The Effect of Marijuana Decriminalization Laws on Traffic Fatalities

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Abstract

Objectives. To examine the effect of city-level cannabis decriminalization on fatal traffic crashes involving young adults.

Methods. We paired a novel dataset of city and county-level marijuana decriminalization laws with a census of fatal traffic crashes from the Fatality Analysis Reporting System from 2010 through 2017. We used a Poisson difference-in-differences approach to exploit the temporal and geographic variation in marijuana decriminalization laws following the U.S. marijuana market expansion in 2009. We examined changes in counts of fatal traffic crashes, crashes involving marijuana, and crashes by time of day in cities with and without marijuana decriminalization laws. We also explored the heterogeneous effects of marijuana decriminalization on different age cohorts.

Results. On average, cities experienced a 13% increase in fatal traffic crashes involving male drivers between the ages of 15 and 24 following the decriminalization of marijuana. However these effects are not significant at the 95% confidence level (incidence rate ratio (IRR) = 1.13; 95% confidence interval = 0.99, 1.30). For all fatal crashes involving 15-24 year old drivers, the effect is strongest on weekend nights when impaired driving is most prevalent (IRR = 1.37; 95% confidence interval = 1.04, 1.80) and most pronounced during the six month period when cannabis is decriminalized (IRR = 1.20; 95% confidence interval = 1.05, 1.38) before attenuating after 6 months of decriminalized marijuana within a city.

Conclusions. Marijuana decriminalization is associated with increases in fatal traffic crashes involving young drivers. This effect contrasts the decrease in fatal traffic events following marijuana legalization reported in the literature. Because cannabis decriminalization policies only lessen the penalty for consumption while marijuana legalization laws stipulate that consumption must occur at home, the incentives and corresponding consequences of such laws have heterogeneous effects on traffic safety.

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1 Introduction

The legal marijuana market in the United States has undergone a significant transformation following a federal memorandum in 2009 which stated that federal funds would not be used to prosecute those in compliance with state medical marijuana laws (Ogden, 2009). Prior to 2009, 13 states had legalized marijuana for medical purposes. In the seven years after the 2009 Ogden Memorandum, 16 more states and Washington D.C. passed medical marijuana laws (MMLs) and the number of medical marijuana patients and dispensaries increased exponentially.\(^1\) In the states that do not enact MMLs, municipalities have taken steps to decriminalize the drug. Because severity of punishment is a cost associated with consumption (Becker, 1968), we exploit the temporal and geographic variation in cannabis decriminalization laws at the city level to test whether a reduction in punishment results in increased marijuana-related traffic deaths.

Drug enforcement in the United States is dictated by the Controlled Substances Act (CSA). Established in 1970, the CSA designates cannabis as a Schedule I drug prohibiting its consumption. However, over the next fifty years, various cities, counties, and states passed laws liberalizing the drug and easing the prohibitive constraints on the legal marijuana market. Drug enforcement, already weakened by state laws that are more permissive toward the drug, was limited further following the issuance of the Ogden Memorandum in 2009.

Marijuana liberalization occurred in three significant waves. First, following the CSA of 1970, states and municipalities across the United States began reducing the severity of punishments by decriminalizing the drug. Second, beginning with California in 1996, states began passing laws allowing marijuana use for medical purposes. The state markets were small prior to 2009. After 2009, the number of medical marijuana states more than doubled with 9 states adopting measures allowing for recreational marijuana consumption.

For states, that have not enacted medical marijuana laws, marijuana possession remains strictly illegal. However, select municipalities in states without marijuana legalization laws began passing measures to reduce the penalty for marijuana possession offenses. Although many decriminalization laws were passed prior to the practice of states enacting MMLs, recent decriminalization laws are viewed as a middle ground between prohibition and legalization. Decriminalization became

\(^1\)Smart (2015) and Smith (2017) document significant increases in patient levels and dispensary presence, respectively.
more common within non-MML adopting states after the issuance of Ogden Memorandum in 2009. City decriminalization dates for our sample are described in Table 1.

Marijuana detection among drivers involved in fatal car crashes has increased dramatically in recent years. Since 2009, the number of fatal crashes where marijuana was detected in a driver has increased by 50%.

