

Blue Laws, DUIs and Alcohol-Related Accidents: Regression Discontinuity Evidence from Colorado

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ABSTRACT. On July 1st, 2008, Colorado Blue Laws banning Sunday packaged liquor sale were repealed. We estimate the effect of this policy change on alcohol-related accidents and traffic citations in a regression discontinuity design. Across specifications, we find no evidence that the repeal of Colorado Blue Laws increased or decreased alcohol-related accidents and alcohol-related traffic citations. This stands in sharp contrast with previous studies that found a 30% increase or more in alcohol-related accidents on Sundays following the repeal of similar laws in New Mexico (I18, C22, R41).

I. Introduction

Blue Laws are restrictions, typically in the form of bans on activities on Sundays, that aim to promote moral codes. Blue Laws in various forms exist in roughly half of all states in the United States. While the original intent of these laws was religious in nature, the Supreme Court of the United States has upheld their constitutionality on the grounds of a state interest in a secular “day of rest.” That this secular day of rest happens to coincide with the Christian Sabbath was deemed not sufficient to violate the Establishment Clause.¹ While Blue Laws were originally written to encourage church attendance and discourage non-religious activities on Sundays (including all retail activities in some cases), most of the current laws in the US are limited to the sale of alcohol, hunting, and car sales at car dealerships.

On July 1st 2008, Colorado became the 35th state to allow Sunday packaged liquor sales, a practice banned by state law since Prohibition ended in 1933. On Sundays prior to the repeal, only 3.2% alcohol-by-volume beer was allowed to be sold in supermarkets, and hard liquor

*Special thanks to Jessica Zender of the Colorado Judicial Branch-Division of Planning and Analysis and Chris Wyckoff of the Denver Safety Office of Policy Analysis. Bo Yu is with the Department of Mathematics and Computer Science, Colorado School of Mines; corresponding author e-mail: byu@mymail.mines.edu, tel: 720-256-0573. Daniel Kaffine is with the Division of Economics and Business, Colorado School of Mines.

could be purchased by the drink at restaurants and bars. Several studies have shown that there is a strong relationship between repealing Blue Laws and alcohol-related accidents (McMillan and Lapham (2006), McMillan et al. (2007), Smith (1978)). In particular, McMillan and Lapham (2006) found that the repeal of the Sunday packaged liquor ban in New Mexico in 1995 resulted in a 29% increase in alcohol-related accidents on Sundays.² The recent repeal of Blue Laws in Colorado provides an opportunity to further evaluate the impact of increased liquor availability on public safety. This paper seeks to answer the question: Does increased alcohol availability following the repeal of Blue Laws increase the number of alcohol-related accidents and driving under the influence (DUI) citations?

There are number of potential behavioral responses to consider following the repeal of Sunday liquor bans. First, repeal opponents claim that the ability to purchase packaged alcohol on Sundays increases the amount of drinking on Sundays, and therefore increases the amount of drinking and driving. Second, others argue that the ability to purchase packaged alcohol moves drinking out of bars and into the home, and thus leads to *less* drinking and driving. This argument was advanced by advocates of House Bill 176 (Blue Law Repeal) in New Mexico. Finally, the ability to purchase packaged liquor on Sundays may have no effect at all, due to intertemporal substitutability in alcohol purchases (i.e. liquor cabinets). Individuals intending to drink on Sunday can simply buy their alcohol at an earlier point in the week, and consume it at their leisure at home. Furthermore, individuals making a spontaneous decision to drink on Sundays could still purchase 3.2% beer at supermarkets and hard liquor at bars.³ Thus, repealing the law may change an individual's purchasing behavior, but not their consumption or driving behavior, leading to little to no impact on drinking and driving.⁴

This paper analyzes the effect of repealing of the Sunday liquor ban on drinking and driving using daily alcohol-related accident counts and weekly DUI citations pre and post policy. To control for confounding factors, we use a regression discontinuity design to identify the effect of the repeal. In contrast with previous studies, we find no evidence of a change in alcohol-related accidents in Colorado due to Blue Law repeal. In addition, we also analyze the effect of repeal on DUI citations and again find no evidence for an effect.

