Harm Reduction in Domestic Violence: Does Marijuana Make Assaults Safer?

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Abstract

Objective: To examine the effect of medical marijuana legalization and marijuana decriminalization on serious domestic assaults.

Methods: NIBRS data on assaults in 25 states for the years 2005—to 2016 was examined using a Poisson analysis. Assaults were disaggregated according to the situation and extent of injury: total assaults, domestic assaults, non-domestic assaults at all levels of seriousness, as well as serious assaults, serious domestic assaults, and serious non-domestic assaults, were employed as dependent variables. Following the emergence of serious domestic assaults as significantly affected by marijuana decriminalization, sub-group analyses were conducted for victims who were white, black, or Hispanic, as well as situational sub-group analyses for the proportion of assaults that occurred at home, assaults where the offender was suspected of alcohol intoxication, and assaults involving weapons. An event study was conducted to test for trends prior to decriminalization. A subsequent robustness check involved a Poisson analysis of state-by-month panel data, and a randomization inference to confirm that results were more reliable than placebo treatment effects.

Results: The Poisson analysis showed that decriminalization reduced domestic assaults involving serious injuries by 22.5%. This was the only result robust to all subsequent checks. Upon further analysis, while the proportion of serious domestic assaults that took place at home did not change, serious domestic assaults involving offender alcohol intoxication were reduced by 40.7% and the number of serious domestic assaults involving weapons also went down by 23.1%.

Conclusions: While all forms of domestic violence can be uniquely traumatizing, incidents resulting in serious injury can lead to lasting physical, mental, and financial consequences for the victim. Hence, it is surprising that most literature on the effects of policy intervention on domestic violence treats such incidents as homogeneous rather than considering differing levels of victim injury. This study provides evidence that decriminalization of marijuana leads to substantial declines in victim injury. Among domestic violence

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assaults where the victim suffered a serious injury, there was a significant decline in incidents where the offender was under the influence of alcohol or used a weapon.

Keywords: Marijuana, Domestic Violence, Interpersonal Violence

1 Introduction

1.1 A New Approach to Measuring Violence

The implicit premise of most criminological research is that no one policy serves as a panacea. Crime and its attendant social harms cannot be entirely eliminated, only reduced. Therefore, the extensive literature on crime prevention often encompasses harm reduction, defined as 'an approach to high-risk behaviors that focuses on mitigating the harmful consequences of such behaviors rather than eliminating the behaviors themselves' (Shannon 2017). Such interventions have been applied with respect to juvenile delinquency (Heller et al., 2017), illegal drug use (Connock et al., 2007; Kleber, 2008; Sporer & Kral, 2007; Wilson et al., 2015; Marotta & McCullagh, 2016; Prangnell et al., 2017; Pates & Riley, 2012), alcohol (Marlatt & Witkiewitz, 2002; Witkiewitz & Marlatt, 2006; Muckle et al., 2012), marijuana (Crippa et al., 2012; Hall & Weier, 2015), sex and sex work (Andrasik & Lostutter, 2012; Cusick, 2006; Rekart, 2005), gambling (Broda et al., 2008; Nelson et al., 2008), and policing (Ratcliffe et al., 2011; Beckett, 2016).

If harm reduction is a useful principle of crime prevention, that necessitates a more meaningful measure of violence, specifically for domestic assault. While all forms of violence may traumatize victims of domestic abuse, those incidents that result in serious injury can lead to consequences not seen in incidents of lesser severity. Serious injuries may necessitate medical attention, affect school or work attendance, and result in lasting physical, mental, and financial consequences for the victim. Serious assaults are far more costly to the victim and society at large than assaults that result in no or minor injury. They may also presage the murder of the victim in a later abusive event. In short, there is a world of difference between a punch and a gunshot wound. However, to date existing literature has not differentiated between crime inci-

dents involving serious injury and non-serious injury, only evaluating total assaults. While this predominant approach evaluates the extensive margin or total number of assaults, an alternative approach would consider the intensive margin of harm, by asking how much injury results from the given number of assaults.

We leverage a policy intervention of considerable external validity to address the link between marijuana laws and domestic violence incidents involving serious injury. When we considered assaults at all levels of seriousness, our results showed that the policy intervention had no effect on violence. However, this masked more striking and significant results concerning the most serious types of violence —decriminalization of marijuana reduced domestic assaults involving serious injury by some 20%. Within incidents with a serious injury, the number of incidents where the offender was under the influence of alcohol or used a weapon also declined significantly. Not only did these findings ostensibly contradict the earlier result, they also contrast with previous literature showing null effects of marijuana usage on violence or aggression. We show that measuring purely on the extensive margin —the number of crimes —inadequately measures both the effect of a policy and the seriousness of harm that crime caused.