This nationwide increase is not limited to states that enact medical or recreational laws and suggests the perceived risk of cannabis use in consumers is abating. Compared to 16% in 2009, by 2017, approximately 36% of young adults surveyed in the National Survey on Drug Use and Health did not associate weekly marijuana use with any health risks.

However, marijuana impairs cognitive and psychomotor skills associated with safe driving (Kelly, Darke and Ross, 2004; Ramaekers et al., 2004; Sewell, Poling and Sofuoglu, 2009) and acute usage significantly increases the risk of motor vehicle collisions (Asbridge, Hayden and Cartwright, 2012; Hartman and Huestis, 2013). Therefore, lowering the real costs of cannabis by reducing criminal punishment could be detrimental to traffic safety.

Even so, Anderson, Hansen and Rees (2013) and Leung (2019) find MMLs are associated with fewer traffic fatalities and argue a substitution away from alcohol is driving the negative effects. Similarly, Ellis et al. (2019) find MMLs negatively affect auto insurance premiums and the effect is largest in areas with elevated drunk driving rates prior to law enactment.

This paper departs from the literature in that we examine the effect of marijuana decriminalization, rather than legalization. After 2009, decriminalization typically occurred at the municipality level within states that did not enact medical marijuana laws. Decriminalization allows cities to reduce penalties for possession of small amounts of marijuana without contradicting the prohibitive laws at the state and federal levels. Thus, while it reduces nonpecuniary costs associated with marijuana use, it does not allow for storefronts, advertising, or legal use conditional on medical need.

Although MMLs provide legal protection to marijuana consumers, the laws include stipulations that limit consumption to a private residence. Thus, it becomes difficult for researchers to disentangle the mechanism through which traffic safety is improving. Specifically, it is not clear whether consumers are substituting away from other substances (e.g., alcohol) or away from travel.

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2Authors’ calculations from FARS dataset.
3Wen, Hockenberry and Druss (2018) find a negative relationship between marijuana legalization the perceived risk of marijuana use in young adults.
In areas that decriminalize cannabis, the legality of the drug has not changed. Instead, decriminalization reduces the severity and probability of punishment without directly affecting consumer incentives to avoid travel.\textsuperscript{4} We contribute to the literature by examining the effect of decriminalization laws on total traffic fatalities as well as marijuana- and alcohol-related traffic fatalities separately.

2 Methods

Traffic fatality data are obtained from the Fatality Analysis Reporting System (FARS). The FARS is a census of all fatal motor vehicle crashes that occur on public roads and it includes driver information, crash location, and whether drugs or alcohol were detected in the drivers involved. Our outcomes of interest include all fatal traffic crashes and those involving a controlled substance by age and gender. Individual crashes are totaled biannually and are aggregated to the city level. Our sample includes all cities in non-medical marijuana states with 2017 populations greater than 100,000. The cities included in the sample are described in the Appendix. Because the U.S. marijuana market changed significantly following the 2009 Ogden Memorandum, we limit our analysis the years to 2010 through 2017 (n = 2,496) to focus on the post-expansion relationship between marijuana liberalization and traffic safety to provide more relevant information to policymakers.

\textit{City decriminalization laws.} Decriminalization of cannabis often occurs within states at the city- or county-level. From our sample of cities in non-medical marijuana states, we determine which cities have decriminalized marijuana and record the dates such measures were enacted. Table 1 provides the cities and dates of marijuana decriminalization. The cities which decriminalized marijuana before the sample period are omitted from the analysis such that our treated group includes only cities that we observe pre-decriminalization observations. The six-month period in which decriminalization is passed is not considered “treated” by our definition.

\textit{Other Variables.} State-level traffic safety laws are included in the analysis and consist of driver texting laws, administrative revocation laws, and drug per se laws. Law enactment dates are obtained from the National Organization for the Reform of Marijuana Laws (NORML), Insurance Institute for Highway Safety (IIHS), Governors Highway Safety Association (GHSA) and are verified

\textsuperscript{4}DeSimone (2002) provides evidence of a positive relationship between early cannabis decriminalization laws and probability of cannabis use.
through Thomson Reuters Westlaw and National Conference of State Legislatures. These dates are cross referenced with those documented by Abouk and Adams (2013) and Anderson and Rees (2015), respectively.

