HIT-AND-RUN OR HIT-AND-STAY: DO STRICTER BAC LIMITS ENCOURAGE DRIVERS TO FLEE THE CRASH SCENE?

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Abstract

We use state-specific annual data from the 1990-2010 US Fatality Analysis Reporting System to examine the effects of traffic policies on hit-and-run fatalities. Results show that lower blood alcohol concentration (BAC) limits may have an unintended consequence of increasing hit-and-run fatality rates, while a similar effect is not present for non-hit-and-run fatalities. Specifically, we find that the 0.08 BAC limit increased hit-and-run traffic fatalities over this period by 13-16 percent. As a potential mechanism, we suspect that intoxicated drivers might flee a crash scene due to severe driving-under-the-influence (DUI) sanctions, which are often more stringent than non-DUI hit-and-run penalties.

Keywords: Motor vehicles; traffic safety; BAC; DUI; hit-and-run fatalities; pedestrians; FARS.

JEL codes: H73; I12; I18.

I. INTRODUCTION

One of the most widely reported and often tragic traffic events is hit-and-run motor vehicle crashes. Every year, thousands of hit-and-run collisions occur in the US killing about 1,500 people and seriously injuring many others (American Automobile Association [AAA], 2005). A hit-and-run crash is when a driver flees the crash scene without stopping to render aid to the victims or file a police report. Besides being illegal in every state, leaving the scene can lead to much more serious injuries and fatalities as 60-70 percent of deaths in traffic collisions occur within the first hour after the crash (e.g., Luchter et al., 1998; Yasmin et al., 2015). Existing research shows that drunk drivers are more likely to run after hitting a pedestrian (e.g., Solnick and Hemenway, 1994). Mothers Against Drunk Driving (MADD), a major traffic safety advocacy group in the US with millions of worldwide members, was founded in 1980 by Candice Lightner, whose 13-year-old daughter was killed by a drunken hit-and-run driver in Southern California. Since then, MADD has been credited with raising public awareness about the dangers of impaired driving and strengthening traffic safety legislation such as raising the minimum legal drinking age and lowering blood alcohol concentration (BAC) limits (Toomey, 2005).

Hit-and-run cases make up about 11 percent of all police-reported traffic crashes (AAA, 2005) and the prevalence of hit-and-run crashes is typically much higher in major cities. For example, nearly half of all crashes in Los Angeles, California involve hit-and-runs (Smith, 2015). The problem is particularly severe for non-motorists, as pedestrian fatalities account for about 60 percent of all hit-and-run fatalities, according to our own calculations using data from the US Fatality Analysis Reporting System (FARS). The National Highway Traffic Safety Administration (NHTSA, 2015) reports that, in 2013, pedestrian deaths accounted for 14 percent of all traffic fatalities and one-fifth of the pedestrians killed in traffic crashes were involved in hit-and-run collisions. Between 1998 and 2007, while the total annual number of pedestrian fatalities in the US declined, the proportion of hit-and-run pedestrian fatalities increased (MacLeod, et al. 2012).

A Miami Herald editorial (2014) reports that almost 70,000 hit-and-run crashes occurred in Florida in 2012, which resulted in 168 fatalities. Legislators in Florida describe the rising number of hit-and-run crashes as a "growing epidemic" and claim that the "prevailing statutes unwittingly encourage drivers to leave the scene." This is because under Florida law prior to 2014, fleeing the scene of a fatal crash carried lighter penalties compared to staying and being charged with driving-under-the-influence (DUI). However, the "Aaron Cohen Life Protection Act" took effect in 2014 which, among other measures, increases the mandatory minimum prison term from two to four years for a driver convicted of leaving the crash scene resulting in the death of a person while DUI (which is not easy to establish even if they are apprehended soon after the crash). This Act was named after Aaron Cohen, a Miami cyclist who was killed in a hit-and-run crash in 2012. The driver never stopped, but turned himself in 17 hours later. Although the driver was on probation for cocaine charges at the time and law enforcement officials found evidence he had been drinking prior to the crash, BAC testing was not feasible due to the time lapse. He was sentenced to a year in jail and then released after serving only 264 days.

Florida is certainly not the only state where legislators are considering policy changes to toughen hit-and-run laws. It's been argued that "[u]nder Pennsylvania law, it's better to be a coward and run" (Farr, 2011). Concerns have been voiced in other states (e.g., California, Colorado, Delaware, New Jersey, Texas) where similar loopholes exist (Fender, 2010; Farr, 2011; Copeland, 2013). Legislators in Texas, for example, closed a loophole in 2013 that was thought to encourage intoxicated drivers who are involved in a collision to flee the scene (Dehn and Koh, 2013). Prior to passage of the new law, leaving the crash scene in Texas was a third-degree felony and carried a maximum penalty of 10 years in prison—only half that for causing a DUI-related traffic fatality.

With the amended law, penalties for hit-and-run fatalities are equal to those for intoxicated manslaughter (i.e. hit-and-run offenses became a second-degree felony and carry a maximum penalty of 20 years in prison.)