1.2 Literature Review

The literature on the relationship between marijuana and violence remains dissatisfying for a number of reasons. First, the vast majority of studies are cross-sectional in nature, leading to endogeneity due to omitted variable bias. Often, these studies examine more generally the link between all forms of substance use, such as alcohol and cocaine usage, and violence. Such

studies generally find a statistically significant result for the overall relationship between substance use and assault (Moore et al., 2008; Boles & Miotto, 2003; Snowden & Pridemore, 2013; MacDonald, 2015), with alcohol having a pronounced effect and the effect for marijuana being more mixed, and potentially mediated by mechanisms such as withdrawal (Moore et al., 2008).

Second, although they can provide useful contextual clues about the causal mechanisms linking substance use and abuse, those studies that are longitudinal are often limited by a small sample size and reliance on self-reported measures (Fals-Stewart et al., 2003; Reingle et al., 2012). However, potential causal and mediating mechanisms unearthed by these longitudinal studies included the consistency of usage (Reingle et al., 2012), victims' substance use (Cunradi et al., 2015), withdrawal (Reingle et al., 2012; Smith et al., 2013), and the extent to which alcohol and marijuana are used as complementary or substitutory substances (O'Hara et al., 2016).

There are several panel data studies that do address the issue of omitted variable bias, using medical marijuana legalization as their treatment variable. However, none of the studies have addressed the effect of marijuana legalization on domestic violence specifically. Rather, studies have addressed marijuana legalization effect on crime generally (Morris et al., 2014), drug trafficking-related violent crime (Gavrilova et al., 2014), rape (Dragone et al., 2016), or driving under the influence (Anderson et al., 2013).

The criminological literature on domestic violence frequently employs harm reduction approaches, the most well-known amongst them being the Minneapolis Domestic Violence Experiment (Sherman & Berk, 1984), in which nearly 1,200 suspects of domestic violence incidents that came to the attention of police were randomly assigned to either arrest or a warning. The experiment showed that arrestees were much less likely to engage in violence subsequently, and was hugely influential, prompting police departments across the United States to implement

mandatory arrest policies in cases of domestic violence. Replication at six further sites showed similar results, although results were not as striking as in the original experiment. A follow-up study conducted 23 years after the original experiment, however, showed that victims were 64% more likely to have died if their partners were arrested and jailed than if warned and allowed to remain at home (L. Sherman & Harris, 2015). Subsequent domestic violence studies employing harm reduction approaches have tended to be randomized controlled trials within unique settings that pose challenges about applicability to larger-scale interventions (Parcesepe et al., 2016).

Despite the innovations that have taken place in domestic violence intervention, domestic violence remains unacceptably high for a specific subset of abusive relationships —in which the perpetrator uses alcohol. Overall, the balance of evidence suggests a strong and pervasive causal link between alcohol and violence. The past decade of research —in which 'increasingly sophisticated studies' (Leonard & Quigley, 2017) have been conducted —support drinking as a contributing cause of violence on every continent (Abramsky et al., 2011; Kishor & Johnson, 2004), and over diverse research settings (Hellmuth et al., 2013; O'Farrell et al., 2004; Stuart et al., 2006; Leonard & Senchak, 1996; Woodin et al., 2014). A 2008 meta-analysis suggested that a small to moderate association between alcohol use and male-to-female partner violence was amplified when measures assessed more severe alcohol problems (Foran & O'Leary, 2008). Additionally, a meta-analytic review of specifically experimental studies conducted between 1981 and 2014 indicated that alcohol resulted in intimate partner aggression (Crane et al., 2016).

Given that causality has been established, it follows that reducing alcohol consumption should reduce the incidence of domestic or intimate partner violence. Anderson et al. (2013)'s study indicating alcohol consumption fell following medical marijuana legalisation suggests

marijuana and alcohol are substitutes. Therefore, one might hypothesize that marijuana liberalisation will have the unintended effect of reducing domestic violence.

1.3 Contributions

This study therefore makes a number of contributions to the literature. First, it utilizes a unique harm reduction approach by measuring victim injury seriousness rather than the number of domestic violence incidents in the wake of marijuana legalization. This approach disambiguates 'assault' by considering the intensive margin - a subset of assaults which result in serious injury - rather than the extensive margin - the number of assaults, regardless of the seriousness of injury. Second, by relying on an analysis of state-level panel data, it minimizes the previously identified problems of endogeneity and omitted variable bias, and avoids the underreporting problems associated with self-reported measures. While a similar econometric approach has been used in other studies relating to marijuana legalization, this is the first study that uses the approach with respect to domestic violence. Third, this study assesses the effects of a large-scale policy intervention on domestic violence, a research area where innovative large-scale solutions are rare. Finally, the study provides supplementary information which is used to analyze the heterogeneous effects of marijuana legalization, such as incidents broken down by victims' race, incidents where the perpetrator was suspected of alcohol intoxication at the time of the incident, whether the offender used a weapon, and whether the offense took place at in the victim's home.

The remainder of the paper is organized as follows. Section 2 describes our empirical strategy while Section 3 describes the data used. Section 4 presents results and Section 5 discusses

robustness checks employed. Section 6 discusses those findings and concludes.