Population and demographic characteristics are collected from intercensal estimates of the U.S. Census Bureau. City unemployment rates are obtained the Bureau of Labor Statistics. We also compile state-level miles per licensed driver at and include state-level per gallon beer tax rates from the Brewers’ Almanac to control for the relative price of alcohol.

**Model.** To estimate the effect of marijuana decriminalization on fatal traffic crashes, we exploit the temporal and geographic variation in policy changes at the city level using a difference-in-differences approach. Because the dependent variable is a count of fatal crashes censored at zero and skewed, we estimate a Poisson model where

\[
F_{csy} = \exp(\beta Decrim_{csy} + X'_{csy} \theta + \alpha_c + \gamma_t + ln(pop_{cy})) \eta_{csy}.
\]

(1)

\(F_{csy}\) is the count of driver fatalities in city \(c\) in state \(s\) in year \(y\). The number of fatalities are standardized to per capita rates by constraining the coefficient on the natural log of the affected population to one.5 City and year fixed effects are represented by \(\alpha_c\) and \(\gamma_t\), respectively.6 The vector \(X'_{csy}\) includes city unemployment rates, state-level per gallon beer tax to control for the relative price of alcohol, and state-level traffic laws that could affect traffic safety such as texting bans and per se drugged driving laws. \(Decrim_{csy}\) is the variable of interest and is equal to one if a city implements measures decriminalizing marijuana possession and is equal to zero otherwise.

3 Results

Because marijuana decriminalization policies will likely have time-varying effects, we first estimate the relationship using an event study approach. This technique allows for the post decriminalization effect to vary over time while alleviating concerns that the effects are not confounded by trends in fatal crashes prior to decriminalization occurring. In addition, statistically significant pre-decriminalization estimates provide evidence of a confounding omitted variable and threatens the

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5See Osgood (2000) for a discussion on offsetting a dependent count variable by the natural log of the population.
6Fernandez-Val and Weidner (2016) show the fixed effects Poisson model does not suffer from incidental parameters.
validity of the estimated effects of decriminalization on fatal traffic crashes. It is well documented that drug use varies by age and gender.\textsuperscript{7} In addition, young males are more likely to operate a vehicle after consuming drugs and alcohol (NIDA, 2016). Because marijuana use is highest among younger males and young males are more likely to drive while impaired, marijuana decriminalization will likely affect this demographic differently than other demographic groups. We focus the analysis on young people, aged 15 to 24 year old. The time-varying incidence rate ratios (IRR) of decriminalization on fatal crashes involving young drivers are illustrated in Figure 1. All specifications include time-varying control variables and city and year fixed effects. The year prior to decriminalization is omitted as the base period (normalized to one), while period “0 and 1” indicate the 6 month period the decriminalization law was enacted and the 6 month period immediately following implementation.

For each sample, no pre-decriminalization coefficient is significantly different from 1. During the period of decriminalization and the six months that follow, there is an increase in fatal crashes involving a 15-24 year old driver (IRR = 1.20; 95% confidence interval = 1.05, 1.38). This effect is driven by young males.

Although estimated with less precision, similar effects are estimated when we examine the effect on fatal crashes where marijuana is detected in a young driver in Figure 2. There are limitations, however, to examining the effect on marijuana-related crashes. First, marijuana can be detected in the body for extended periods of time following consumption, and detection alone does imply impairment. Second, detection is often conditional upon the responding officer’s decision to test the driver. These decisions to test may be systemically different and could bias the estimated differences in actual marijuana prevalence among drivers. For these reasons, we also examine the effects by time of day. These results are provided in Table 2.

The estimated effects from the difference-in-differences equation are also included in Table 2. The estimates in Panel A describe the effect of marijuana decriminalization on fatal traffic crashes involving drivers aged 15-24. The effect is strongest for crashes involving young male drivers and suggest that fatal crashes involving young males increase by 13% following the decriminalization of marijuana (95% confidence interval = 0.99, 1.30).

