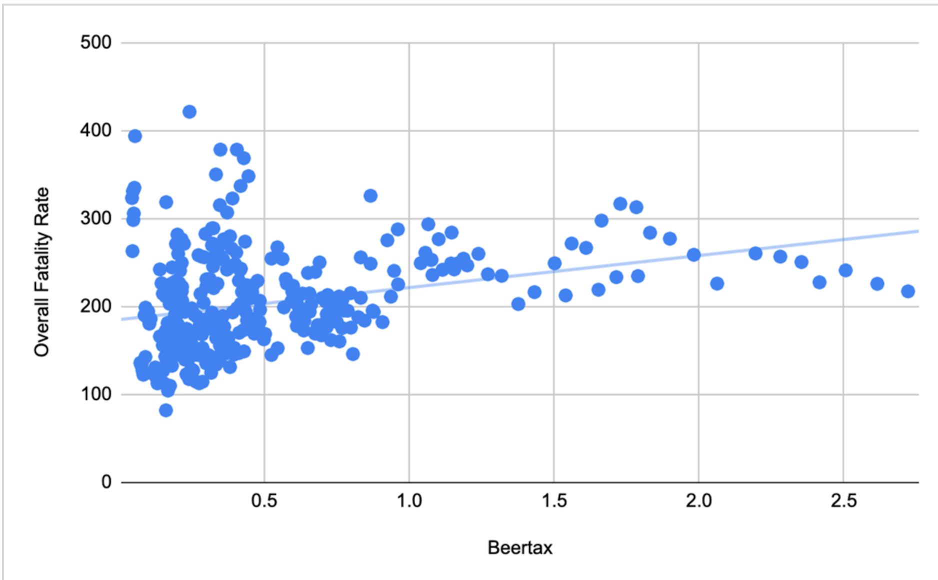
1. State (state): Factor indicating the state.
2. Year (year): Factor indicating the year.
3. Spirits Consumption (spirits): Numeric value representing spirits consumption.
4. Unemployment Rate (unemp): Numeric value indicating the unemployment rate.
5. Per Capita Personal Income (income): Numeric value in 1987 dollars.
6. Employment/Population Ratio (emppop): Numeric value representing the employment-to-population ratio.
7. Beer Tax (beertax): Numeric value denoting the tax on a case of beer.
8. Minimum Legal Drinking Age (drinkage): Numeric value indicating the minimum legal drinking age.
9. Percent of Drivers Aged 15–24 (youngdrivers): Numeric value representing the percentage of drivers aged 15–24.
10. Average Miles per Driver (miles): Numeric value indicating the average miles traveled per driver.
11. Preliminary Breath Test Law (breath): Factor indicating whether there is a preliminary breath test law.
12. Mandatory Jail Sentence (jail): Factor indicating whether a mandatory jail sentence is imposed.
13. Mandatory Community Service (service): Factor indicating whether mandatory community service is imposed.
14. Number of Vehicle Fatalities (fatal): Numeric value representing the total number of vehicle fatalities.
15. Number of Night-Time Vehicle Fatalities (nfatal): Numeric value representing night-time vehicle fatalities.
16. Number of Single-Vehicle Fatalities (sfatal): Numeric value representing single-vehicle fatalities.
17. Number of Alcohol-Involved Vehicle Fatalities (afatal): Numeric value representing alcohol-involved vehicle fatalities.
18. Population (pop): Numeric value representing the population.
19. US Unemployment Rate (unempus): Numeric value representing the US unemployment rate.

This dataset is useful for researching the connections between socioeconomic characteristics, drinking habits, and traffic deaths in the US. It provides information on the possible factors that influence road safety and can help create interventions and policies that effectively lower the number of traffic fatalities and accidents.

