STRATHCLYDE

DISCUSSION PAPERS IN ECONOMICS

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NO 18-12

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Drink, Death and Driving: Do BAC Limit Reductions Improve Road Safety?*

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September 13, 2018

Abstract

This study exploits a natural experiment in Scotland where the legal blood alcohol content (BAC) limit was reduced from 0.8mg to 0.5mg per 100ml of blood while staying constant in all other parts of the UK. Using a difference–in–differences design, we find that this change in the BAC level had no impact on either traffic accident or fatality rates.

Keywords: Road Traffic Fatalities; Traffic Accidents; Difference-in-Differences; Blood Alcohol Content

JEL: I12; I18; K42

*We gratefully acknowledge the support of The Carnegie Trust for support for this project (Grant Number VAC007905).

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1 Introduction

Motor vehicle crashes are the leading cause of death for those aged 15-35 in developed countries (US Centers for Disease Control and Prevention, 2015). Even non-fatal car accidents cause substantial negative externalities and financial costs in the form of injury, health care costs, car repairs, higher insurance premiums, and lost time and productivity. For the UK, Morris et al. (2006) calculates that the average traffic accident is associated with costs to the tune of £40,000-50,000. Policy makers have tried to tackle this problem through a number of measures. Higher gasoline taxes have been shown to be associated with a drop in fatalities, not least because it makes driving more costly (Grabowski and Morrisey, 2006). Because alcohol impairment is a leading contributor to traffic accidents, drink driving has received particular attention. Carpenter and Dobkin (2009) show that keeping the legal drinking age at 21 helps prevent around 400 fatalities per year. Hansen (2015) finds that drivers who experience harsher penalties for drink driving offenses are effectively deterred from recidivating. Many countries have also lowered the legally permitted blood alcohol content (BAC) which is the topic of this paper. Exploiting differential timing across US states in lowering their BAC limits from over 0.10 to 0.08 mg per 100ml, Dee (2001) concludes that BAC limit reductions helped reduce road fatalities by 16.5%.

Our study provides the first evidence on the effectiveness of BAC limit reductions in the UK and makes several novel contributions. First, we investigate whether a further reduction in the BAC limit – from 0.08mg to 0.05mg – still has a marginal effect on traffic fatalities. Second, the institutional setting of the UK makes for a particularly clean natural experiment. US states – the main focus of the previous literature – are very heterogeneous, rendering the decision to lower BAC limits potentially endogenous even when state and time-fixed effects are controlled for. In contrast, the UK is a more homogenous country particularly with respect to anti-alcohol sentiment, traffic laws and policing. We exploit a reduction in the BAC limit that took place in Scotland in 2014 where the other ten regions of Great Britain[1] (GB) maintained their limits. There is little indication of policy endogeneity that might jeopardize the validity of our difference-in-differences design. Finally, the UK also offers particularly detailed data. Due to data limitations, previous studies have mainly focused on fatalities even though they account

[1]Great Britain comprises the whole United Kingdom except Northern Ireland.

for a small fraction of all traffic accidents. For this study, we are in the unique position to be able to leverage rich, geo-coded data on more than 1,176,672 accidents leading to 1,576,187 casualties and 14,737 fatalities between 2009 and 2016.

2 Data and methods

Our data come from the Department of Transport's STATS19 police report system on road accidents and road casualties. This provides us with data on the universe of police-reported traffic accidents alongside demographic details on everyone involved, including drivers, passengers, and pedestrians. We combine the accident data with annual population estimates for each of Great Britain's eleven NUTS1 regions, of which our treated region Scotland is one, in order to calculate monthly fatality and accident rates per 100,000 people for every month from 2009 to 2016 for each region. We match these data to regional weather indicators obtained from the MET office, in particular information on the mean temperature, number of days with sunshine per month, amount of rainfall, and number of days with air frost.

Table 1 shows the means and standard deviations of our main outcome variables for both our treatment region, Scotland, and our 10 control regions in England and Wales. We show fatality and accident rates for treatment and control for the 24 months leading up to the reform as well as the 24 months following the change in the BAC limit.