2 Empirical Strategy

To estimate the effect of marijuana decriminalization or medical legalization on assault, we use a Poisson regression. The general equation for analysis is:

$$Y_{it} \sim Poisson(\lambda_{it}) = \beta_0 + \beta Law_{it} + X_{it} + \phi_i + \gamma_t + \varepsilon_{it} \tag{1}$$

Where $Y_{it} \sim Poisson(\lambda_{it})$ is the number of incidents for each category of assaults measured in state i during year t. Law_{it} estimates a continuous variable of the proportion of the year the state had the marijuana law in effect. X_{it} is a vector of state-level control variables. ϕ_i and γ_t are state and year fixed effects. Standard errors are clustered at the state level to account for serial correlation (Bertrand et al., 2004). Models are weighted by the average of the state's population according to the Census and the population covered by NIBRS agencies in that state. [1]

Using this general equation, we test the effect of marijuana liberalization on 18 total dependent variables. The first set of six tests use the number of domestic assaults, the number of non-domestic assaults, and the number of total assaults as dependent variables, considering both decriminalization and medical legalization. The second set of six tests subsets the previous dependent variables to those where the victim suffered a serious injury.

To examine the heterogeneity of effects that decriminalization had on serious injury domestic assaults, the final set of tests looked whether effects changed based on victim or case characteristics. First, we disaggregated serious domestic assaults by victims' race and ethnicity:

[1] Models weighed with Census population only provide similar results.

assaults involving white victims, assaults involving black victims, and assaults involving Hispanic victims. The three case characteristics we examined were incidents where the offender was suspected of being under the influence of alcohol, where the offender used a weapon, and incidents that occurred in the victim's home[2].

As the probability of identifying at least one significant result due to chance increases as more hypotheses are tested, therefore increasing chances of incorrectly rejecting a null hypothesis, we use the Bonferroni correction to adjust the relevant p-value. The Bonferroni correction counteracts the problem of multiple comparisons through multiplying the p-value of each coefficient by the number of tests. Since there are 18 tests, the reported p-values are multiplied by 18. The Bonferroni correction is a conservative method —other methods, such as the Holm-Bonferroni and Šidák corrections are less stringent. We opted to use the Bonferroni correction to avoid making Type I errors, even at the expense of committing Type II errors.

Lastly, considering that changes in state laws may take time to affect social and behavioral patterns, we ran an event study on domestic assaults involving serious injury to track changes from year to year. An event study analyses the impact of an event on the outcome by tracking how the outcome changes within a defined period before and after the initial implementation of the treatment. In other words, a state which decriminalized marijuana in 2004 is, in the year 2005, treated as equivalent to a state which decriminalized marijuana in 2012, is in the year 2013.

$$log(Y_{it}) = \alpha + \sum_{j=-5}^{5} \beta_j \left[D_{st}^{j} = 1 \right] + X_{it} + \phi_i + \gamma_t + \varepsilon_{it} \tag{2}$$

[2]For assaults that occurred at the victim's home, we consider the proportion of assaults occurring at home rather than the number of assaults.

The variables D^j are dummy variables equal to 1 when marijuana was decriminalized j years ago in state s, as of year t. As in Equation (1), Y_{it} is the number of incidents for each category of assaults measured in state i during year t, X_{it} is a vector of state-level control variables, ϕ_i and γ_t are state and year fixed effects, and $\epsilon_i t$ is an error term.

For this event study, we considered the period beginning five years prior to marijuana decriminalization and ending five years after marijuana decriminalization, with the year just before marijuana decriminalization as the reference year.

3 Data

This study seeks to measure the effect of marijuana liberalization on domestic violence generally, and domestic violence that causes serious victim injuries specifically. For this, we require data that provides information on how many domestic violence incidents occur as well as characteristics of each incident such as injuries sustained by the victim. The Federal Bureau of Investigation's National Incident-Based Report System (NIBRS) is a crime data set whose wealth of information for each crime, victim, and offender meets these criteria and makes it uniquely suited to this task.

This study uses a state-by-year panel data set of 25 states over 12 years, beginning in 2005 and ending in 2016, a time period which saw substantial changes to state laws regulating marijuana in the United States.

3.1 Measuring Violence

We use the FBI's National Incident-Based Reporting System (NIBRS) to measure the number of domestic violence incidents as well as the small subset of incidents that leads to a serious injury for the victim[3]. NIBRS provides detailed information on each crime reported to the law enforcement agency. The data contains information on the type of crime committed, where it occurred, the relationship between the victim and offender, the victim's demographics, which weapons - if any - were used by the offender, and what injuries the victim sustained[4].

As submitting data to NIBRS is voluntary, not all agencies do so. During the time period studied, 2,644 agencies from the 25 states used reported data to NIBRS every month of the year for all 12 years. Three other states —Arizona, Kentucky, and South Dakota —and Washington, D.C., also reported data. However, Arizona, Kentucky, and Washington D.C. were dropped from the dataset because their reporting agencies covered fewer than 100,000 people in the state. South Dakota reported zero serious domestic and non-domestic assaults in the year 2006 and was dropped for all years so that the panel dataset would remain balanced.