Our analysis is relevant to debates surrounding both Blue Laws and alcohol availability laws in general. Given the substantial number of

fatalities a year from drinking and driving, empirical evidence detailing which policies are effective in reducing fatalities is very important.⁵ This study also highlights the general importance of considering potential substitution patterns when crafting public policy.⁶

II. Data

A. ALCOHOL-RELATED ACCIDENTS

Daily accident counts in the city and county of Denver from January 1st 2007 to December 31st 2009 were obtained from the Denver Safety Office of Policy Analysis. An accident is classified as alcohol-related if the driver was: 1) driving a motor vehicle while ability-impaired by alcohol, 2) driving a motor vehicle while under the influence of alcohol (DUI), or 3) driving a motor vehicle with a blood alcohol of 0.08. It should be noted that compared to McMillan and Lapham (2006) study in New Mexico, our accident dataset covers fewer years (three years versus ten years) and fewer people (600,000 versus 1.5 million). Given the recent nature of the repeal, data on post-repeal accidents beyond the end of 2009 is simply unavailable at this time. While a longer time series could further control for seasonality in accidents, the flexible polynomial used below in the regression discontinuity design will allow for control for smooth trends in accidents unrelated to the repeal.⁷

A binary indicator was created as a control for extra enforcement days, based on the “Heat Is On!” program, where major police enforcement activities are conducted on high risk days (holidays, summer weekends, etc.). Additional control variables include daily precipitation (aggregated rainfall and snowfall) for Denver county, average weekly gas prices for the state of Colorado, the monthly state unemployment rates, and number of daily non-alcohol-related accidents.⁸ Precipitation increases the chance of an accident in general, and thus may also increase the chance of an alcohol-related accident. Gas prices are included as increased gas prices decrease driving demand, potentially shifting drinking from bars into individuals' homes. Unemployment is included as it may affect drinking and driving through two channels: first, economic downturns may increase stress, and drinking may serve as a coping mechanism. Second, increased unemployment and economic downturns reduce household income, decreasing drinking as household budgets run leaner.⁹ Finally non-alcohol-related accidents is included as

a measure for the number of drivers.

B. ALCOHOL-RELATED TRAFFIC CITATIONS

The daily number of alcohol-related traffic citations given in the state of Colorado (except Denver County) from January 1st 2007 to December 31st 2009 was also collected for our analysis of the effect of Blue Law repeal.¹⁰ The number of DUI counts per day in the original data represented when the citation was reported to the courthouses, not when it occurred. For this reason, observed counts on weekends are essentially zero (most courthouses are closed on weekends), while the number of counts observed on Mondays is significantly higher than the counts observed on any other day. This occurs because citations issued on Saturdays and Sundays are recorded on Monday. This problem was addressed by aggregating the daily data into weekly data from Tuesday to Monday.

Data on additional control variables affecting citation counts was also collected. In addition to the control variables used in the accidents model, a binary variable indicating whether or not a federal holiday fell on a Monday of that week is also constructed. If a holiday fell on a Monday, any citations given on that weekend or Monday would be recorded on Tuesday. This implies that we should expect a significant decrease in citations on weeks with a Monday federal holiday. Likewise, a binary variable indicating whether the previous week had a Monday federal holiday was included to capture the significant increase in citations for that week.

C. SUMMARY STATISTICS

Table 1 presents accident and citation counts pre-repeal and post-repeal. There is no obvious change in either the number of daily alcohol-related accidents or the number of weekly alcohol-related traffic citations due to the Blue Law Repeal. The official date Colorado Blue Laws were lifted (July 1st 2008) separates our dataset into two intervals of roughly similar length, so the pre-repeal and post-repeal counts cover an almost identical time period.

There is an average of 2.68 alcohol-related accidents per day in Denver (average of 2.67 accidents pre-repeal and 2.68 accidents post-repeal), while there is an average of 74.6 alcohol-related traffic citations

per day in Colorado (average of 76.1 citations pre-policy and 73.1 citations post-policy). Of all the alcohol-related accidents in Denver from 2007 to 2009, 21% occurred on Sundays (21% pre-repeal, 21% post-repeal). Though overall accidents increased slightly post-repeal, Sundays were one of the few days with a *decrease* in accidents.

TABLE 1–Traffic Citations and Accidents: Colorado 2007-2009

	Pre-Repeal	Post-Repeal
Alcohol-related accidents (Mondays)	147	139
Alcohol-related accidents (Tuesdays)	142	123
Alcohol-related accidents (Wednesdays)	139	144
Alcohol-related accidents (Thursdays)	146	156
Alcohol-related accidents (Fridays)	224	252
Alcohol-related accidents (Saturdays)	352	353
Alcohol-related accidents (Sundays)	311	307
Alcohol-related accidents (Total)	1,461	1,474
Non-alcohol related accidents (Total)	32,888	31,524
Alcohol-related traffic citations	41,026	40,452
Non-alcohol-related citations	211,278	193,653

Notes: Counts of alcohol-related accidents in Denver County by day and counts of alcohol-related traffic citations in Colorado (except Denver County), pre and post repeal.