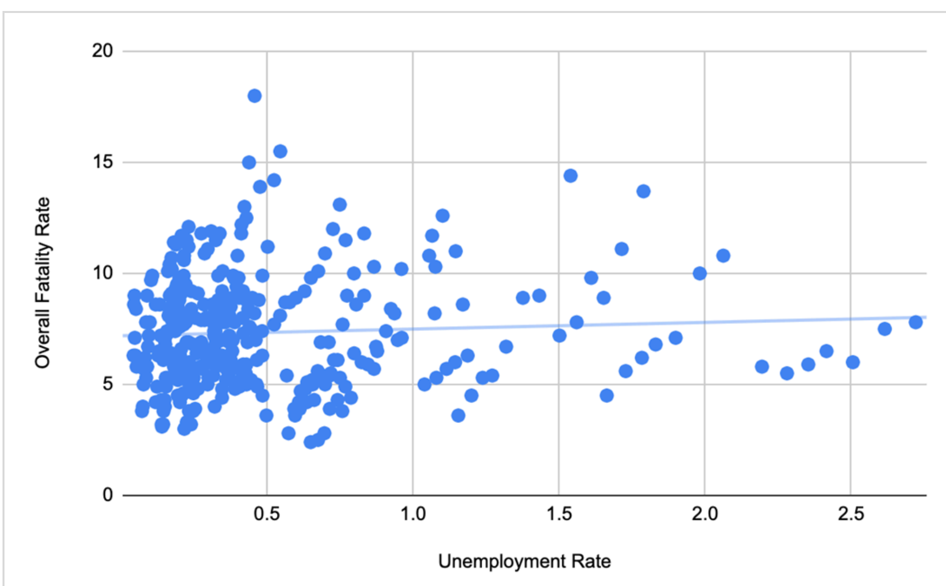
4. Exploratory Analysis

The goal of exploratory analysis is to understand the data by its distribution. The following plots help us understand the trend and overall view of the dataset.

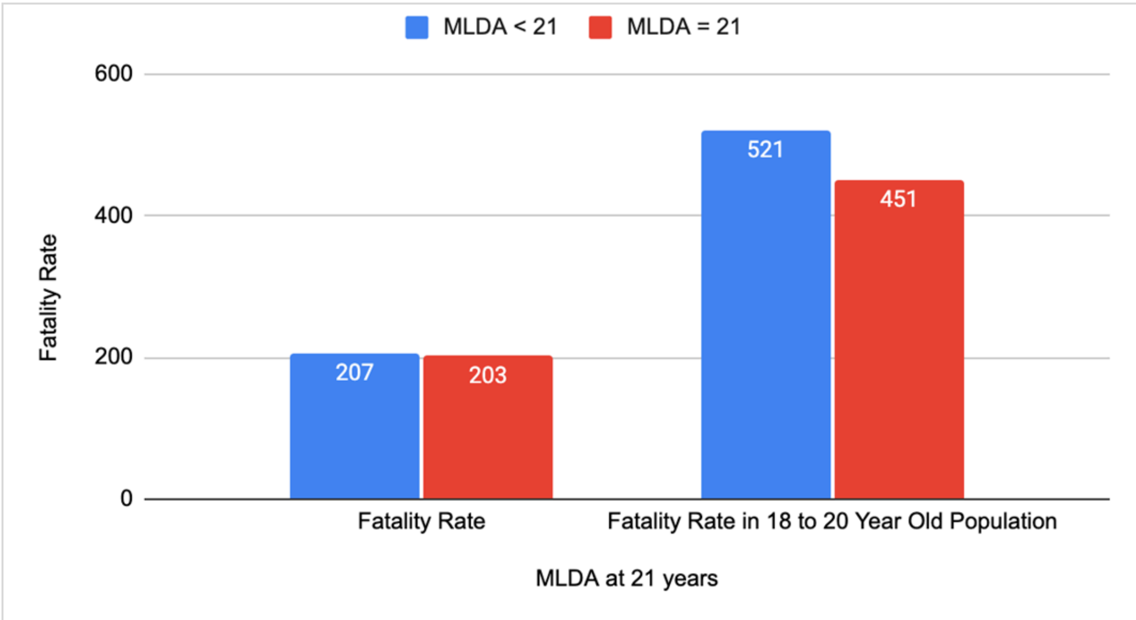
1. Fatality Rate (per mil) with respect to Beertax: With an increase in Beertax, the fatality rates tend to increase.