While previous research has not attempted a panel-based evaluation of how drunk driving and hit-and-run penalties affect hit-and-run collisions, it has identified several individual and environmental factors that are associated with such incidents. Hit-and-runs are more prevalent in urban areas, at nighttime and early morning, under poor lighting conditions, during weekends, and on high-speed roads (Solnick and Hemenway, 1995; Tay et al., 2008; 2009). Drivers involved in hit-and-runs are more likely to be young (under the age of 25), male, intoxicated, and to drive a stolen vehicle and/or without a valid license (Kim et al., 2008; MacLeod et al., 2012). Interestingly, alcohol-impairment of pedestrians is also an important factor in traffic fatalities (Holubowycz, 1995). Most of the existing research on hit-and-run crashes and fatalities is descriptive in nature, however. To the best of our knowledge, no prior studies have rigorously investigated the longitudinal effects of traffic policies on hit-and-run traffic fatalities.

In this paper, we use state-specific annual data from the 1990-2010 FARS to examine the effects of various traffic policies on both hit-and-run and non-hit-and-run traffic fatalities. We present compelling evidence that stricter DUI penalties may unintentionally increase hit-and-run incidents. Specifically, we find that during our period of analysis, the 0.08 BAC limit has increased hit-and-run traffic fatalities by 13-16 percent and hit-and-run pedestrian fatalities by about 8 percent, while this law had no significant effect on non-hit-and-run fatalities. The impact of BAC laws on hit-and-run fatalities persists even after controlling for alcohol consumption per capita.

II. DATA

The motor vehicle fatality data used in this study come from FARS, which is a publicly available data source maintained by NHTSA. FARS is a census of all motor vehicle traffic crashes that occur on public roads in the US and result in a fatality within 30 days. We obtained annual data on total, pedestrian, and hit-and-run traffic fatalities for the period of 1990-2010 for all 50 states (Washington, D.C. is excluded). Crash characteristics including the hit-and-run designation come from police crash reports. Traffic fatalities refer to both occupants (i.e. drivers and passengers) as well as non-occupants (e.g., pedestrians, bicyclists) killed in traffic crashes. Given that the largest group of hit-and-run victims is pedestrians, a key part of the analyses focuses on this group. A motor vehicle traffic crash is defined as a hit-and-run collision when the driver of a contact vehicle in the crash does not stop to render aid (including drivers who flee the scene on foot) before law enforcement officials arrive at the scene. We subtract this figure from all traffic fatalities to obtain the count of "non-hit-and-run traffic fatalities," to carry out a side-by-side comparison between hit-and-run and all other traffic fatalities.

Table 1 provides descriptive statistics for the entire sample, which includes 1,050 observations (50 states over 21 years). The average annual number of traffic fatalities in a given state is about 818 of which 31 are identified as hit-and-run victims. On average, during the 1990-2010 period, hit-and-run victims make up about 3 percent of total traffic fatalities. When we restrict our attention to just pedestrian fatalities, however, about 16 percent of these are identified as hit-and-run. The descriptive statistics in this table also reflect the large variations in the fatality measures both between and within states.

In terms of DUI laws, the maximum allowable BAC limits varied between 0.04g/dL and 0.12g/dL, with about half of the state-year observations having a BAC limit of 0.08g/dL or lower. A 0.08 BAC per se statute makes it a violation in itself to exceed the 0.08 limit, regardless of whether a crash occurred or any other signs of intoxication are evident. We use both this 0.08 indicator and the continuous BAC measure in our analyses. In addition, we include other traffic policy indicators for whether the state had an administrative license revocation law, a speed limit of 70mph or greater, and a primary seat belt law.

Following the literature (e.g. Dee and Evans, 2001), we account for three control variables in all specifications. First, we use the natural logarithm of state resident population as the exposure variable. Next, we include the unemployment rate and real personal income per capita because it has been shown that business cycles can greatly affect motor vehicle fatalities (e.g. Ruhm, 2000). In most specifications, we also control for various other state-specific characteristics—proportion of young drivers (age 24 and younger), urban and rural vehicle miles traveled (VMT) per capita, real gas prices, and the proportion of light trucks among all motor vehicles. Finally, some specifications account for alcohol consumption per capita. Appendix Table A1 provides detailed definitions as well as data sources for all variables used in the analyses.

[Insert Table 1 here]

III. METHODS AND RESULTS

Hit-and-run fatalities are relatively rare (and include zeros), so we follow conventional practice in the traffic safety literature by utilizing count data models (e.g. Dee and Evans, 2001). Specifically, we estimate negative binomial regressions that condition on state fixed-effects to account for overdispersion in fatality counts (Hausman et al., 1984). Each model also includes a vector of year fixed-effects that absorb the annual secular trends in traffic safety across the entire country. We regress the state-by-year fatality counts on a vector of traffic policies and other state-specific characteristics.