Though NIBRS is a national crime data set that satisfies our criteria, two other commonly used crime data sets merit discussion. The FBI's Uniform Crime Reporting (UCR) Program data provides monthly counts for a number of crimes but where it succeeds in breadth of coverage - nearly all agencies in the United States report - it is limited by its shallowness of information. UCR data contains only the number of crimes committed in a given month, providing no information about the victim's injuries or their relationship to the offender.

The second data set to discuss is the National Crime Victimization Survey (NCVS), a nation-

[3]Approximately 5% of domestic violence incidents leave the victim with a serious injury.

[4]The crime location is a broad category representing types of locations such as a bar, victim residence, or a school, rather than the specific place in the city where the crime happened.

ally representative survey of households in the United States that measures victimization. Its major benefit is that it is based on victim reports, it is able to better measure the "dark figure" of crime that goes unreported. In crimes such as domestic violence, surveys are likely to be more accurate in measuring the true number of crimes that occurred than official police records as victims may not report to the police. The NCVS also contains information about victim injuries and victim's relationship to the offender, meeting both of our criteria for choosing a crime data set for this study. However, as the NCVS interviews all members of a surveyed household, there is concern that victim's will not report domestic violence for fear that their abusive partner finds out (Tjaden & Thoennes, 1998). A second issue with the NCVS is that while representative at a national level, it is unlikely to be representative at the state level, and in some cases does not survey anyone from certain states(Langton et al., 2017). Recent changes to the NCVS have been made to improve state-level data but occurred beginning in 2013, leaving too few years to study[5]

NIBRS data contains two crucial components for this analysis - which crime happened and, through information about the victim and offender's relationship, if that crime constitutes domestic violence. We first subset the NIBRS data from its wide variety of crimes reported to only those that are either simple or aggravated assault.[6] Using the victim-offender relationship information, we classify the assault as domestic violence if the victim and offender are dating, married, or family members.[7].

[5]One method in the NCVS design to develop state-level data is to estimate a state's crime based on that of "like place[s]" (Langton et al., 2017). As this means a state's crime data is from people who may not live in that state, its use in measuring state-level policy effects is improper.

[6]NIBRS data provide detailed information for each crime victim, with each entry recording up to ten crimes. We consider a victim to be an assault victim if any of these ten crimes are simple or aggravated assault. In the vast majority of cases, only one crime is reported. In 2016, 9% of all victims and 6% of assault victims reported two crimes in the incident. Fewer than 1% of all victims or assault victims reported more than two crimes in the incident.

[7]As NIBRS includes up to ten offenders, this introduces the possibility that an assault can include multiple offenders whose relationship to the victim can be classified as both a domestic violence and non-domestic violence assault. To avoid this double-counting, we consider a domestic violence relationship to supersede other relation-

In addition to the offender's relationship to the victim, NIBRS says whether the offender is suspected of being under the influence of alcohol and what weapon they used during the assault[8]. We consider an assault to include weapon use if the offender used any weapon other than their body. As NIBRS does not indicate if the weapon was used to directly harm to victim - or merely to threaten or intimidate them - this may overcount the number of assaults where the victim was injured by a weapon.

NIBRS provides eight categories for victim injury: 1) no injury, 2) minor injury, 3) apparent broken bones, 4) unconsciousness, 5) possible internal injury, 6) loss of teeth, 7) severe laceration, 8) other major injury. If a victim suffered any of the injury categories other than "no injury" or "minor injury", they are considered to have suffered a serious injury. Victim injury information comes from two sources: police observation at the scene and information reported to the officer by the victim[9].

As with any data that compiles information from thousands of different agencies, there may be differences in reporting rates and practices for some variables - some agencies may not accurately report victim injuries. While this will increase the noise in any estimate, it is unlikely to bias our results as differences in reporting are unlikely to be related to changes in marijuana laws.

One concern with the measure of serious injury is that while marijuana liberalization may

ships such that a victim who has both kinds of relationships with their offenders will be considered the victim of a domestic assault only. A non-domestic violence assault, therefore, requires that the offender-victim relationships only consist of only known relationships that are not family or dating.

[8]NIBRS provides data on whether the victim or the reporting police officer believe that the offender used drugs or alcohol in relation to the crime. However, the indicator for drug usage does not differentiate being under the influence of marijuana with using other drugs. This variable is also largely unreported by police. For example, several states in the sample reported around 15 drug-related assaults in a calendar year. As this variable has significant flaws in data quality we do not analyze it separately.

[9]Personal communication with Criminal Justice Information Services' NIBRS coordinator Drema Fouch on April 5th, 2018.

be unlikely to be related to police data practices, it may influence whether victims report an injury to police. Marijuana has been associated with increased pain tolerance among users, possibly reducing the chance that users who suffer an injury realize the full extent of that injury (Campbell et al., 2001; Milstein et al., 1975; Cooper et al., 2013; Kramer, 2015). If marijuana liberalization increases victim usage, they may be less likely to report - or may downplay - a serious injury to the reporting officer[10]. However, as the injuries studied are both serious and frequently visible to the reporting officer, we find it unlikely that marijuana use by the victim will cause a significant decline in serious injury reporting.