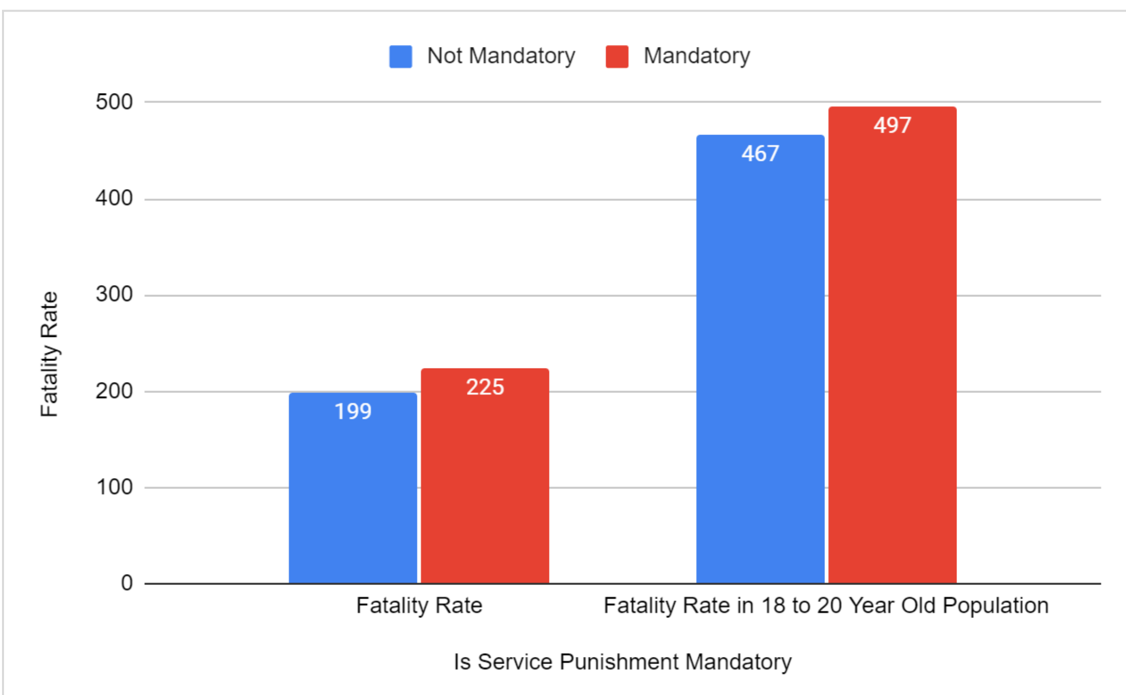
2. Fatality Rate (per mil) with respect to Unemployment Rate: With an increase in the unemployment rate, the fatality rates tend to increase.



3. Fatality Rate (per mil) vs. MLDA at 21 years: With MLDA increased to 21 years, the fatalities overall have a marginal change, but the fatalities in the 18-20-year-old population are lowered.



4. Fatality Rate vs. Is Service Punishment Mandatory: With Jain Punishment mandatory, the fatalities overall and in the 18-20-year-old population have a marginal increase.



5. Empirical Methods and Results

Models 1 to 5 demonstrate the effect of the policy of change in beer tax on the fatality rates. These models illustrate the method used to conclude eventually.

Model 1: $frate = \beta_0 + \beta_1 \times beertax + u$

This model with just the Beertax variable gives a biased estimator for the variable.

```
53. regress frate beertax
```

Source	SS	df	MS
Model	101686.587	1	101686.587
Residual	987468.538	334	2956.49263
Total	1089155.12	335	3251.20933

Number of obs	=	336
F(1, 334)	=	34.39
Prob > F	=	0.0000
R-squared	=	0.0934
Adj R-squared	=	0.0906
Root MSE	=	54.374

frate	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
beertax	36.46054	6.216983	5.86	0.000	24.23117	48.68992
_cons	185.3308	4.356714	42.54	0.000	176.7607	193.9008

Model 2: $frate = \beta_0 + \beta_1 \times beertax + \beta_2 \times Year(f.e.) + u$