III. Analysis of Alcohol-Related Accidents

We first look at the response of daily alcohol-related accidents to the repeal of the Sunday packaged alcohol ban. Our identification strategy utilizes a regression discontinuity design, as estimates using ordinary least squares regression may be confounded by time-varying omitted variables. Even within the relatively short time period of this study there are likely unobserved factors that would bias OLS estimates. The use of regression discontinuity design allows for control of these unobservables, provided they do not change discontinuously at the same time as the Blue Law repeal (Hahn et al. (2001))

A. METHOD

Due to the integer nature and relatively low number of occurrences of daily accidents, a count model with a negative binomial regression is used to estimate the effect of repeal on daily alcohol-related accidents. The reduced form of the model is:

$$Acc_t = \alpha + \beta * Repeal_t + \gamma * X_t + g(t) + \varepsilon_t \quad (1)$$

where $g(t)$ is a flexible polynomial used to control for trends unrelated to the repeal. X_t represents a vector containing additional regressors such as extra police enforcement days, weekly gas prices, monthly unemployment rates, daily counts of non-alcohol-related accidents, precipitation levels and daily and monthly fixed effects. The variable $Repeal_t$ is an indicator variable that takes a value of 1 for observations after Blue Law repeal. We can interpret the estimate of our repeal regressor β as a $e^\beta - 1$ percent change in alcohol-related accidents due to the repeal of the Blue Laws. Again, provided any unobservable trends are continuous through the policy date, estimates of β will be consistent.

B. ANALYSIS

We begin by looking at daily alcohol-related accidents from January 1st 2007 to December 31st 2009 for the city and county of Denver in the first panel of Table 2.¹¹ The first column presents estimation results for a linear regression including only day of week and month dummy regressors and an indicator variable for the repeal. This regression is similar to a hypothesis test to determine whether the mean changed post-repeal. A look at the results suggests that there is no evidence for such a change - though negative, the estimate is small and statistically insignificant. Next, in columns 2-6 additional regressors (precipitation, extra police enforcement days, gas prices, unemployment rates, non-alcohol related accidents), a linear time trend, and a quadratic time trend are introduced. In columns 2 and 5, the flexible polynomial $g(t)$ was modeled as a linear time trend, while in columns 3 and 6 it was modeled as a quadratic time trend. Across specifications, the repeal effect is small and statistically insignificant. Under the Bayesian Information Criterion (BIC), the specification in column 5 was the preferred model, with a point estimate of a 1.5% increase in accidents.¹²

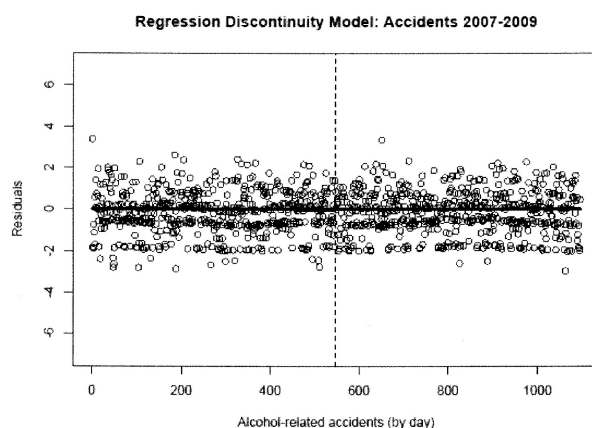
TABLE 2—Alcohol-Related Traffic Accidents

	(1)	(2)	(3)	(4)	(5)	(6)
<i>Daily Accidents</i>						
Repeal	-0.029 (0.042)	-0.030 (0.085)	-0.032 (0.084)	0.015 (0.092)	0.015 (0.092)	0.012 (0.094)
Observations	1096	1096	1096	1096	1096	1096
Pseudo R2	0.25	0.25	0.25	0.25	0.25	0.25
<i>Weekly Accidents</i>						
Repeal	-0.027 (0.043)	-0.046 (0.086)	-0.050 (0.085)	0.0051 (0.049)	-0.024 (0.086)	-0.024 (0.087)
Observations	156	156	156	156	156	156
Pseudo R2	0.07	0.07	0.08	0.11	0.11	0.11
<i>Sunday Accidents</i>						
Repeal x Sunday	-0.023 (0.10)	-0.023 (0.10)	-0.022 (0.099)	-0.021 (0.099)	-0.021 (0.099)	-0.021 (0.099)
Observations	1096	1096	1096	1096	1096	1096
Pseudo R2	0.25	0.25	0.25	0.25	0.25	0.25
Additional Regressors	N	N	N	Y	Y	Y
Linear Trend	N	Y	Y	N	Y	Y
Quadratic Trend	N	N	Y	N	N	Y