The BAC reduction was largely unanticipated. The legislation was introduced in the Scottish Parliament at the end of October 2014; it was unanimously approved and went into effect on 5th December 2014. Table 1 shows that accident and fatality rates were at very similar levels across Scotland and the rest of Great Britain in the pre-treatment period. One concern with our difference-in-differences identification strategy is that Scotland may have lowered its BAC limit because it had more traffic fatalities to begin with, thus rendering the policy change endogenous. However, row 2 of Table 1 shows that there were no statistically significant differences in fatality rates between Scotland and the other regions. Nor are there any differences for vulnerable subgroups such as young drivers. In fact, Scotland experienced fewer accidents per capita than the rest of Britain in the years leading up to the reform.

Moreover, a simple comparison of the means in Table 1 indicates that the lower BAC limit had little effect on either accidents or fatalities. In order to further test this hypothesis while ex-

	FATALITIES				ACCIDENTS			
	Scotland		England & Wales		Scotland		England & Wales	
	Pre-Reform*[⋆]*	***Post-Reform****[†]*	***Pre-Reform****[⋆]*	***Post-Reform****[†]*	***Pre-Reform****[⋆]*	***Post-Reform****[†]*	***Pre-Reform****[⋆]*	***Post-Reform****[†]*
#/Month	14.96	15.25	129.88	132.67	740.63	704.13	11123.17	10861.17
	(3.96)	(4.20)	(19.01)	(14.99)	(46.87)	(44.30)	(1064.53)	(649.92)
Total Rate	0.28	0.28	0.23	0.23	13.88	13.07	19.46	18.70
	(0.07)	(0.08)	(0.03)	(0.03)	(0.88)	(0.83)	(1.84)	(1.15)
16-25 Rate	0.42	0.44	0.41	0.39	30.95	29.21	50.21	47.63
	(0.29)	(0.31)	(0.08)	(0.11)	(3.02)	(2.80)	(4.67)	(3.63)
Over 25 Rate	0.31	0.30	0.25	0.25	14.44	13.69	20.00	19.36
	(0.10)	(0.07)	(0.04)	(0.03)	(1.08)	(0.91)	(1.91)	(1.12)
Night-time Rate	0.11	0.1	0.09	0.1	3.81	3.61	5.52	5.39
	(0.06)	(0.04)	(0.02)	(0.02)	(0.36)	(0.37)	(0.54)	(0.42)
Daytime Rate	0.18	0.18	0.13	0.13	10.07	9.47	13.94	13.31
	(0.07)	(0.07)	(0.02)	(0.02)	(0.67)	(0.63)	(1.36)	(0.85)
Weekend Rate	0.11	0.11	0.09	0.87	4.00	3.81	5.57	5.31
	(0.06)	(0.04)	(0.02)	(0.02)	(0.61)	(0.56)	(0.75)	(0.59)
Weekday Rate	0.17	0.17	0.14	0.14	9.88	9.26	13.89	13.39
	(0.4	(0.06)	(0.02)	(0.02)	(0.70)	(0.67)	(1.41)	(1.02)
Male Rate	0.42	0.43	0.34	0.35	18.06	16.92	26.5	25.53
	(0.13)	(0.12)	(0.05)	(0.04)	(1.26)	(1.39)	(2.78)	(1.68)
N	24	24	24	24	24	24	24	24

[⋆] Pre Reform denotes the period December 2012 to November 2014
[†] Post Reform denotes the period December 2014 to November 2016

Table 1: Outcome variable means and standard deviations

plicitly accounting for potentially confounding factors, we implement a difference-in-differences design of the following form:

$$y_{rt} = \beta_0 + \beta_1 Scot_r + \beta_2 Post_t + \beta_3 Scot_r * Post_t + \tau_t + \theta_r + \gamma X_{rt} + \epsilon_{rt} \quad (1)$$

where y_{rt} are the accident and fatality rates in region r during month t, $Scot_r$ is an indicator for the treatment region, $Post_t$ is dummy that is equal to 1 in post-December 2014 months, X_{rt} represents our weather covariates. We also control for a full set of month-year fixed effects and region fixed effects. We also experimented with several specifications of region-specific time trends, neither of which changed our results. Our main coefficient of interest is β_3. It will yield the unbiased effect of the BAC limit reduction on our outcomes of interest as long as the pre-treatment residuals in Scotland and the other regions follow parallel time-trends ("common time-trends assumption"). Figures 1 and 2 show fatality and accident rates over time. They indicate that our main identifying assumption is likely to be met. Indeed, accident rates follow strikingly similar trajectories and show identical seasonal patterns. The data for fatalities are slightly noisier, but the Scotland and England/Wales time series move closely together.