In this model, even after using the time fixed effects with year, the Beertax variable still gives a biased estimator for the variable.

```
55. regress frate beertax year1 year2 year3 year4 year5 year6
```

Source	SS	df	MS
Model	107442.939	7	15348.9912
Residual	981712.186	328	2993.02496
Total	1089155.12	335	3251.20933

Number of obs	=	336
F(7, 328)	=	5.13
Prob > F	=	0.0000
R-squared	=	0.0986
Adj R-squared	=	0.0794
Root MSE	=	54.709

frate	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
beertax	36.63358	6.26	5.85	0.000	24.31877	48.94839
year1	.10271	11.1718	0.01	0.993	-21.87471	22.08013
year2	-8.100875	11.17218	-0.73	0.469	-30.07905	13.8773
year3	-7.070598	11.17168	-0.63	0.527	-29.04778	14.90659
year4	-10.95187	11.16975	-0.98	0.328	-32.92526	11.02152
year5	-1.509135	11.1688	-0.14	0.893	-23.48064	20.46237
year6	-1.450838	11.16775	-0.13	0.897	-23.42028	20.51861
_cons	189.3821	8.448465	22.42	0.000	172.762	206.0021

Model 3: frate = $\beta_0 + \beta_1 \times$ beertax + $\beta_2 \times$ Year(f.e.) + $\beta_3 \times$ State(f.e.) + u

In this model, after using the time fixed effects and state fixed effects, the Beertax variable gives a close-to-true estimator for the variable. Now, with the close-to-true estimator, we can use this variable as a control variable to calculate the effect of MLDA21.

```
59. regress frate beertax state1 state2 state3 state4 state5 state6 state7 state8 state9
  >  state10 state11 state12 state13 state14 state15 state16 state17 state18 state19 sta
  > te20 state21 state22 state23 state24 state25 state26 state27 state28 state29 state30
  >  state31 state32 state33 state34 state35 state36 state37 state38 state39 state40 sta
  > te41 state42 state43 state44 state45 state46 state47 year2 year3 year4 year5 year6

      Source |       SS           df       MS      Number of obs   =       336
-------------+----------------------------------   F(53, 282)      =     52.75
       Model |  989358.727        53  18667.1458   Prob > F        =    0.0000
    Residual |   99796.398       282  353.887936   R-squared       =    0.9084
-------------+----------------------------------   Adj R-squared   =    0.8912
       Total |  1089155.12       335  3251.20933   Root MSE        =    18.812

------------------------------------------------------------------------------
       frate | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
     beertax |  -57.51198   19.12805    -3.01   0.003    -95.16386   -19.86009
      state1 |   10.12659   31.77181     0.32   0.750    -52.41343     72.6666
      state2 |  -47.02494   14.44837    -3.25   0.001    -75.46529   -18.58459
      state3 |  -36.04511   11.24251    -3.21   0.002      -58.175   -13.91522
      state4 |  -128.4855   10.09751   -12.72   0.000    -148.3615   -108.6094
      state5 |  -126.7446   10.42837   -12.15   0.000    -147.2719   -106.2173
      state6 |  -164.8562   10.64962   -15.48   0.000     -185.819   -143.8934
      state7 |  -108.7742   10.26172   -10.60   0.000    -128.9735   -88.57492
      state8 |  -12.58269   22.75987    -0.55   0.581    -57.38348    32.21811
      state9 |   55.99159   46.85254     1.20   0.233    -36.23351    148.2167
```

Model 4: frate = $\beta_0 + \beta_1 \times$ beertax + $\beta_2 \times$ MLDA21 + $\beta_3 \times$ State(f.e.) + u