Notes: This table presents results from 18 separate negative binomial count regressions. The values reported for each estimation are the coefficient of the repeal variable and robust standard errors (in parentheses), except for the Sunday accidents panel. Counts of daily alcohol-related accidents was the response variable in the first panel. All specifications for daily accidents included day dummy variables and month dummy variables. Additional regressors for all panels included non-alcohol-related accidents, precipitation, extra police enforcement days, Denver gas prices, and statewide unemployment rates. In the second panel, the daily alcohol-related accident counts were aggregated to the weekly level and the day dummy variables were dropped. In the third panel, the coefficient of the interaction variable between Repeal and Sunday is reported. This coefficient can be interpreted as the percent change of alcohol-related accidents on Sundays due to the Repeal. * indicates 5 percent significance, ** indicates 1 percent significance.

Figure 1 plots residuals from the specification in column 5 with the repeal and time trend regressors excluded, against a polynomial with

repeal intercept fitted to these residuals. The residuals should reveal both the time trend and effect of the repeal, as those variables were excluded.



While the figure suggests no jump in accidents at the repeal date, it also reveals that there is significant noise in the data. One concern is that we may be rejecting a real effect because of a lack of power. In order to address this issue, daily accident data is first aggregated into weekly counts.¹³

For the weekly estimations, the day dummy variables were removed, but the other control variables remain the same. A week with extra police enforcement means at least one day of that week had extra police enforcement. Looking at the second panel of Table 2, estimates are once again small and insignificant, with smaller standard errors for specifications with additional control variables. Finally, we look at alcohol-related accidents on Sundays only. If a change in alcohol-related accidents due to the repeal is expected, looking at Sundays exclusively should uncover this effect, in contrast to the weekly aggregations. The third panel in Table 2 presents estimates of the effect of the repeal on Sundays only by interacting the repeal indicator variable and the Sunday dummy variable. The estimates for the repeal regressor are negative and insignificant for all specifications. If anything, this suggests that Sunday accidents may have decreased after the repeal. Thus, we find that under the specification most likely to uncover an effect, there is no evidence the repeal increased alcohol-related accidents. Similar estimates were constructed using interaction effects with all other days of the week, and

the results are presented in Table 3 using the relative risk framework per McMillan and Lapham (2006).

TABLE 3—Relative Risks of Alcohol-Related Accidents in Denver, 2007-2009

Day	Alcohol-Related Accidents	95% Confidence Interval
Monday	0.96	(0.70, 1.21)
Tuesday	0.82	(0.56, 1.09)
Wednesday	1.03	(0.77, 1.28)
Thursday	1.06	(0.81, 1.31)
Friday	1.13	(0.92, 1.34)
Saturday	0.99	(0.80, 1.17)
Sunday	0.98	(0.78, 1.17)

Notes: This table presents results from 7 different negative binomial count regressions. The values reported for each estimation are the coefficient of the interaction variable (between the respective day of week and repeal) and the corresponding 95% confidence interval. A linear time trend with additional regressors was the preferred specification, and were included in all estimations.

Estimates greater than 1 represent increased accidents due to the policy, and values less than 1 represent decreased accidents. Confidence intervals for all days span 1, and the Sunday relative risk estimate of 0.98 is statistically distinct from the 1.29 Sunday relative risk estimate found in Table 1 of McMillan and Lapham (2006).

One criticism of using a global polynomial in regression discontinuity design is that observations at the start and end of the sample may unduly affect the estimate of the discontinuity. Following Imbens and Lemieux (2008), interaction effects between Sundays and the repeal indicator are estimated using a local linear regressions with a rectangular kernel of bandwidths 8, 10, and 12 months. This method estimates separate linear time trends on both sides on the repeal, and the effect of the repeal is given by the jump at the repeal date.¹⁴ In contrast to the global polynomial estimations, these separate time trends imply that pre(post)-policy observations do not affect post(pre)-policy estimates. The estimates of the repeal coefficient in the first three columns of Table 5 represent separate local linear regressions for the varying bandwidths, and include the full set of covariates. The estimates across bandwidths

are all negative and insignificant, which further suggests that Sunday accidents did not increase post policy.