3.2 Other Data

A state is considered to have a marijuana policy on the date that policy is enacted. For both decriminalization and medical legalization we construct a continuous variable between the values of 0 to 1 indicating the proportion of the year with the law in effect.[11] As laws within states are not necessarily homogeneous, any effect we see on marijuana liberalization is likely to be a conservative. Notably, states with conservative marijuana laws may be home to cities with more relaxed city ordinances.[12]

States which have decriminalized marijuana or legalized medical marijuana are generally in either coastal regions or in the North-West. No state in the Southern United States decriminalized or legalized medical marijuana during the study period. However, if more recent data or a wider number of states were available, southern states with law changes would be included.

[10] NIBRS does not include information on whether the victim was under the influence of drugs or alcohol during the incident.

[11] For example, if a law was implemented on August 1st (the 213th day of a non-leap year), the variable would have a value of 0.58 (213/365) for that year.

[12] For example, in 2017 the city of Atlanta decriminalized marijuana despite being in a state (Georgia) where the possession of marijuana is still a crime.

Both Louisiana and Arkansas, for example, legalized medical marijuana in 2017.

Marijuana laws are not randomly assigned; they are the product of conditions within the state that lead to legal changes. In order to control for these conditions, we use a number of demographic and economic variables at the state level. The bulk of these variables come from the U.S. Census' annual American Community Survey. We consider six demographic variables: the state population, percent of the population that is male, Black, Hispanic, aged 15-24 years, and that is foreign-born[13].

As a measure of the state's social and economic well-being, we consider the percentage of the population that is married, is in the labor force, does not have a high school degree or equivalent,is living in poverty, is working in manual trades, the percentage of households headed by a woman, and the median household income[14].

Marijuana use may be co-morbid with other drug usage as well as alcohol use. We use the drug death rate per 100,000 population data from the Center for Disease Control as a measure of drug users in the state, with a fair amount of confidence that drug deaths are not caused by marijuana use. This variable is lagged by a year. As a measure of alcohol use, we use National Institute on Alcohol Abuse and Alcoholism (NIAAA) data that estimates per capita ethanol consumption for each state[15]. This variable is converted into per capita "drinks" consumed based on the conversion equation included in the NIAAA's report.

Finally, police responses to domestic violence are affected by manpower constraints. To measure police manpower capacity, we turn to the Uniform Crime Reporting (UCR) Program's Law Enforcement Killed and Assaulted data which reports the number of sworn officers em-

[13]As in some states not all agencies report to NIBRS, we use the average of the population covered by NIBRS agencies and the total state population.

[14]The education variable is of those aged 25 or older.

[15]For population aged 14 and older.

ployed in an agency. We aggregate these agencies into a total number of sworn police officers in the state.

4 Results

4.1 Main analysis

Table 1 provides summary statistics for the study. Overall, 26.1% of the state-years had decriminalized marijuana, and 26.0% of state-years legalized medical marijuana. At all levels of seriousness, domestic assaults, non-domestic assaults and total assaults per 100,000 people ranged between hundreds to thousands. Considering assaults involving serious injury only, these were considerably more rare. In one year, one state reported only .36 domestic assaults involving serious injury per 100,000 people covered by NIBRS reporting in that state. As for the race and ethnicity subgroups, a number of states reported zero serious domestic assaults involving Black victims in a year, which was not surprising as they were states with a high percentage of the population that was White (at least 86%). Similarly, the states which reported zero serious domestic assaults involving Hispanic victims in a year were states such as West Virginia and Louisiana with a low percentage of the population that was Hispanic (less than 5%). Most serious domestic assaults occurred at home (81.5%), with nearly all involving an offender that was under the influence of alcohol, and half involving a weapon.

Table 2 presents the results from our main analysis, reporting the incident rate ratio of the effect of decriminalization or medical legalization of marijuana on various dependent variables. Panel A reports results where the independent variable is marijuana decriminalization.

Columns (1)—(3) provide the coefficients for decriminalization's effect on total assault, domestic assault, and non-domestic assault. None of these results are significant. Columns (4)—(6) of Panel A report the results for decriminalization on serious total assault, serious domestic assault, and non-domestic assault. Strikingly, decriminalization returns a significant effect for domestic assaults involving serious injuries, with an IRR of .775 or a reduction of 22.5%. Also significantly affected is non-domestic assault with an IRR of .810 or a reduction of 19%[16]. Panel B reports results where the independent variable is legalization of medical marijuana, for assaults at all levels of seriousness (Columns (1)—(3)) and those involving serious injury only (Columns (4)—(6)). Medical legalization does not return significant results for any of these dependent variables.

The finding that decriminalization reduces serious domestic assaults[17] was a surprising result, for a number of reasons. First, there were no changes in levels of assault involving all levels of injury. This suggests that while the same number of assaults were happening following decriminalization, fewer of them involved serious injuries. Second, this was contrasted with the finding that medical legalization of marijuana had seemingly no effect on assaults, whether one considered assaults at all levels of injury or only those involving serious injury.