The third row describes the effect of decriminalization on fatal crashes that occur on Friday

\textsuperscript{7}The National Survey on Drug Use and Health reports drug use estimates by age and gender.
and Saturday night. Drug and alcohol detection in drivers most often occurs at this time. Thus, if marijuana decriminalization has an effect on traffic safety, the effect should be largest on weekend nights. Conversely, because drug and alcohol use is less common during the week days, the effects on weekday fatal crashes should be zero. Non-statistically significant effects on weekday fatal crashes provides evidence of an omitted variable and weakens the results. Fatal crashes involving young drivers increases significantly on weekend nights. However, there is no evidence of an effect on weekday fatal crashes for this age cohort alleviating concerns of an omitted variable driving the results. Similar effects are not found for fatal crashes involving older drivers suggesting the effects are limited to demographics more likely to consume illicit substances and therefore, be affected by the change in the severity of punishment associated with marijuana use.

The increase in fatal crashes contrasts the negative effects on traffic fatalities associated with medical marijuana laws (see, e.g., Anderson, Hansen and Rees, 2013; Leung, 2019; Santaella-Tenorio et al., 2017). However, medical marijuana laws stipulate consumption must occur in a private residence. Thus, travel behavior is affected concurrently with the changes to the legal status of marijuana hindering the researcher’s ability to disentangle the effects. Our results suggest that marijuana decriminalization without explicitly affecting consumer travel behavior does not have same negative effects that MMLs have on fatal traffic crashes.

4 Public Health Implications

The marijuana market in the United States significantly changed over the past ten years. As more states continue to implement marijuana liberalizing polices, understanding the unintended consequences of such policies is growing increasingly important. While recent research focuses on the implications of legalized medical and recreational marijuana, the effects of marijuana decriminalization within states where marijuana use is still prohibited is largely ignored by the literature. We provide evidence that marijuana decriminalization has a positive effect on fatal traffic crashes that is strongest immediately following decriminalization and for demographics most likely to consume marijuana.

Marijuana decriminalization policies, often argued as a compromise between prohibition and

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8Ellis et al. (2019) marijuana legalization leads to a decrease in car insurance premiums.
legalization, reduce the legal costs of marijuana consumption. As such, one might expect a less adverse impact on public health for decriminalization legalization. When we compare our other results to those in the legalization literature, however, decriminalization causes more traffic fatalities than legalization. The effect is the strongest among young males aged 15-24 years old during weekend nights. The prohibitions for motor vehicle operation that are often coupled with cannabis legalization seem to be reducing the impact of motor vehicle crashes. From a public health perspective, then, we must be careful not to assume the impact of decriminalization will be some intermediate impact between criminalization and legalization or we will miss a critical opportunity to inform policy which will help mitigate the ‘spillover’ effects of relaxed cannabis laws on traffic fatalities.

Thus, while the literature finds a negative effect of legalization on traffic fatalities, our results suggest that reducing the nonpecuniary costs of marijuana through decriminalization without explicitly affecting travel behaviors will adversely affect traffic safety. As the U.S. becomes more permissive toward marijuana, policies should be crafted to discourage travel and limit this spillover effect.
References


Ogden, David W. 2009. “Memorandum for Selected United States Attorneys.”


Smart, Rosanna. 2015. “The Kids Aren’t Alright but Older Adults Are Just Fine: Effects of Medical Marijuana Market Growth on Substance Use and Abuse.”


5 Tables and Figures

Table 1: Cities with Decriminalization Laws with No Prior MMLs

<table>
<thead>
<tr>
<th>City</th>
<th>Date of Decriminalization</th>
<th>City</th>
<th>Date of Decriminalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicago, IL</td>
<td>August, 2012</td>
<td>Tampa, FL</td>
<td>April, 2016</td>
</tr>
<tr>
<td>St. Louis, MO</td>
<td>June, 2013</td>
<td>Orlando, FL</td>
<td>October, 2016</td>
</tr>
<tr>
<td>Milwaukee, WI</td>
<td>June, 2015</td>
<td>Gainesville, FL*</td>
<td>August, 2016</td>
</tr>
<tr>
<td>Miami, FL*</td>
<td>July, 2015</td>
<td>Pasadena, TX*</td>
<td>March, 2017</td>
</tr>
<tr>
<td>Hialeah, FL*</td>
<td>July, 2015</td>
<td>Houston, TX*</td>
<td>March, 2017</td>
</tr>
<tr>
<td>Miami Gardens, FL*</td>
<td>July, 2015</td>
<td>Dallas, TX*</td>
<td>December, 2017</td>
</tr>
<tr>
<td>Pembroke Pines, FL*</td>
<td>November, 2015</td>
<td>Kansas City, MO</td>
<td>April, 2017</td>
</tr>
<tr>
<td>Hollywood, FL*</td>
<td>November, 2015</td>
<td>Atlanta, GA</td>
<td>October, 2017</td>
</tr>
<tr>
<td>Miramar, FL*</td>
<td>November, 2015</td>
<td>Mesquite, TX*</td>
<td>December, 2017</td>
</tr>
<tr>
<td>Pompano Beach, FL*</td>
<td>November, 2015</td>
<td>Garland, TX*</td>
<td>December, 2017</td>
</tr>
<tr>
<td>Davie, FL*</td>
<td>November, 2015</td>
<td>Baton Rouge, LA</td>
<td>March, 2018</td>
</tr>
<tr>
<td>West Palm Beach, FL*</td>
<td>December, 2015</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Decriminalization dates describe the month of which cities in the sample decriminalize marijuana. A city is considered to have decriminalized marijuana if the provisions are in place for the entire calendar month.