One concern is that the actual start date of the policy and the date when people react to the policy may be different (if people are initially unaware they can purchase alcohol on Sundays in liquor stores).¹⁵ To address this issue, additional estimates of the repeal effect are presented in the last three columns of Table 4 for regressions including the full set of additional covariates, a linear time trend (as chosen by the BIC), and an indicator variable for alternate repeal dates one, two, and three weeks past the actual repeal. The estimates for the repeal coefficient for these alternate dates are small and fluctuate around zero, and are not statistically significant.

TABLE 4—Alcohol-Related Sunday Accidents: Additional Analysis

	<i>Local Linear Regression</i>			<i>Alternate Start Dates</i>		
	12 Months	10 Months	8 Months	7/8/2008	7/15/2008	7/22/2008
Repeal x Sunday	-0.170 (0.159)	-0.186 (0.172)	-0.066 (0.198)	-0.005 (0.099)	-0.007 (0.099)	0.016 (0.099)
Observations	365	305	245	1096	1096	1096
Pseudo R2	0.31	0.33	0.32	0.25	0.25	0.25

Notes: This table presents results from 6 separate regressions with alcohol-related accident counts as the response variable. The values reported for each estimation are the coefficient of the interaction variable (between Sundays and repeal) and robust standard errors (in parentheses). The first three columns present estimates under local linear regression with a rectangular kernel and varying bandwidths. The last three columns report estimations using alternate start dates of 1, 2, and 3 weeks following the actual date of the repeal. A linear time trend with additional regressors was the preferred specification (BIC) in Table 2, and were included in all three alternate state date estimations. * indicates 5 percent significance, ** indicates 1 percent significance.

TABLE 5—Alcohol-Related Traffic Citations

	(1)	(2)	(3)	(4)	(5)	(6)
Repeal	0.008 (0.037)	-0.085 (0.060)	-0.088 (0.060)	0.022 (0.034)	-0.073 (0.049)	-0.071 (0.050)
“Heat Is On”	0.004 (0.025)	0.006 (0.025)	0.006 (0.025)	0.005 (0.020)	0.006 (0.020)	0.008 (0.020)
Monday Federal Holiday	-0.394** (0.032)	-0.395** (0.032)	-0.394** (0.032)	-0.258** (0.032)	-0.257** (0.031)	-0.255** (0.032)
Week After Monday Federal Holiday	0.228** (0.032)	0.227** (0.031)	0.227** (0.031)	0.115** (0.030)	0.114** (0.029)	0.114** (0.029)
Observations	156	156	156	156	156	156
Adjusted R2	0.66	0.67	0.67	.077	0.78	0.78
Additional Regressors	N	N	N	Y	Y	Y
Quadratic Time Trend	Y	Y	Y	Y	Y	Y
Cubic Time Trend	N	Y	Y	N	Y	Y
Quartic Time Trend	N	N	Y	N	N	Y

Notes: This table presents results from 6 separate regressions. The values reported for each estimation are the coefficient of the repeal variable and robust standard errors (in parentheses). For all specifications, the log of weekly alcohol-related citations was the response variable. In addition to the regressors listed, local gas prices, state unemployment rates, and non-alcohol-related traffic citations were included as the additional regressors. * indicates 5 percent significance, ** indicates 1 percent significance.

While there is a positive but insignificant effect of the repeal in the daily and weekly dataset, there is no evidence of an increase of alcohol-related accidents on Sundays. This stands in sharp contrast to the results of McMillan and Lapham (2006), who found a large and significant increase in alcohol-related accidents in New Mexico. The authors suggest analyzing driving-while-impaired citations to corroborate their results, which we do in the following section.

IV. Analysis of Alcohol-Related Traffic Citations

This section examines the effect of Blue Law repeal on alcohol-related traffic citations in Colorado. Again, OLS estimation is likely a poor estimation strategy, as the estimate of the effect of repealing the ban may

be confounded by unobserved time covariates. To address this issue, regression discontinuity design is again employed.