Tables 2 and 3 present estimation results for the conditional fixed-effects negative binomial models. Table 2 breaks overall traffic fatalities into hit-and-run and non-hit-and-run. A similar comparison is carried out among pedestrian fatalities in Table 3. For each of the right-hand-side variables, we report the estimated incidence rate ratios (IRR) and the corresponding standard errors (in parentheses).[1] IRRs, which are the exponentiated coefficients, refer to the predicted change in fatalities when the variable of interest is increased by one unit above its mean, holding everything else constant. If the estimated IRR is greater (less) than one, then a positive (negative) relationship exists between a fatality count and the particular regressor. Statistical significance of the estimated effects is based on a test of the null hypothesis that no relationship is present between a fatality measure and the regressor (i.e., IRR=1). For comparison purposes, we present the results for hit-and-run (Columns 1-5) and non-hit-and-run traffic fatalities (Columns 6-10) side-by-side. At the bottom of each specification, we also report the mean of the dependent variable to offer perspective for the estimated effects.

In Column 1 of Table 2, we include the exposure variable (population), the macroeconomic indicators, and the traffic policy measures. The estimated IRR indicates that adopting a 0.08 BAC per se law *increases* hit-and-run fatalities by about 11.5 percent (i.e., about 3.6 additional fatalities per state or approximately 179 additional fatalities across the US in a given year. While administrative license revocation and primary seatbelt laws do not have a statistically significant effect on hit-and-run fatalities, higher speed limits increase them ($p<0.05$).

Column 2 adds other control variables, none of which have any statistically significant effect except for the proportion of light trucks (positive; $p<0.01$). This result is consistent with earlier findings (e.g., Anderson, 2008; Li, 2012) in that light trucks offer better protection for their occupants compared to passenger cars, but at the same time they increase the fatalities of other types of vehicle occupants as well as pedestrians. It is important to note that the addition of these state-

[1] For brevity, we omit the estimation results for year fixed-effects, which can be obtained from the authors upon request.

specific characteristics does not alter the estimated effect nor the statistical significance of the 0.08 BAC per se law. Moreover, the impact of the 0.08 BAC law on hit-and-run fatalities persists even after controlling for alcohol consumption per capita (Column 3).

[Insert Table 2 here]

In Columns 4 and 5, we replace the 0.08 BAC per se law with the actual BAC limit (x100). The latter measure does not account for per se status, but it displays more variation than the former.[2] Results using this alternative BAC measure are consistent with the ones presented above. Specifically, using the estimated IRR from Column 4, decreasing the BAC limit from 0.09 to 0.08 increases the hit-and-run fatality count by 2.9 percent ($p<0.05$). Lastly, the addition of alcohol consumption per capita in Column 5 yields a larger estimated IRR for the BAC limit that is also statistically more significant ($p<0.01$) compared to that in Column 4. Overall, Columns 1-5 in Table 2 consistently present evidence supporting the unintended impact of BAC laws on hit-and-run fatalities.

In Columns 6-10, we examine how traffic policies affect non-hit-and-run fatalities, if at all. Stricter BAC laws are positively related to non-hit-and-run fatalities as well, but the estimated IRRs are much smaller and most are not statistically significant. The sole exception is in Column 8, when alcohol consumption per capita is included in the specification. Here, the 0.08 BAC per se law increases non-hit-and-run fatalities by 1.8 percent ($p<0.05$). Interestingly, lower speed limits and primary seat belt laws, which are not significantly associated with hit-and-run fatalities (except for speed limit >=70mph in Column 1), turn out to be effective in lowering non-hit-and-run fatalities ($p<0.01$). In contrast to the results reported in Columns 1-5, macroeconomic conditions as well as urban and rural VMT also have statistically significant effects on non-hit-and-run fatalities.

[2] For example, the state of Georgia first reduced its BAC limit from 0.12 to 0.10 in 1991 and then further down to 0.08 in 2001.

In our sample, more than 60 percent of the hit-and-run fatalities pertain to pedestrians. Therefore, in Table 3, we restrict our attention to pedestrian fatalities only and divide these into two groups—hit-and-run versus non-hit-and-run. The results presented in Columns 1-3 indicate that the 0.08 BAC per se law increases hit-and-run pedestrian fatalities by about 8 percent, which translates into approximately 1.5 additional pedestrian fatalities annually in a representative state or 75 fatalities nationwide. Columns 4 and 5 replace the 0.08 BAC law indicator with the BAC limit, and the results are qualitatively the same. In terms of magnitude, reducing the BAC limit from 0.09 to 0.08 raises annual pedestrian hit-and-run fatalities in the entire country by 28 (3 percent).

[Insert Table 3 here]

Another traffic policy is also significant in Table 3. Primary seat belt laws have a positive effect on hit-and-run fatalities, which turns statistically significant in Columns 3 ($p<0.01$) and 5 ($p<0.05$). This is somewhat counterintuitive, but may be due to a so-called "compensating behavior" as suggested by Peltzman (1975), i.e. wearing a seat belt may give drivers a false sense of security, cause them to drive less carefully, leading to more crashes). This mechanism would lead to a positive correlation between seat belt laws and the fatalities of pedestrians and other non-occupants, because these groups do not benefit from the protection of seat belts. In fact, this mechanism could explain the opposite seat-belt-law findings in Tables 2 and 3. Another difference, although the estimated effects are only marginally significant, is that the proportion of young drivers increases pedestrian hit-and-run fatalities. As it was the case in Table 2, the proportion of light trucks is positively related to pedestrian hit-and-run fatalities and accounting for alcohol consumption per capita in Table 3 does not meaningfully affect the estimates for BAC laws.