In this model, after using the state fixed effects and Beertax variable, the dummy variable MLDA21 gives a biased estimator for the variable. We aim to estimate the impact of MLDA21 on the fatality rate.

```
69. regress frate beertax drinkage21 state1 state2 state3 state4 state5 state6 state7 st
  > ate8 state9 state10 state11 state12 state13 state14 state15 state16 state17 state18
  > state19 state20 state21 state22 state23 state24 state25 state26 state27 state28 stat
  > e29 state30 state31 state32 state33 state34 state35 state36 state37 state38 state39
  > state40 state41 state42 state43 state44 state45 state46 state47

      Source |       SS           df       MS      Number of obs   =       336
-------------+----------------------------------   F(49, 286)      =     56.26
       Model |  986785.707        49  20138.4838   Prob > F        =    0.0000
    Residual |  102369.417       286  357.935026   R-squared       =    0.9060
-------------+----------------------------------   Adj R-squared   =    0.8899
       Total |  1089155.12       335  3251.20933   Root MSE        =    18.919

------------------------------------------------------------------------------
       frate | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
     beertax |  -61.49352   18.86613    -3.26   0.001     -98.6276   -24.35945
  drinkage21 |   5.740144   3.297956     1.74   0.083    -.7512008    12.23149
      state1 |   13.93994   31.59704     0.44   0.659    -48.25229    76.13218
      state2 |  -50.60546   15.04246    -3.36   0.001    -80.21344   -20.99749
      state3 |  -38.27856   11.52148    -3.32   0.001    -60.95622   -15.60089
      state4 |  -134.0338   10.71059   -12.51   0.000    -155.1154   -112.9523
      state5 |  -131.9094   11.08232   -11.90   0.000    -153.7226   -110.0961
      state6 |  -166.5861   10.83758   -15.37   0.000    -187.9177   -145.2546
```

Model 5: frate = $\beta_0 + \beta_1 \times$ beertax + $\beta_2 \times$ MLDA21 + $\beta_3 \times$ State(f.e.) + $\beta_4 \times$ Year(f.e.) + u

In this model, after using the time fixed effects, state fixed effects, and Beertax variable, the dummy variable MLDA21 gives a biased estimator for the variable.

```
73. regress frate beertax drinkage21 state1 state2 state3 state4 state5 state6 state7 st
  > ate8 state9 state10 state11 state12 state13 state14 state15 state16 state17 state18
  > state19 state20 state21 state22 state23 state24 state25 state26 state27 state28 stat
  > e29 state30 state31 state32 state33 state34 state35 state36 state37 state38 state39
  > state40 state41 state42 state43 state44 state45 state46 state47 year2 year3 year4 ye
  > ar5 year6 year7

      Source |       SS           df       MS      Number of obs   =       336
-------------+----------------------------------   F(55, 280)      =     51.57
       Model |  991294.534        55  18023.537    Prob > F        =    0.0000
    Residual |  97860.5907       280  349.50211    R-squared       =    0.9101
-------------+----------------------------------   Adj R-squared   =    0.8925
       Total |  1089155.12       335  3251.20933   Root MSE        =    18.695

------------------------------------------------------------------------------
       frate | Coefficient  Std. err.      t    P>|t|     [95% conf. interval]
-------------+----------------------------------------------------------------
     beertax |  -67.28119    19.7115    -3.41   0.001    -106.0827   -28.47965
  drinkage21 |   7.738904   3.963538     1.95   0.052    -.0632113    15.54102
      state1 |   22.20252   32.53209     0.68   0.495      -41.836    86.24104
      state2 |  -49.46495   14.92143    -3.32   0.001    -78.83737   -20.09253
      state3 |  -37.89929   11.39448    -3.33   0.001    -60.32901   -15.46956
      state4 |  -135.7538   10.76229   -12.61   0.000    -156.9391   -114.5686
      state5 |  -133.0718   11.03424   -12.06   0.000    -154.7924   -111.3512
      state6 |  -166.3814   10.71267   -15.53   0.000     -187.469   -145.2938
      state7 |  -113.2563   10.55014   -10.74   0.000     -134.024   -92.48865
      state8 |  -5.471264   23.22427    -0.24   0.814    -51.18759    40.24506
```

Model 6: frate = β0 + β1 × beertax + β2 × MLDA21 + β3 × Jail + β4 × Service + β5 × Unemp + β6 × Income + β7 × State(f.e.) + β8 × Year(f.e.) + u