A. METHOD

As previously noted, daily DUI citations in Colorado are aggregated to a weekly level (Tuesday to Monday) to remove any daily lags attributed to when the citation was given and when it was recorded. The average weekly count of DUIs exceeds 600 citations a week, so a linear model with the log counts of DUIs as the response variable is used.¹⁶ The reduced-form model is:

$$Cit_t = \alpha + \beta * Repeal_t + \gamma * X_t + g(t) + \varepsilon_t \quad (1)$$

where $g(t)$ represents a flexible polynomial used to control for trends unrelated to the repeal. The covariate vector X_t no longer includes precipitation or daily dummies.¹⁷ However, we now include two dummy variables for Monday Federal Holiday and Week after Monday Federal Holiday (reasons mentioned previously) and a variable for non-DUI citations. Non-DUI citations may serve as a proxy for the number of people driving in the state (more drivers may lead to more citations), and may also capture changes in law enforcement effort (more effort may lead to more citations).

B. ANALYSIS

Table 5 presents citation results under several specifications, where the coefficient on repeal represents the effect of the policy on DUI citations. The first three columns are estimated without gas prices, unemployment and non-DUI citations. All specifications include a quadratic time trend, while column 2 adds a cubic time trend and column 3 adds a quartic time trend. The final three columns include the full set of covariates, and column 5 is estimated with a cubic trend, and column six is estimated with a quartic trend. Across specifications, there is little evidence of an effect of the repeal. The estimates for the repeal regressor fluctuate around zero and are statistically insignificant. Comparing adjusted R^2 across specifications, column 6 is the preferred specification, and yields a negative estimate for the effect of the repeal.¹⁸

Again as a robustness check, we consider a local linear regression of

alcohol-related traffic citations. The first three columns of Table 6 present results under a local linear regression specification (including additional covariates), using a rectangular kernel and a varying bandwidth spanning 12, 10, and 8 months. Estimates of the effect of the repeal are again insignificant. The last three columns of Table 6 also present estimates of the repeal effect under alternate start dates from one to three weeks after the official repeal.¹⁹ Again, estimates in Table 6 indicate no significant changes in DUI citations due to the repeal.

TABLE 6—Alcohol-Related Traffic Citations: Additional Analysis

	<i>Local Linear Regression</i>			<i>Alternate Start Dates</i>		
	12 Months	10 Months	8 Months	7/8/2008	7/15/2008	7/22/2008
Repeal	-0.007 (0.037)	0.007 (0.039)	0.038 (0.044)	-0.050 (0.047)	-0.049 (0.047)	-0.031 (0.047)
Observations	52	44	36	156	156	156
Adjusted R2	0.87	0.87	0.85	0.78	0.78	0.78

Notes: This table presents results from 6 separate regressions with logged weekly counts of alcohol-related citations as the response variable. The values reported for each estimation are the coefficient of the repeal variable and robust standard errors (in parentheses). The first three columns present estimates under local linear regression with a rectangular kernel and varying bandwidths. The last three columns report estimations using alternate start dates of 1, 2, and 3 weeks following the actual dates of the repeal. A cubic time trend with additional regressors was the preferred specification in Table 4, and were included in all three alternate start date estimations. * indicates 5 percent significance, ** indicates 1 percent significance.

As an additional robustness check, we consider higher orders of the polynomial time trend. In the interest of being completely exhaustive and avoiding any misspecification of unobservables, the model is estimated up to an 8th order time trend.²⁰ Table 7 presents the results under these higher-order time trends, and illustrates that the lack of an increase in citations is robust across a wide range of polynomial time trends. Figure 2 plots the residuals from an estimation excluding the repeal regressor and polynomial time trends, along with a fitted 3rd order polynomial and repeal intercept. The 3rd order polynomial fits the residuals well with a reasonable degree of smoothness, and there is little visual evidence of a jump at the repeal date.

One possible concern is that there may be citation quotas for police to satisfy for a given time period. However, because of the severity of drinking and driving, it seems unlikely that police officers would not cite

an impaired driver simply because they satisfied their quota.

TABLE 7—Alcohol-Related Traffic Citations: Higher Order Time Trends

	Cubic	Quartic	Quintic	Sextic	Septic	Octic
Repeal	-0.073 (0.049)	-0.071 (0.050)	-0.033 (0.078)	-0.049 (0.078)	-0.049 (0.079)	-0.039 (0.081)
Observations	156	156	156	156	156	156
Adjusted R2	0.78	0.78	0.78	0.78	0.78	.078

Notes: This table presents 6 separate regressions with logged weekly alcohol-related traffic citations as the response variable. The values reported for each estimation are the coefficient of the repeal variable and robust standard errors (in parenthesis). Each column presents an estimation with successively higher-order polynomial time trends. The Schwarz Criterion (BIC) indicates a cubic polynomial is the preferred specification. * indicates 5 percent significance, ** indicates 1 percent significance.