Given that the most significant result thus far was that for the effect of marijuana decriminalization on serious domestic assault, we decided to analyze this effect by sub-group. This was done considering both demographic sub-groups and situational sub-groups. As reported in Table 3, we first considered the effect of marijuana decriminalization on serious domestic assault incidents affecting White victims, Black victims, and Hispanic victims separately (Columns

[16]This result ceases to be significant when results are weighted by total state population rather than NIBRS-covered state population. For this reason, we do not further investigate the result.

[17]For assaults involving the three most serious categories of injury —unconsciousness, possible internal injury, and severe laceration —decriminalization is related to negative but not statistically significant results.

(1)—(3)). The results suggested that while White and Hispanic victims suffered from fewer serious domestic assaults following decriminalization, the same could not be said for Black victims though this subgroup had a much wider confidence interval than the other victim groups. The reason for this is unclear. Given that most assaults, as is the case for most crimes, are intra-racial in nature with the perpetrator and the victim being of the same race, it is possible that marijuana decriminalization did not affect Black perpetrators similarly in causing them to inflict less serious injuries on their victims. The reason for this is unclear. Speculatively, one could attribute this to unchanged patterns of behavior around marijuana consumption for Black victims or differential enforcement of decriminalization among different races, but in the absence of further verification, a definite conclusion would be precipitate. We caution against drawing conclusions on disparate racial effects of decriminalization based solely on this study.

However, further analysis by situational sub-groups provided a more convincing explanation. We considered if marijuana decriminalization might also result in changes to the situational variables in serious domestic assaults —the proportion of incidents that took place at home, the number of incidents that where the perpetrator was suspected of alcohol intoxication, and the number of incidents involving a weapon. While the proportion of serious domestic assaults that took place at home did not change, serious domestic assaults involving offender alcohol intoxication were reduced by 40.7% (IRR .593), and the number of serious domestic assaults involving weapons also went down (IRR .769)[18].

The graph of the event study is presented in Figure 1. The horizontal axis represents the number of years since decriminalization, while the vertical axis represents the incidence rate

[18]For assaults involving only guns and not other kinds of weapons, decriminalization is related to negative but not statistically significant results.

ratio of serious domestic assaults compared to the reference year, -1 (the year prior to decriminalization). The dot represents the point estimates, while the bars represent the 95 percent confidence intervals. Prior to T=0, most of the confidence estimates cross the IRR = 1 (no change) boundary, suggesting that there are no pre-trends on the whole. There is one exception: T = -1 presents an estimate within a 95 percent confidence interval, suggesting that compared to the reference year, or year prior to prior to decriminalization, there was an increase in serious domestic assaults. So, if anything, the event study suggests that serious domestic assaults were increasing prior to marijuana decriminalization. The post-period of T = 1 to T = 5 suggests that the decline in serious domestic assaults kicks in within five years after post-decriminalization, with T= 3 and T = 4 showing an IRR less than 1 within a 95 percent confidence interval.

4.2 Robustness Checks

Before further discussion of our results, we specify several robustness checks in order to confirm the validity of our overall identification strategy, as well as several decisions made during the research process.

First, we ran an analysis on a state-by-month level dataset, resulting in 25 states with 144 months over the same time period. The reason for this check was that many states introduced changes in the law in the middle of the year. In the state-by-year analysis, this was resolved by giving the dependent variable the value of the proportion of the year when the law is in place during the year of the law's passage. In the state-by-month analysis, the treatment variable is a binary. If the law was enacted during the middle of the month, we considered that month treated.

Ultimately, the state-by-month analysis was less preferable as it is too granular to reflect longer-term transitions in patterns of behavior around marijuana use, a hypothesis supported by Hunt & Pacula's (2017) study on early impacts of marijuana legalization on prices in Colorado and Washington.

Tables 4 and 5 report the findings for this analysis, with Table 4 reporting the impact of decriminalization and medical legalization on all assaults and assaults involving serious injury. As with the main results, Panel A reports the coefficients form marijuana decriminalization and Panel B reports the coefficients for medical marijuana decriminalization. Most of the analyses conducted on a state-by-month basis, similarly to the main state-by-year data, return non-significant results. The state-by-month analysis confirmed that decriminalization led to a drop in domestic assaults involving serious injury, with similar estimates to the yearly results. Interestingly, the state-by-month analysis suggests that legalizing medical marijuana leads to an increase in total, domestic, and non-domestic assaults at all levels of seriousness, though the main analysis returned nulls.

Table 5 reports the effects of decriminalization on serious domestic assaults, divided into race and ethnicity-based or situational sub-groups. As with the yearly results, the monthly results showed that domestic assaults involving White victims and Hispanic victims went down following decriminalization. The monthly results also confirmed that decriminalization led to a significant reduction in serious domestic assaults involving alcohol or weapons, by 39.4% (IRR .616) and 22.4% (.786) respectively.