Comparing Columns 6-10 with Columns 1-5 in Table 3 reveals that BAC laws have differential effects on hit-and-run and non-hit-and-run traffic fatalities of pedestrians. In particular, BAC laws are not significantly associated with the latter, regardless of specification. In contrast to hit-and-run pedestrian fatalities, administrative license revocation (negative), primary seat belt laws (positive and highly significant), proportion of young drivers (positive and highly significant), and urban traffic density (positive) are all significantly related to non-hit-and-run pedestrian fatalities. Lastly alcohol consumption per capita is not associated with non-hit-and-run pedestrian fatalities, highlighting the observed pattern that alcohol impairment may be a much more important factor for hit-and-run crashes.

In addition to the results presented here, we estimated conditional fixed-effects Poisson models with clustering at the state level. Although this exercise increases the standard errors somewhat, it also yields larger estimated effects. Overall, the findings of this robustness check did not alter our key results or conclusions and can be obtained from the authors upon request.

IV. DISCUSSION AND CONCLUSION

The key policy implication of this research is that stricter BAC laws may lead to more hit-and-run fatalities, both among vehicle occupants and pedestrians. We suspect that some drivers who are under the influence of alcohol or drugs might flee a crash scene due to severe DUI sanctions, which are often more stringent than non-DUI hit-and-run sanctions. Our analysis has some shortcomings that are mainly due to data limitations. Typically, FARS includes extensive crash characteristics (e.g., time of the crash and the vehicles involved), but this is not the case given the nature of hit-and-run fatalities. Driver characteristics are missing for the most part, unless they were later captured or turned themselves in, which results in severe sample selection issues. Moreover, even victim characteristics are missing for a large majority of observations. Hence, we are unable to investigate the contributions of other factors including alcohol involvement, lighting conditions, urban versus rural area differences, posted speed limit at the crash, and nighttime vs. daytime collisions.

Another limitation is the absence of state-specific data on hit-and-run laws for the period of our analysis. A recent study examining hit-and run penalties for eight states in 2011 reveals a wide range of legal sanctions including fines, jail or prison sentences, and license suspensions (Frisman, 2013). In addition, the level of each of these penalties depends on injury severity of the victim. Ideally, these policies would be included in the analyses to better understand the effects of DUI laws. Unfortunately, data on state-specific legal sanctions for hit-and-run crashes are not available for most years during the 1990-2010 period.

Despite these data limitations, prior findings in the existing literature provide some support for our presumption that the estimated effects could at least partly be due to intoxicated drivers fleeing crash scenes. It's been shown those drivers with positive BAC levels as well as those with previous violations including DUI arrests and license suspensions are more likely to leave the crash scene (e.g. Solnick and Hemenway, 1994; 1995, MacLeod et al., 2012). While all these studies are subject to the sample selection issues mentioned above, they do offer some consistent patterns about the characteristics of the drivers who flee the collision scenes. Similarly, they show that those who flee are more likely to be young and male, both of which are positively related to the likelihood of drunk driving. Interestingly, individuals who most frequently engage in DUI also turn out to be relatively more knowledgeable about drunk driving laws compared to those who do not drink and drive. (Sloan et al., 2014).

While our analysis cannot address nor verify possible mechanisms, we present compelling evidence that DUI penalties may unintentionally increase hit-and-run incidents. It is important to note, however, that the unintended effects of the 0.08 BAC laws seem far smaller compared to their intended effects. Previous studies have established that the adoption of 0.08 BAC limits led to large and statistically significant reductions in traffic fatalities. Dee (2001), for example, found that 0.08 BAC limits may be effective only when combined with administrative license revocations, but the nationwide adoption of these two drunk-driving policies would reduce annual traffic fatalities by about 1,200. This effect size is much larger than our estimates of the unintended effect. In addition, BAC laws seem to work well in that they achieve reductions in drunk driving mainly through the channel of deterrence rather than through incapacitation or rehabilitation (Hansen, 2015). A complete welfare analysis of the 0.08 BAC laws including optimal design (as in Kenkel, 1993, for example) is well beyond the scope of this paper, but could be a fruitful avenue for future research.

Finally, the unintended effect of DUI laws we discover in the present study runs parallel to other traffic policy findings, especially in developing countries, where poor enforcement of traffic laws can also produce unintentional consequences. For example, Hijar et al. (2003) find that lax traffic law enforcement in Mexico has paradoxically raised pedestrian fatalities and led to 90 percent of traffic crashes being classified as hit-and-run. Our findings have direct implications for policymakers who seek to reduce the number of hit-and-run crashes and fatalities (especially among pedestrians), which are extremely costly, yet often preventable. Rather than just raising BAC limits, as our findings seem to suggest, a better deterrence strategy would be to jointly design and implement DUI and hit-and-run laws in an effort to maximize their effectiveness while minimizing potential unintentional consequences.