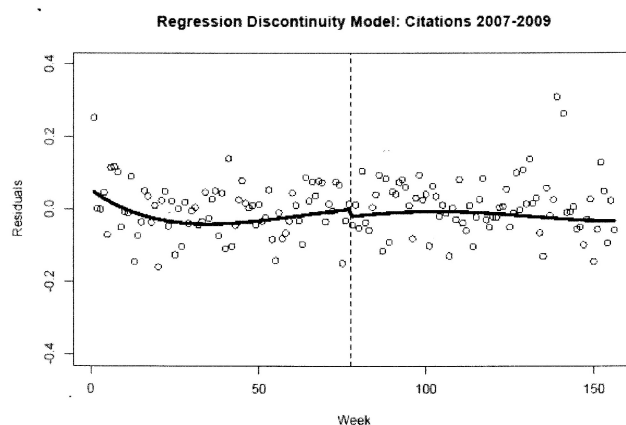


Figure 2. Residual plot of alcohol-related traffic citations (by week)

Another issue of concern is that a change in DUI citations may represent a change in enforcement effort, a change in drinking and driving, or both. However, as long as police enforcement trends do not change discontinuously at the same time as the repeal, our identification strategy holds (Hahn et al. (2001)). There was no official announcement that police enforcement effort changed at the time of the repeal. Finally, even if there was an unannounced increase in police enforcement effort at the time of the repeal, this would likely positively bias our estimates for the repeal effect.²¹ As we found no evidence of a positive effect of the repeal

on DUI citations, there is no indication that the repeal significantly increased drinking and driving.

V. Conclusions

Utilizing a regression discontinuity design, the effect of the repeal of Colorado Blue Laws on alcohol-related accidents and DUI citations was estimated. Across specifications we find little evidence that the repeal affected drinking and driving behavior. The striking discrepancy between the results found for Colorado in this paper and the New Mexico studies by McMillan and Lapham (2006) and McMillan et al. (2007) raises several interesting questions. Are Colorado drivers and New Mexico drivers significantly different? Despite geographic proximity, the two states do vary along a number of key demographic indicators, such as population density (three times higher in Colorado), median income (nearly \$15,000 higher in Colorado), and ethnicity (substantially larger Hispanic and Native American populations in New Mexico). Alternatively, there may have been changes in attitudes towards drinking and driving between 1995 (public awareness campaigns for example) when New Mexico's Blue Laws were repealed, and 2008 when Colorado's were repealed.

Finally, we should note that though an effect on drinking and driving was not found, one should not conclude that there are no benefits associated with Blue Laws. For example, Gruber and Hungerman (2008) find that repeal of Blue Laws led to decreases in church attendance and donations across various states, which may lessen positive externalities associated with group exposure in churches. Furthermore, they find increased risky behavior in young adults post-repeal, which may or may not be welfare-improving. Nonetheless, our results suggest that, when evaluating the costs and benefits of Blue Laws, there may not be grounds to include reduced drinking and driving as one of the benefits of Blue Law restrictions on Sunday liquor purchases.

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Endnotes

1. Four landmark cases related to Blue Laws were decided in 1961: *McGowan v. Maryland* 366 U.S. 420 (1961); *Gallagher v. Crown Kosher Super Market of Mass., Inc.*, 366 U.S. 617 (1961); *Braunfeld v. Brown*, 366 U.S. 599 (1961); and *Two Guys from Harrison vs. McGinley*, 366 U.S. 582 (1961). The Court concluded that Blue Laws were beneficial in that they promoted health, safety, and morality.
2. A related study using a county-level analysis of the same New Mexico dataset found a 33% increase in alcohol-related accidents following the lifting of the ban (McMillan et al. (2007)). A study in Perth, Australia, finds that most people believe an increase in alcohol availability would lead to an increase in their drinking behavior (Smith and Reidy-Crofts (1988)).
3. Pat Ferrier reports in *The Coloradoan* that liquor store owners found consumers did shift their purchasing decisions, purchasing alcohol on Sundays rather than the night before. Furthermore, 3.2% beer sales had dropped by nearly two-thirds once full-strength beer became available in liquor stores on Sundays (*Bottoms up for Sunday liquor sales*, *The Coloradoan*, July 5th, 2009).
4. A recent study by Davis (2008) of a driving law in Mexico City that restricted driving on one weekday per week (based on the vehicle's license plate number) found no evidence that the law reduced pollution levels, despite nearly universal

compliance. Essentially, drivers intertemporally adjusted by taking more trips on days when they were allowed to drive, and in some cases even bought a second car with a different day restriction, leading to no change in aggregate pollution levels.