*- City decriminalization results from county decriminalization laws.
The Poisson-estimated coefficients are depicted in the figure. The coefficient on the year prior to a city decriminalizing marijuana is normalized to zero. Year 0 indicates a city decriminalizes marijuana while year 1 is the first full year or treatment. The 95% confidence intervals are displayed at each point. Years greater than five years prior or five years following decriminalization are combined into a bin at -5 years and +5 years, respectively.
Figure 2: City-level Time-varying Decriminalization Effects (2010-2017)

The Poisson-estimated coefficients are depicted in the figure. The coefficient on the year prior to a city decriminalizing marijuana is normalized to zero. Year 0 indicates a city decriminalizes marijuana while year 1 is the first full year or treatment. The 95% confidence intervals are displayed at each point. Years greater than five years prior or five years following decriminalization are combined into a bin at -5 years and +5 years, respectively.
<table>
<thead>
<tr>
<th>Panel A: Fatal Crashes Involving Drivers Aged 15-24 Years</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>1.087</td>
<td>1.134</td>
<td>1.009</td>
</tr>
<tr>
<td>Marijuana-related</td>
<td>1.264</td>
<td>1.364</td>
<td>0.907</td>
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<tr>
<td>Weekend Nights</td>
<td>1.366</td>
<td>1.425</td>
<td>1.273</td>
</tr>
<tr>
<td>Weekday</td>
<td>0.966</td>
<td>1.003</td>
<td>0.900</td>
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<table>
<thead>
<tr>
<th>Panel B: Fatal Crashes Involving Drivers Aged 25–44 Years</th>
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</thead>
<tbody>
<tr>
<td>Overall</td>
<td>0.927</td>
<td>0.946</td>
<td>0.900</td>
</tr>
<tr>
<td>Marijuana-related</td>
<td>1.221</td>
<td>1.263</td>
<td>1.045</td>
</tr>
<tr>
<td>Weekend Nights</td>
<td>1.134</td>
<td>1.182</td>
<td>1.068</td>
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<tr>
<td>Weekday</td>
<td>0.834</td>
<td>0.839</td>
<td>0.829</td>
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</table>

<table>
<thead>
<tr>
<th>Panel C: All Fatal Crashes, All Ages</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>1.009</td>
<td>1.002</td>
<td>0.987</td>
</tr>
<tr>
<td>Marijuana-related</td>
<td>1.249</td>
<td>1.306</td>
<td>1.208</td>
</tr>
<tr>
<td>Weekend Nights</td>
<td>1.215</td>
<td>1.222</td>
<td>1.208</td>
</tr>
<tr>
<td>Weekday</td>
<td>0.825</td>
<td>0.816</td>
<td>0.848</td>
</tr>
</tbody>
</table>

Table includes Poisson-estimated coefficients of the effect of cannabis decriminalization laws on driver fatalities by age and gender. Observations are at the city-year level and each specification includes city and year fixed effects, state-level traffic safety laws, and city-level monthly unemployment rates. Standard errors are clustered at the city level, \(* * * p < 0.01, * * p < 0.05, * p < 0.10\).† - Pre-treated mean of rate of fatal crashes per 100,000 people within the demographic category.