The second robustness check involved a randomization inference to confirm that our results were more reliable than placebo treatment effects, by randomly assigning the treatment vector —the date of a law change —to each state in our data. The treatment vector was assigned 1000

times, and in every case had a smaller treatment effect than the actual result.

5 Discussion and Limitations

The key finding in this study was that decriminalization led to a decrease in the number of domestic assaults where the victim was seriously injured, by about 20%. Otherwise, the decriminalization of marijuana or its medical legalization had non-significant effects on assault, contrary to fears that legalizing marijuana would result in increased violence. This was despite the fact that marijuana decriminalization had no effect on the total number of domestic assaults, or indeed any other type of assault, suggesting that following decriminalization, the same number of domestic assaults occurred but led to fewer serious injuries. This shows a stunning effect of marijuana decriminalization on what we term the intensive margin of injury.

Further analyses offered a compelling explanation for this dynamic: that decriminalization reduced serious domestic assaults involving alcohol by nearly half (40.7%), as well as serious domestic assaults involving weapons by nearly a quarter (23.1%). Given the evidence that alcohol is a substance which aggravates violence (Leonard, 2005; Stith et al., 2004; Foran & O'Leary, 2008), the alcohol finding suggests both that (a) marijuana and alcohol are substitutes rather than complements, and (b) the substitutionary use of marijuana likely mitigates the severity of assaults. Despite the longstanding debate over whether marijuana contributes to violence, the medical literature suggests that marijuana is effective as a short-term sleep aid (Nuutinen, 2018) and may contribute to excessive daytime sleepiness (Babson et al., 2017). By making would-be assailants sleepier, marijuana consumption may make the nature of assaults less serious and injuries less severe. This is likely the simplest explanation and is certainly incomplete. This

substance-based mechanism is behavioral in nature, and is premised on marijuana decriminalization increasing consumption to the extent that assailants are more likely to be under the influence of marijuana at the time of assault. Unfortunately, this assumption could not be tested, given the data quality flaws in NIBRS' indicator for drug usage and the fact that NIBRS does not differentiate marijuana from other drugs.

Decriminalization also resulted in serious domestic assaults involving weapon use decreasing by nearly a quarter (23.1%); likely also a contributory factor as to why the number of domestic assaults have remained the same while serious domestic assaults have decreased. Domestic assaults are less likely to inflict serious injury on the victim if a weapon is not used (Sorenson, 2017). That being said, Sorenson's study shows that guns were used most often to intimidate or threaten a partner; therefore, when a gun, as opposed to a non-gun external weapon or bodily force, was used, IPV victims were less likely to have visible injuries but were more likely to be frightened. Displaying or using a gun to threaten can facilitate coercive control, a condition in intimate partner violence whereby an abuser intimidates their victim; Sullivan & Weiss (2017) suggest that such threats are significant and unique predictors for the severity of victims' experience of post-traumatic stress disorder symptoms. Given that the NIBRS data similarly indicates weapon use if the perpetrator had a weapon during the incident and does not require that a firearm be discharged, it is possible that marijuana decriminalization has led a decrease in serious domestic assault because it has also increased perpetrators' propensity to use weapons as a form of coercive control, thus causing such incidents to be classified as entailing non-serious injury. However, given that weapon use has also declined among serious domestic assaults, it may be more likely that perpetrators are less likely to pick up a weapon in the first place.

It is unclear why there is an effect of marijuana decriminalization but not medical legal-

ization. One possible answer is that states which have legalized medical marijuana are much involved in regulating the substance —and restricting access to it. Doubtless, the legalization of medical marijuana may increase rates of consumption for recreational purposes, as Anderson et al. (2013) suggests, as some amount of medical marijuana makes it way to the general public. Nevertheless, medical legalization may still not increase consumption to the extent that it affects rates of serious domestic assault.

Further research may clarify the relationship between (a) alcohol and marijuana use, (b) the relationship between marijuana use and weapon use, and (c) the effect of marijuana use on violence. As future years of NIBRS data become available, the power of similar studies will increase as there will be more years of data from NIBRS-participating states where medical marijuana - and later recreational marijuana - is legal. Marijuana laws are changing with increasing regularity; it is important that research continue in this field and assess what impact these changes have on crime.