5. In Colorado in 2006 there were 207 fatalities due to drunk driving, and 13,470 fatalities nation-wide. While auto fatalities have remained relatively constant nation-wide, alcohol-related fatalities as a percentage of total fatalities have fallen from 60% in 1982 to around 40% in 2006. From <http://www.alcoholalert.com/drunk-driving-statistics.html>.
6. While far from an original insight, this is an important point to reiterate whenever possible, particularly when considering policies affecting activities with significant intertemporal substitutes.
7. A longer time series would also create additional challenges in terms of identifying the effect of repeal, as the potential for confounding influences on estimates increases. For example, McMillan and Lapham (2006) control for time-varying effects unrelated to the repeal of New Mexico Blue Laws over the 10 year span of study with a 29-knot quadratic spline, and seasonal effects were controlled for with a Fourier series with annual and biannual periods.
8. "Heat is on" dates are found at: <http://www.dot.state.co.us/trafficsafety/heat/>. Unemployment rates for Colorado were obtained at: <http://www.coworkforce.com/lmi/ali/lfpage.asp>. Gas prices in Colorado were obtained at: <http://www.eia.doe.gov/>. Daily precipitation levels for Denver County were obtained at: <http://www.crh.noaa.gov/bou/?n=climo>
9. The impact of unemployment and broader macroeconomic variables on drinking is the subject of much research. There have been a number of conflicting results, with papers such as Dee (2001) finding that binge drinking is strongly counter-cyclical, while papers such as Ruhm and Black (2002) find that income effects dominate and drinking is pro-cyclical.
10. This dataset was obtained with the help of the Colorado Judicial Branch - Division of Planning and Analysis. An alcohol-related traffic citation was issued to anyone Driving Under the Influence (DUI) or Driving While Ability Impaired (DWAI). In addition to alcohol-related citations, daily counts on non-alcohol-related traffic citations was also included (e.g. speeding tickets, reckless driving, broken tail light). While Denver County data was not available for the entire dataset, analysis of the 2008 sub-sample when Denver County data was available yielded qualitatively similar results compared to those presented below.
11. Pseudo R^2 values are calculated for each regression, calculated as one minus the residual deviance divided by the null deviance. The Durbin-Watson and Ljung-Box tests suggest that there was no serial correlation in our residuals.
12. Matsudaira (2008) utilizes a similar approach of model selection using the BIC. He estimates the effect of summer school attendance on school performance, fitting separate third-order polynomials (as chosen by the BIC) on either side of a mandated test score cutoff.
13. While this reduces the number of observations considerably, it may reduce the inherent variability of the data. Furthermore, note that the daily accident estimates effectively test for a percentage change in daily accidents. Given the significant heterogeneity in mean accidents across days, a weekly aggregation will allow us to test if there was a percentage change in *total* weekly accidents due to the policy.
14. In other words, the effect of the policy is given by the difference in the left-side and

- right-side limits of the linear trends as they approach the repeal date.
15. In actuality, liquor store owners reported a significant spike in initial sales on Sundays lasting several months immediately following the passage of the repeal (see Pat Ferrier, *Bottoms up for Sunday liquor sales*, The Coloradoan, July 5th, 2009).
 16. Each of the estimations presented below were replicated with a count model with no discernible effect on results.
 17. Colorado weather varies significantly across the state, with sunny and warm weather on the plains and blizzards in the mountains, or vice versa.
 18. A visual inspection of the data suggests a general cubic trend, which agrees with the specification chosen by both the AIC and the BIC model selection criterion.
 19. As column 6 of table 5 was the preferred specification, the additional regressors as well as a cubic time trend were included for these estimations.
 20. Dinardo and Lee (2004) note that misspecification of the global polynomial can lead to biased estimates of the discontinuity, as well as erroneous interpretation of the standard errors.
 21. It is difficult to imagine a scenario where law enforcement would *decrease* enforcement effort on Sundays because of the repeal.