REFERENCES

AAA. 2005. *Fact Sheet: Hit And Run Drivers Kill Nearly 1500 People Annually*. Washington, DC: AAA Foundation for Traffic Safety.

Anderson, D. Mark. 2008. "Safety for Whom? The Effects of Light Trucks on Traffic Fatalities", *Journal of Health Economics*, 27(4), 973-989.

Copeland, Larry. November 10, 2013. "Fatal hit-and-run crashes on rise in U.S.," *USA TODAY*. Accessed May 23, 2015. http://www.usatoday.com/story/news/nation/2013/11/10/hit-and-run-crashes-los-angeles/3452699.

Dee, Thomas S. 2001. "Does Setting Limits Save Lives? The Case of 0.08 BAC Laws." *Journal of Policy Analysis and Management,* 20(1), 111-128.

Dee, Thomas S., and William N. Evans. 2001. "Behavioral Policies and Teen Traffic Safety." *American Economic Review*, 91(2), 91-96.

Dehn, Justin, and Elizabeth Koh. August 9, 2013. "In an Accident, Drivers Have New Reasons Not to Run," *The Texas Tribune,* Accessed May 23, 2015. http://www.texastribune.org/2013/08/09/penalties-hit-and-runs-rise/

Farr, Stephanie. August 9, 2011. "To flee or not to flee: Justice is blind drunk," *Philly*. Accessed May 23, 2015. http://articles.philly.com/2011-08-09/news/29867468_1_dui-conviction-drunk-drivers-mandatory-prison-sentence.

Fender, Jessica. December 26, 2010. "Colorado laws may make it wise for drunk drivers to flee the scene of a crash," *The Denver Post.* Accessed May 23, 2015. http://www.denverpost.com/news/ci_16944089#.

Frisman, Paul. 2013. Driving Under the Influence and Hit and Run Laws. Office of Legislative Research Report 2013-R-0235. Hartford, CT: Connecticut General Assembly. Accessed May 23, 2015. http://cga.ct.gov/2013/rpt/2013-R-0235.htm.

Hansen, Benjamin. 2015. "Punishment and Deterrence: Evidence from Drunk Driving," *American Economic Review*, 105(4), 1581-1617.

Hausman, Jerry, Bronwyn H. Hall, and Zvi Griliches. 1984. "Econometric models for count data with an application to the patents-R&D relationship." *Econometrica*, 52(4), 909-938.

Hijar, Martha, James Trostle, and Mario Bronfman. 2003. "Pedestrian injuries in Mexico: a multi-method approach," *Social Science & Medicine*, 57(11), 2149-2159.

Holubowycz, Oksana. T. 1995. "Age, sex and blood alcohol concentrations of killed and injured pedestrians." *Accident Analysis & Prevention*, 27(3), 417-422.

Kenkel, Donald S. 1993. "Do drunk drivers pay their way? A note on optimal penalties for drunk driving," *Journal of Health Economics*, 12(2), 137-149.

Kim, Karl, Pradip Pant, and Eric Yamashita. 2008. "Hit-and-Run Crashes: Use of Rough Set Analysis with Logistic Regression to Capture Critical Attributes and Determinants," *Transportation Research Record: Journal of the Transportation Research Board*, 2083, 114-121.

Li, Shanjun. 2012. "Traffic safety and vehicle choice: quantifying the effects of the 'arms race' on American roads," *Journal of Applied Econometrics*, 27(1), 34-62.

Luchter, Stephen, Andrew Smith, Jing Wang. 1998. "Fatal injuries in light vehicle crashes: time to death and cause of death. *Annual Proceedings of the Association for the Advancement of Automotive Medicine*, 42, 277-286.

MacLeod, Kara E., Julia B. Griswold, Lindsay S. Arnold, and David R. Ragland. 2012. "Factors associated with hit-and-run pedestrian fatalities and driver identification," *Accident Analysis & Prevention*, 45, 366-372.

Miami Herald. February 5, 2014. "Get tough on hit-and-run drivers," *Miami Herald.* Accessed April 20, 2014. http://www.miamiherald.com/2014/02/05/v-print/3915226/get-tough-on-hit-and-run-drivers.html.

NHTSA. 2015. *Traffic safety facts 2013 Data–Pedestrians*. DOT HS 812 124. Washington, DC: NHTSA's National Center for Statistics and Analysis.

Peltzman, Sam. 1975. "The Effects of Automobile Safety Regulation," *Journal of Political Economy*, 83(4), 667-726.

Ruhm, Christopher J. 2000. "Are recessions good for your health?" *Quarterly Journal of Economics*, 115(2), 617-650.

Sloan, Frank A., Lindsey M. Eldred, and Yanzhi Xu. 2014. "The behavioral economics of drunk driving," *Journal of Health Economics*, 35, 64-81.

Smith, Dakota. February 10, 2015. "Los Angeles taps social media to fight hit-and-run," *Los Angeles Daily News*. Accessed May 23, 2015. http://www.dailynews.com/general-news/20150210/los-angeles-taps-social-media-to-fight-hit-and-run.