3 Results and discussion

Figures 1 and 2 are consistent with the comparison of means in Section 2. There is little in the way of a break in the series after the introduction of the policy, and even two years later accident and fatality rates remain flat in both Scotland and the rest of Great Britain. Our regression results in Table 2 confirm this. Column (1) of Panel A indicates that lowering the BAC limit has not led to a statistically significant drop in fatalities, even though the effect is very precisely estimated. Adding covariates (column 2) does not change this result, and our finding is robust to the inclusion of region-specific time trends (column 3).

In order to explore these results in more detail, we make use of the detailed information we had on each accident. We begin by analysing whether there was an effect on fatalities occurring at different times of the day. Previous studies (e.g. Young and Bielinska-Kwapisz (2006)) have shown that alcohol-related fatalities spike during night-time and weekends[2]. However, we find

[2]Night-time is defined as any time after 6pm and before 6am; weekend is defined as any time after 6pm on Friday to 6am on Monday.

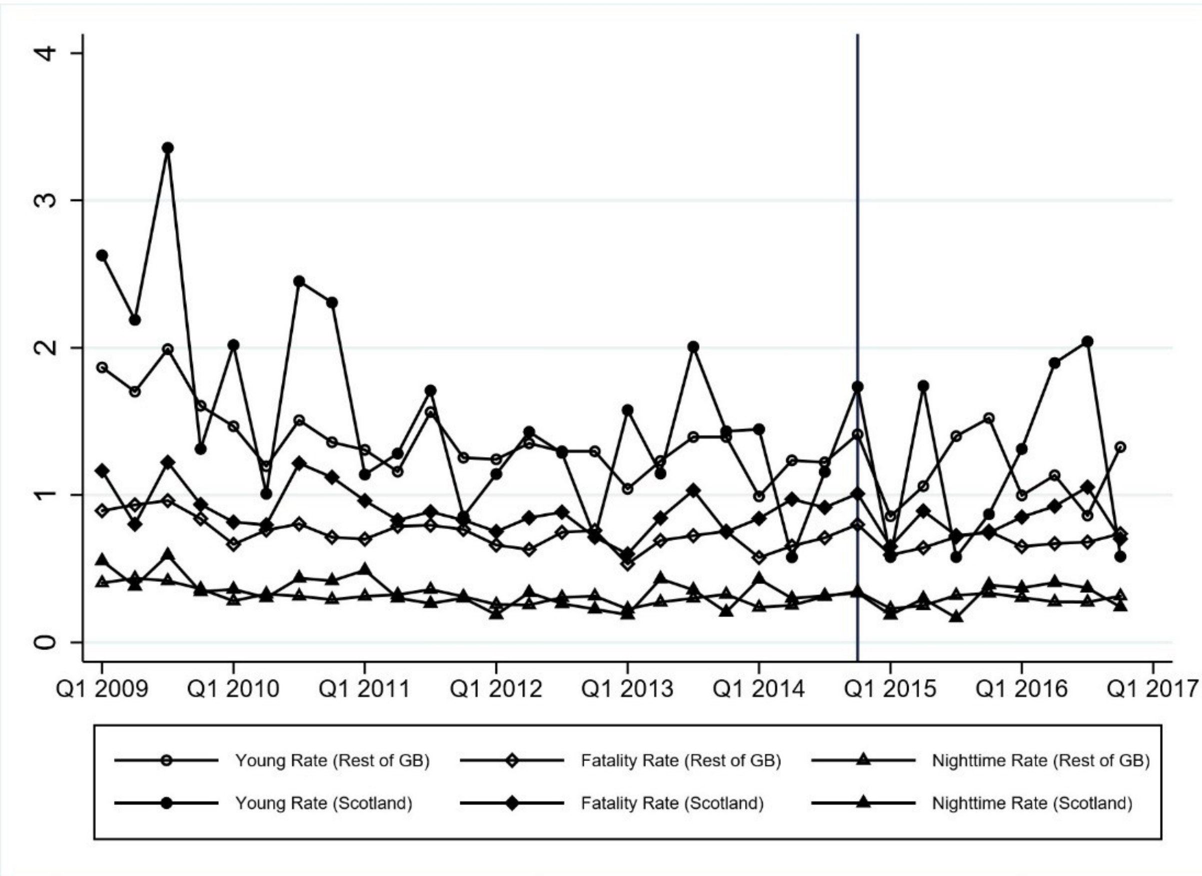

Figure 1: Quarterly total, night time and young fatality rate

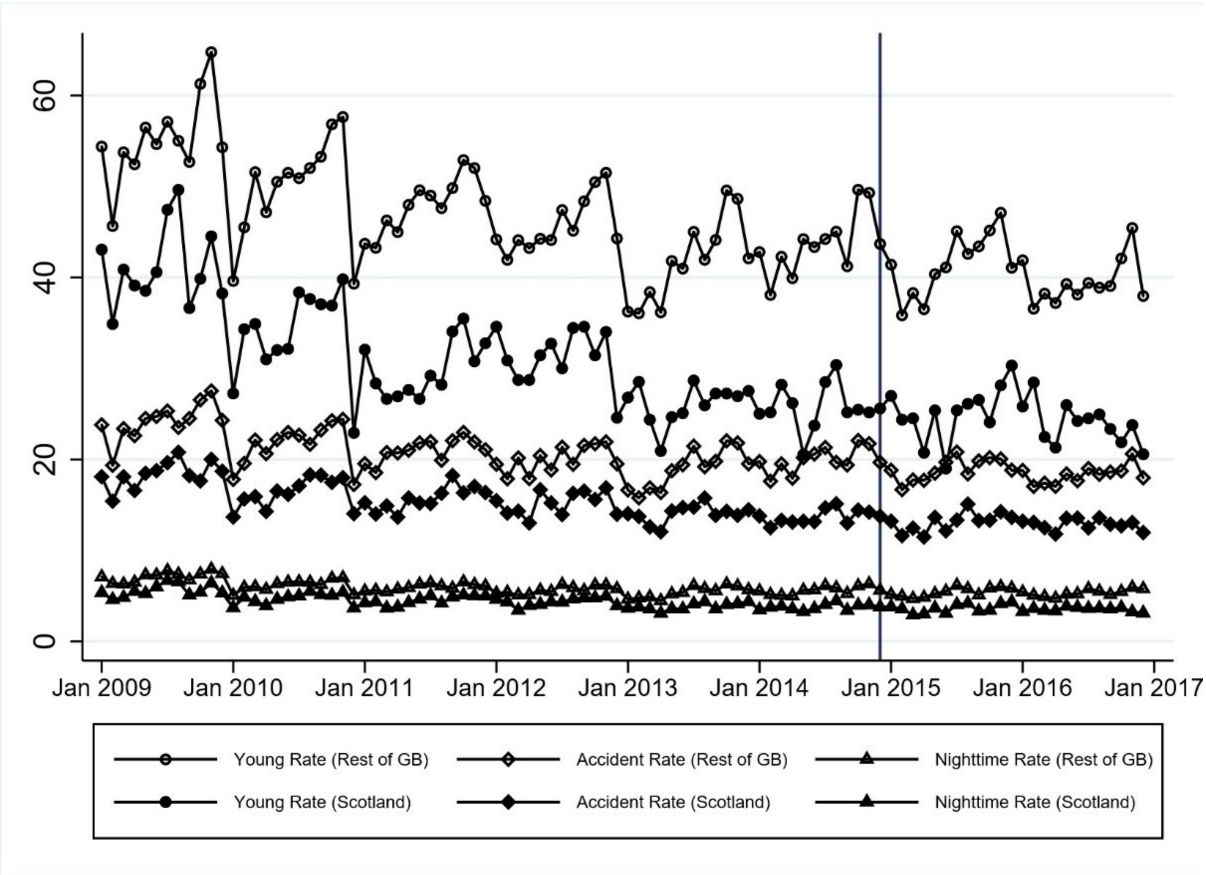

Figure 2: 2009-2016 monthly total, night time and young accident rates

no statistically significant evidence that the change in BAC limit had an effect on fatality rates in Scotland at night-time (column 4); daytime (column 5); or at weekends (column 6). There is a small negative effect for fatality rates on weekdays (column 7). Anecdotally, this may be driven by changes in attitude to post-work alcohol consumption after the introduction of the new BAC limit. But in any case, this effect is small and not statistically significant at the 1% level. We also considered whether younger drivers or male drivers were more affected by the policy change. Table 1 shows that both groups are at a particularly pronounced risk of getting involved in both fatal and non-fatal accidents. Focusing explicitly on 16-25 year old drivers (column 8) and on male drivers (column 9), we again find no evidence that the BAC limit reduction had an effect on fatality rates among these groups.