In this model, after using the time fixed effects, state fixed effects, and Beertax variable, along with additional control variables related to punishment (jail, service) and economic variables (like unemployment, income), the dummy variable MLDA21 gives a biased estimator for the variable. The coefficient of beer tax is -55.3, which has a negative relationship between beer tax and fatality rate. The MLDA21 variable has a positive coefficient (0.85). The value is low but is statistically insignificant. The Jail and Service dummy variables (indicating the presence of jail and service punishments, respectively) have positive but statistically insignificant coefficients, suggesting that these punishment measures do not significantly impact the overall fatality rate. The unemployment rate (unemp) has a negative and statistically significant coefficient of -7.71, indicating that higher unemployment rates are associated with lower overall fatality rates.

frate	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
beertax	-55.3392	16.98869	-3.26	0.001	-88.78307	-21.89532
drinkage21	.8525711	3.512422	0.24	0.808	-6.06197	7.767112
jail_dum	2.250555	12.30627	0.18	0.855	-21.97552	26.47663
service_dum	2.782969	14.12929	0.20	0.844	-25.03189	30.59783
unemp	-7.707698	1.078441	-7.15	0.000	-9.830713	-5.584684
income	.0068929	.0022469	3.07	0.002	.0024696	.0113161
state1	46.40796	30.43093	1.53	0.128	-13.49826	106.3142
state2	-18.79276	18.40491	-1.02	0.308	-55.02461	17.43908
state3	-42.22094	16.93212	-2.49	0.013	-75.55345	-8.888419
state4	-150.2508	17.18016	-8.75	0.000	-184.0716	-116.43
state5	-147.0182	27.48229	-5.35	0.000	-201.1197	-92.91662
state6	-228.9575	19.77927	-11.58	0.000	-267.895	-190.0201
state7	-135.2877	15.69763	-8.62	0.000	-166.19	-104.3854

Model 7: frate = $\beta_0 + \beta_1 \times$ beertax + $\beta_2 \times$ MLDA21 + $\beta_3 \times$ Jail + $\beta_4 \times$ Service + $\beta_5 \times$ Unemp + $\beta_6 \times$ Income + $\beta_7 \times$ Spirits + $\beta_8 \times$ Miles + $\beta_9 \times$ Baptist + $\beta_{10} \times$ Mormon + $\beta_{11} \times$ Dry + $\beta_{12} \times$ State(f.e.) + $\beta_{13} \times$ Year(f.e.) + u

frate	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
beertax	-33.47495	18.39053	-1.82	0.070	-69.68142	2.731526
drinkage21	.9696894	3.291461	0.29	0.769	-5.510395	7.449773
jail_dum	4.943442	11.28161	0.44	0.662	-17.26729	27.15418
service_dum	-1.976393	13.00992	-0.15	0.879	-27.58976	23.63697
unemp	-5.691448	1.050477	-5.42	0.000	-7.759581	-3.623314
income	.0081235	.0020893	3.89	0.000	.0040102	.0122367
spirits	80.6433	11.33137	7.12	0.000	58.33459	102.952
miles	.0012279	.0008232	1.49	0.137	-.0003928	.0028486
baptist	-7.115296	4.994286	-1.42	0.155	-16.94783	2.717236
mormon	.3844676	4.036314	0.10	0.924	-7.562052	8.330987
dry	2.140054	1.212518	1.76	0.079	-.2470995	4.527207
state1	206.7049	134.8102	1.53	0.126	-58.70362	472.1133
state2	102.57	112.6249	0.91	0.363	-119.161	324.3009
state3	-33.34781	20.93788	-1.59	0.112	-74.56939	7.873777
state4	-164.8693	32.78491	-5.03	0.000	-229.4148	-100.3238

In this model, after using the time fixed effects, state fixed effects, and Beertax variable, along with additional control variables related to punishment (jail, service), economic variables (like unemployment, income), and demographic variables (religious inclination), the dummy variable MLDA21 gives a positive estimator for the variable. The coefficient of beer tax is -33.4, which has a negative relationship between beer tax and fatality rate. The MLDA21 variable has a positive coefficient (0.85). The value is low but is statistically insignificant. The Jail and Service dummy variables (indicating the presence of jail and service punishments, respectively) have positive but insignificant coefficients. The unemployment rate (unemp) has a negative and statistically significant coefficient of -5.69, indicating that higher unemployment rates are associated with lower overall fatality rates. Thus, an MLDA of 21 does not significantly impact the overall fatality rate.