Solnick, Sara J., and David Hemenway. 1994. "Hit the bottle and run: the role of alcohol in hit-and-run pedestrian fatalities," *Journal of Studies on Alcohol*, 55(6), 679-684.

Solnick, Sara J., and David Hemenway. 1995. "The hit-and-run in fatal pedestrian accidents: victims, circumstances and drivers," *Accident Analysis & Prevention*, 27(5), 643-649.

Tay, Richard, Shakil Mohammad Rifaat, and Hoong Chor Chin. 2008. "A logistic model of the effects of roadway, environmental, vehicle, crash, and driver characteristics on hit-and-run crashes," *Accident Analysis & Prevention*, 40(4), 1330-1336.

Tay, Richard, Upal Barua, and Lina Kattan. 2009. "Factors contributing to hit-and-run in fatal crashes," *Accident Analysis & Prevention*, 41(2), 227-233.

Toomey, Traci L. 2005. "American Beverage Licensees attack Mothers Against Drunk Driving," *Addiction*, 100(10), 1389-1391.

Yasmin, Shamsunnahar, Naveen Eluru, and Abdul R. Pinjari. 2015. "Analyzing the Continuum of Fatal Crashes: A Generalized Ordered Approach," *Analytic Methods in Accident Research*, 7, 1-15.

Table 1: Descriptive statistics, 1990-2010 (N=1,050)

	Mean	Std. Dev.	Min	Max
Fatality measures				
Traffic fatalities	818.016	808.066	56	5,192
Hit-and-run (H&R) traffic fatalities	31.090	53.714	0	437
Non-H&R traffic fatalities	786.927	759.394	55	4,755
Pedestrian fatalities	101.257	139.241	0	986
H&R pedestrian fatalities	18.695	31.182	0	261
Non-H&R pedestrian fatalities	82.562	109.037	0	725
Policy measures				
BAC<=.08 per se	0.512	0.500	0	1
BAC limit (x100)[1]	8.935	1.040	4	12
Administrative license revocation	0.760	0.424	0	1
Speed limit >=70mph	0.433	0.496	0	1
Primary seat belt law	0.312	0.459	0	1
Control variables				
Population (1,000)	5,606	6,152	454	37,334
Real personal income per capita ($1,000)[2]	35.773	6.099	22.171	58.514
Unemployment rate (%)	5.427	1.773	2.300	13.800
Proportion of drivers <= age 24 (%)	14.333	2.248	9.926	27.852
Urban vehicle miles traveled (VMT) per capita (1,000)	5.242	1.442	2.115	9.228
Rural VMT per capita (1,000)	4.798	2.362	0.631	13.459
Real gas prices ($ per gallon)[2]	1.526	0.556	0.740	3.427
Proportion of light trucks (%)[3]	42.038	9.287	18.441	67.831
Alcohol consumption per capita (gallons of ethanol)	2.643	0.543	1.481	5.387

Notes: Observations are state by year. [1]Number of observations in this case is 1,044 (Maryland did not have any BAC limits until 1996). [2]In constant 2010 dollars. [3]Light trucks include pickups, panels, delivery vans, personal passenger vans, passenger minivans, and utility-type vehicles.

Table 2: Estimation results for hit-and-run and non-hit-and-run traffic fatality counts, 1990-2010