Similarly, the policy change has not had any effect on overall accident rates. Column (1) in Panel B of Table 2 indicates that the BAC limit reduction in fact slightly increased the monthly accident rate by 0.18 accidents per 100,000. Given a pre-treatment mean of 13.88, this translates into a 1.3% increase, but of course this effect is not statistically significant. Neither the inclusion of control variables, nor a break-down across drivers' demographic characteristics reveals a drop in accidents. The estimates are also precise enough to rule out any large undetected effects. For instance the upper bound of the 95% confidence interval of the point estimate in column (1) would indicate a drop in the accident rate of about 5.5%, which is small compared to Dee's (2001) finding of a 16.5% drop in fatalities. We therefore interpret our estimates as reasonably precisely estimated zero effects that all but rule out that the policy change led to substantial improvements in road safety. All standard errors account for clustering at the region-level. Calculating p-values using the wild-bootstrap procedure suggested by Cameron et al. (2008) - which may be more appropriate if the number of clusters is small – also does not change the results.

4 Conclusion

We study the effect of reducing blood alcohol content (BAC) limits from 0.08mg to 0.05mg per 100ml of blood. We exploit a natural experiment in Great Britain that was created when one region, Scotland, lowered its BAC limit in 2014 while all other regions kept their BAC limits unchanged. With data that not only cover fatalities but all police-recorded road traffic accidents

Panel A: Fatality Rate									
	(1) Total	**(2) Total**	**(3) Total**	**(4) Night-time**	**(5) Daytime**	**(6) Weekend**	**(7) Weekday**	**(8) Young**	**(9) Male**
$Scot_r * Post_t$	-0.008	-0.008	-0.016	-0.003	-0.005	0.006	-0.014**	-0.038	-0.015
	(0.005)	(0.006)	(0.012)	(0.005)	(0.004)	(0.004)	(0.006)	(0.032)	(0.013)
Observations	1,056	1,056	1,056	1,056	1,056	1,056	1,056	1,056	1,056
R-squared	0.394	0.397	0.4	0.263	0.327	0.326	0.281	0.267	0.368
Region Specific Time Trends	No	No	Yes	No	No	No	No	No	No
Covariates	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Panel B: Accident Rate									
	(1) Total	**(2) Total**	**(3) Total**	**(4) Night-time**	**(5) Daytime**	**(6) Weekend**	**(7) Weekday**	**(8) Young**	**(9) Male**
$Scot_r * Post_t$	0.182	0.193	-0.591	-0.150	0.343	0.040	0.153	0.321	0.071
	(0.471)	(0.475)	(1.188)	(0.142)	(0.340)	(0.147)	(0.337)	(0.193)	(0.336)
Observations	1,056	1,056	1,056	1,056	1,056	1,056	1,056	1,056	1,056
R-squared	0.655	0.656	0.753	0.715	0.629	0.667	0.664	0.661	0.678
Region Specific Time Trends	No	No	Yes	No	No	No	No	No	No
Covariates	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses are heteroscedasticity robust and clustered at the NUTS1 regional level, *** $p<0.01$, ** $p<0.05$, * $p<0.1$
Results correspond to β_3 in regression equation (1), region and year-month fixed effects are included in all specifications.

Table 2: Difference-in-Differences Regression Results

and that allow us to evaluate this policy change in a homogenous policy environment, Great Britain offers the ideal setting for this study. Even though our difference-in-differences model is well identified and yields precise estimates, we find little evidence that a reduction of the BAC limit led to a drop in either road traffic accident or fatality rates.

While there may be other reasons to pursue a reduction in the BAC limits, our results suggest that further BAC limit reductions might disappoint policymakers' expectations with respect to improvements in road safety. This is not to say that previous BAC limit reductions have been an ineffective means of preventing traffic fatalities. Instead, our results indicate that the marginal returns to further BAC reductions in terms of road safety are small, which is a result that policy makers should take into account when weighing the costs and benefits of alcohol-control policies.

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