Model 8: f1820rate = $\beta_0 + \beta_1 \times$ beertax + $\beta_2 \times$ MLDA21 + $\beta_3 \times$ Jail + $\beta_4 \times$ Service + $\beta_5 \times$ Unemp + $\beta_6 \times$ Income + $\beta_7 \times$ Spirits + $\beta_8 \times$ Miles + $\beta_9 \times$ Baptist + $\beta_{10} \times$ Mormon + $\beta_{11} \times$ Dry + $\beta_{12} \times$ State(f.e.) + $\beta_{13} \times$ Year(f.e.) + u

In this model, we regress the fatality rate of the population of more than 18 but less than 21 years of age and after using the time fixed effects, state fixed effects, Beertax variable, along with additional control variables related to punishment (jail, service), economic variables (like unemployment, income), and demographic variables (religious inclination), the dummy variable MLDA21 gives a negative and significant estimator for the variable. The coefficient of beer tax is -41.32, which has a negative relationship between beer tax and fatality rate. The MLDA21 variable has a negative coefficient of -39.82. The value is meaningful and is statistically significant. The Jail and Service dummy variables (indicating the presence of jail and service punishments, respectively) have insignificant coefficients. The unemployment rate (unemp) has a negative and marginally significant coefficient of -10.56, indicating that higher unemployment rates are associated with lower overall fatality rates. Thus, an MLDA of 21 has a significant impact on the fatality rate of the Population between 18 and 21 years of age.

f1820rate	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
beertax	-41.32408	96.22371	-0.43	0.668	-230.7651	148.1169
drinkage21	-39.82965	17.22172	-2.31	0.021	-73.73502	-5.924287
jail_dum	31.43102	59.02809	0.53	0.595	-84.78091	147.6429
service_dum	-53.70374	68.07106	-0.79	0.431	-187.7191	80.31159
unemp	-10.56079	5.496351	-1.92	0.056	-21.38177	.260182
income	.0168494	.0109316	1.54	0.124	-.0046722	.038371
spirits	273.6126	59.28846	4.61	0.000	156.8881	390.3372
miles	-.005303	.0043072	-1.23	0.219	-.0137829	.0031769
baptist	-35.6919	26.13131	-1.37	0.173	-87.13809	15.75428
mormon	21.39283	21.11897	1.01	0.312	-20.18528	62.97094
dry	-.8806567	6.344189	-0.14	0.890	-13.37082	11.60951
state1	1080.228	705.3597	1.53	0.127	-308.4533	2468.909
state2	881.5324	589.2807	1.50	0.136	-278.6176	2041.682
state3	-141.4247	109.552	-1.29	0.198	-357.106	74.2566
state4	-416.3652	171.5386	-2.43	0.016	-754.0828	-78.64754
state5	-369.7292	187.9702	-1.97	0.050	-739.7968	.3383483

6. Conclusion

Through the models, we have found that Beertax, unemployment rates, and Income correlate with increased overall fatalities, indicating economic factors' influence on risky behaviors. These economic factors play the majority role in controlling the overall fatalities in road accidents. Also, an increase in the Minimum Legal Drinking Age does not significantly impact the overall fatalities, illustrating that more prominent factors are at play.

Considering fatalities involving individuals aged between 18 and 21 years, the fatality rate is significantly negatively correlated with the MLDA Law implementation, indicating that the new Law has significantly reduced the fatality rates involving individuals aged between 18 and 21 years.

While the overall fatality rate is not affected after MLDA implementation, there is a significant decrease in the fatality rate due to MLDA implementation in a localized population of ages between 18 and 21.

6. References

Dictionary: https://search.r-project.org/CRAN/refmans/AER/html/Fatalities.html

MLDA Data: U.S. history of alcohol minimum purchase age by state - Wikipedia:
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