	Hit-and-run traffic fatalities					Non-hit-and-run traffic fatalities				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln(population)	2.361**	2.675**	3.512**	2.607**	3.431**	1.414**	1.756**	1.984**	1.744**	1.967**
	(0.263)	(0.311)	(0.477)	(0.299)	(0.457)	(0.072)	(0.092)	(0.113)	(0.092)	(0.112)
Real personal income per capita	0.985	0.992	0.983	0.991	0.982*	1.009**	1.008**	1.005	1.008**	1.005*
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Unemployment rate	0.992	0.997	0.994	1.000	0.997	0.989**	0.990**	0.988**	0.990**	0.989**
	(0.013)	(0.013)	(0.013)	(0.013)	(0.013)	(0.004)	(0.003)	(0.003)	(0.003)	(0.003)
BAC<=.08 per se	1.115**	1.113**	1.116**			1.015	1.016	1.018*		
	(0.034)	(0.034)	(0.032)			(0.009)	(0.009)	(0.008)		
BAC limit (x100)				0.971*	0.967**				0.997	0.996
				(0.012)	(0.011)				(0.003)	(0.003)
Administrative license revocation	1.017	0.987	0.995	0.989	0.997	0.988	0.998	1.000	0.998	1.000
	(0.045)	(0.043)	(0.041)	(0.044)	(0.042)	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)
Speed limit >=70mph	1.074*	1.059	1.053	1.070	1.064	1.096**	1.066**	1.060**	1.065**	1.060**
	(0.038)	(0.037)	(0.036)	(0.039)	(0.037)	(0.011)	(0.010)	(0.010)	(0.010)	(0.010)
Primary seat belt law	0.988	0.995	1.019	0.983	1.004	0.955**	0.957**	0.964**	0.959**	0.964**
	(0.033)	(0.033)	(0.032)	(0.033)	(0.032)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Proportion of drivers <= age 24		1.006	1.010	1.005	1.009		1.004	1.005*	1.004	1.005*
		(0.009)	(0.009)	(0.009)	(0.009)		(0.002)	(0.002)	(0.002)	(0.002)
Urban VMT per capita (1,000)		1.007	0.965	1.010	0.967		1.051**	1.043**	1.052**	1.044**
		(0.027)	(0.026)	(0.027)	(0.026)		(0.008)	(0.008)	(0.008)	(0.008)
Rural VMT per capita (1,000)		1.035	1.011	1.033	1.007		1.056**	1.049**	1.056**	1.049**
		(0.032)	(0.030)	(0.032)	(0.031)		(0.008)	(0.008)	(0.008)	(0.008)
Real gas prices		0.862	0.935	0.815	0.888		0.942	0.957	0.931	0.947
		(0.162)	(0.164)	(0.154)	(0.155)		(0.055)	(0.053)	(0.054)	(0.053)
Proportion of light trucks (%)		1.012**	1.012**	1.012**	1.011**		1.003**	1.003**	1.003**	1.003**
		(0.003)	(0.003)	(0.003)	(0.003)		(0.001)	(0.001)	(0.001)	(0.001)
Alcohol consumption per capita			1.584**		1.604**			1.159**		1.156**
(gallons of ethanol)			(0.149)		(0.151)			(0.031)		(0.032)
N	1,050	1,050	1,050	1,044	1,044	1,050	1,050	1,050	1,044	1,044
Dependent variable mean	31.090	31.090	31.090	31.148	31.148	786.927	786.927	786.927	787.692	787.692
Log-likelihood	-2,852.62	-2,841.51	-2,830.36	-2,825.95	-2,814.28	-5,085.28	-5,036.92	-5,022.68	-5,008.90	-4,995.30

Notes: These estimates are based on negative binomial regressions that condition on state fixed-effects. Each model also includes a vector of year fixed-effects. For each explanatory variable, we report the incidence rate ratios (IRR) and the standard errors in parentheses. Statistical significance is based on a test of the hypothesis that IRR = 1. *, ** Significance at the 5 and 1 percent, respectively.

Table 3: Estimation results for hit-and-run and non-hit-and-run pedestrian fatality counts, 1990-2010

	Hit-and-run pedestrian fatalities					Non-hit-and-run pedestrian fatalities				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Ln(population)	3.476**	3.560**	5.045**	3.486**	4.986**	2.777**	2.677**	2.833**	2.679**	2.831**
	(0.605)	(0.624)	(1.017)	(0.611)	(1.005)	(0.255)	(0.261)	(0.298)	(0.262)	(0.298)
Real personal income per capita	1.011	1.014	1.006	1.013	1.004	1.011*	1.010*	1.008	1.010*	1.009
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Unemployment rate	0.996	0.997	0.993	0.998	0.994	0.996	0.995	0.995	0.996	0.995
	(0.014)	(0.014)	(0.013)	(0.014)	(0.013)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
BAC<=.08 per se	1.083**	1.078*	1.077*			1.017	1.020	1.020		
	(0.032)	(0.033)	(0.032)			(0.014)	(0.014)	(0.014)		
BAC limit (x100)				0.970*	0.970*				0.991	0.991
				(0.013)	(0.012)				(0.006)	(0.006)
Administrative license revocation	0.971	0.951	0.954	0.948	0.952	0.956*	0.959*	0.959*	0.957*	0.957*
	(0.042)	(0.042)	(0.041)	(0.042)	(0.041)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Speed limit >=70mph	1.030	1.019	1.006	1.029	1.017	1.029	1.021	1.019	1.020	1.019
	(0.037)	(0.037)	(0.037)	(0.038)	(0.037)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)
Primary seat belt law	1.051	1.059	1.091**	1.047	1.078*	1.039*	1.037*	1.041**	1.039*	1.043**
	(0.035)	(0.036)	(0.037)	(0.036)	(0.037)	(0.016)	(0.016)	(0.016)	(0.016)	(0.017)
Proportion of drivers <= age 24		1.016	1.019*	1.016	1.019*		1.011**	1.011**	1.011**	1.011**
		(0.009)	(0.009)	(0.009)	(0.009)		(0.004)	(0.004)	(0.004)	(0.004)
Urban VMT per capita (1,000)		1.032	0.997	1.033	0.996		1.032*	1.027*	1.032**	1.028*
		(0.028)	(0.028)	(0.028)	(0.028)		(0.013)	(0.013)	(0.013)	(0.013)
Rural VMT per capita (1,000)		1.049	1.022	1.050	1.022		1.003	0.999	1.003	0.999
		(0.036)	(0.035)	(0.036)	(0.035)		(0.015)	(0.015)	(0.015)	(0.015)
Real gas prices		0.900	1.000	0.895	1.003		1.106	1.125	1.098	1.117
		(0.172)	(0.187)	(0.169)	(0.186)		(0.103)	(0.105)	(0.101)	(0.104)
Proportion of light trucks (%)		1.009**	1.007*	1.009*	1.007*		1.001	1.001	1.001	1.001
		(0.003)	(0.003)	(0.004)	(0.003)		(0.002)	(0.002)	(0.002)	(0.002)
Alcohol consumption per capita			1.584**		1.607**			1.075		1.073
(gallons of ethanol)			(0.170)		(0.173)			(0.055)		(0.055)
N	1,050	1,050	1,050	1,044	1,044	1,050	1,050	1,050	1,044	1,044
Dependent variable mean	18.695	18.695	18.695	18.708	18.708	82.562	82.562	82.562	82.413	82.413
Log-likelihood	-2,430.37	-2,419.21	-2,410.34	-2,401.59	-2,392.21	-3,280.18	-3,268.61	-3,267.60	-3,245.79	-3,244.82

Notes: These estimates are based on negative binomial regressions that condition on state fixed-effects. Each model also includes a vector of year fixed-effects. For each explanatory variable, we report the incidence rate ratios (IRR) and the standard errors in parentheses. Statistical significance is based on a test of the hypothesis that IRR = 1. *, ** Significance at the 5 and 1 percent, respectively.

Appendix Table A1: Variable definitions and data sources

Variable	Definition	Source
Fatality measures		
1 Traffic fatalities	All fatalities in motor vehicle traffic crashes	NHTSA Fatality Analysis Reporting System (FARS)
2 Hit-and-run (H&R) traffic fatalities	All fatalities in hit-and-run motor vehicle traffic crashes, where hit-and-run refers to cases where a vehicle is a contact vehicle in the crash and does not stop to render aid (including drivers who flee the scene on foot).	FARS
3 Non-H&R traffic fatalities	The difference between (1) and (2) above	FARS
4 Pedestrian fatalities	Pedestrian fatalities in motor vehicle traffic crashes	FARS
5 H&R pedestrian fatalities	Pedestrian fatalities in hit-and-run motor vehicle traffic crashes	FARS
6 Non-H&R pedestrian fatalities	The difference between (4) and (5) above	FARS
Policy measures		
7 BAC<=.08 per se	The maximum allowable blood alcohol content of the driver is .08. A BAC per se statute makes it a violation in itself to exceed a BAC limit regardless of whether there is other evidence of intoxication.	NHTSA Alcohol-Highway Safety Digest Topics and the Alcohol Policy Information System (APIS)
8 BAC limit (x100)	BAC limit is the maximum allowable blood alcohol content of the driver.	APIS
9 Administrative license revocation	Equals one if a state had an administrative license revocation law (ALR) in a given year and zero otherwise. ALR permits law enforcement to suspend or revoke a license of someone who fails or refuses to take an alcohol test after a traffic stop or vehicle crash.	Anderson, Hansen, and Rees (2013)*
10 Speed limit >=70mph	Equals one if a state had a speed limit of 70 mph or greater in a given year and zero otherwise.	Anderson, Hansen, and Rees (2013)*
11 Primary seat belt law	Equals one if a state had a primary enforcement of seat belt law in a given year and zero otherwise.	Anderson, Hansen, and Rees (2013)*

*Anderson, D. Mark, Benjamin Hansen, and Daniel I. Rees. 2013. "Medical Marijuana Laws, Traffic Fatalities, and Alcohol Consumption." *Journal of Law and Economics* , 56(2), 333-369.

Appendix Table A1, continued

Variable	Definition	Source
Control variables		
12 Population	Estimates of the July 1 resident population	Bridged-Race Population Estimates, National Center for Health Statistics, Centers for Disease Control and Prevention
13 Real personal income per capita	Personal income per capita in constant 2010 dollars	Bureau of Economic Analysis
14 Unemployment rate	Annual average state unemployment rate	Local Area Unemployment Statistics, US Bureau of Labor Statistics
15 Proportion of drivers <= age 24	Proportion of drivers age 24 and younger among all licensed drivers, including restricted drivers and graduated driver licenses. Age distribution is estimated.	Federal Highway Administration (FHWA), US Department of Transportation
16 Urban/rural VMT per capita	Vehicles miles traveled on urban/rural public roads	FHWA
17 Real gas prices	Annual weighted average regular grade unleaded gasoline prices for retail outlets excluding taxes ($ per gallon) in constant 2010 dollars	US Energy Information Administration
18 Proportion of light trucks	Proportion of light trucks among all registered motor vehicles. Light trucks include pickups, panels, delivery vans, personal passenger vans, passenger minivans, and utility-type vehicles.	FHWA
19 Alcohol consumption per capita	Gallons of ethanol per capita age 21 and older	Haughwout, LaVallee, and Castle (2015)**

**Haughwout, Sarah P., Robin A. LaVallee, I-Jen P. Castle, 2015. Surveillance Report #102: Apparent Per Capita Alcohol Consumption: National, State, and Regional Trends, 1977–2013. Arlington, VA: NIAAA, Division of Epidemiology and Prevention Research, Alcohol Epidemiologic Data System.