Table 1: Summary statistics

Variable	Mean	S.D.	Min.	Max.
Independent variables				
Decriminalization	.26	.44	0	1
Medical legalization	.26	.44	0	1
Total Assaults (per 100,000 population)				
Total assaults	1,161.00	419.78	375.18	2,294.35
Domestic assaults	542.90	204.42	220.39	1,164.12
Non-domestic assaults	463.02	181.72	128.10	1,053.80
Serious Assaults (per 100,000 population)				
Total assaults	60.19	42.29	0.95	233.61
Domestic assaults	18.40	12.75	0.36	58.37
Non-domestic assaults	27.59	19.53	0.60	135.67
Serious Assaults (proportion of all assaults)				
Total assaults	0.05	0.03	0.00	0.14
Domestic assaults	0.03	0.02	0.00	0.10
Non-domestic assaults	0.06	0.03	0.00	0.25
Serious domestic assaults by victim race (per 100,000 population)				
White victims	11.81	7.09	0.24	37.49
Black victims	5.67	9.18	0.00	45.20
Hispanic victims	1.34	1.52	0.00	8.20
Serious domestic assaults by situation (proportion of total)				
Occurred at victim's home	0.81	0.06	0.54	1.00
Involving alcohol	0.89	0.10	0.00	1.00
Involving a weapon	0.49	0.13	0.14	0.82
Demographic variables				
ACS State population (in 100,000s)	47.24	50.86	6.21	278.63
NIBRS-covered population (in 100,000s)	17.79	18.27	0.77	67.12
Percent male	49.30	.66	48.13	51.54
Percent black	9.78	9.27	0.19	33.93
Percent Hispanic	8.44	7.55	0.55	39.07
Percent aged 15—24 years	14.05	0.98	11.88	18.00
Percent foreign-born	6.97	4.09	1.13	16.9
Socio-economic variables				
Percent married	53.58	3.62	44.8	64.0
Percent female head of household	9.49	2.03	5.39	16.00
Percent in labor force	65.36	3.87	53.09	72.36
Percent no high school degree	9.52	3.55	4.17	21.43
Median household income	52,870	8,642	37,410	75,040
Percent in poverty	13.78	2.97	7.04	20.38
Percent working in manual trades	19.80	2.88	13.47	27.40
Other				

Number of police officers (in 1000s)	10.89	11.14	1.21	56.69
Drug death rate (lagged)	13.92	5.56	2.01	40.67
Per capita alcohol consumption (in number of drinks)	529.36	134.52	270.93	1,017.60

Table 2: Main Results: Annual Data

	All Assaults			Serious Injuries		
	Total Assault	Domestic Assault	Non-domestic Assault	Total Assault	Domestic Assault	Non-domestic Assault
$exp(\hat{\beta})$	1.033	.987	1.010	.880	.775***	.810**
p	4.26	10.5	14.7	.069	.000	.008
[CI]	[.979, 1.089]	[.941, 1.035]	[.927, 1.101]	[.807, .960]	[.695, .864]	[.720, .911]
N	300	300	300	300	300	300

(a) Panel A: Marijuana Decriminalization

	All Assaults			Serious Injuries		
	Total Assault	Domestic Assault	Non-domestic Assault	Total Assault	Domestic Assault	Non-domestic Assault
$exp(\hat{\beta})$	1.081	1.074	1.119	1.015	.984	.983
p	2.64	1.39	1.93	13.4	13.3	15.5
[CI]	[.973,1.201]	[.992,1.162]]	[0.976,1.283]	[.927, 1.111]	[.895, 1.082]	[.813, 1.188]
N	300	300	300	300	300	300

(b) Panel B: Medical Marijuana Legalization

Note: For each set of models, the following covariates are included: All models are estimated using population weights.

Table 3: Effect of Decriminalization on Serious Domestic Assaults by Sub-group: Annual data

	Race and Ethnicity Sub-groups			Situational Sub-groups		
	White Victims	Black Victims	Hispanic Victims	Home (Proportion)	Offender Alcohol Involvement	Weapon Assault
$exp(\hat{\beta})$	.804***	.818	.691*	.969	.593***	.769***
p	.001	2.37	0.030	4.81	.000	.000
[CI]	[.723, .895]	[.629, 1.062]	[.549, .870]	[.916, 1.024]	[.531, .663]	[.689, .859]
N	300	300	300	300	300	300

Note: For each set of models, the following covariates are included: All models are estimated using population weights.

Table 4: Main Results: Monthly Data

	All Assaults			Serious Injuries		
	Total Assault	Domestic Assault	Non-domestic Assault	Total Assault	Domestic Assault	Non-domestic Assault
$exp(\hat{\beta})$	1.065	1.010	1.051	0.910	0.788***	0.852
p	.496	12.0	4.40	.569	.000	.105
[CI]	[1.007, 1.126]	[.966, 1.144]	[.957, 1.166]	[.835, .992]	[.706, .881]	[.760, .955]
N	300	300	300	300	300	300

(a) Panel A: Marijuana Decriminalization

	All Assaults			Serious Injuries		
	Total Assault	Domestic Assault	Non-domestic Assault	Total Assault	Domestic Assault	Non-domestic Assault
$exp(\hat{\beta})$	1.115*	1.094**	1.155*	1.062	1.022	1.071
p	.032	.002	.016	.326	8.64	1.88
[CI]	[1.042, 1.195]	[1.037, 1.155]	[1.061, 1.257]	[1.010, 1.116]	[.963, 1.084]	[.986, 1.164]
N	300	300	300	300	300	300

(b) Panel B: Medical Marijuana Legalization

Note: For each set of models, the following covariates are included: All models are estimated using population weights.

Table 5: Sub-group Results: Monthly data

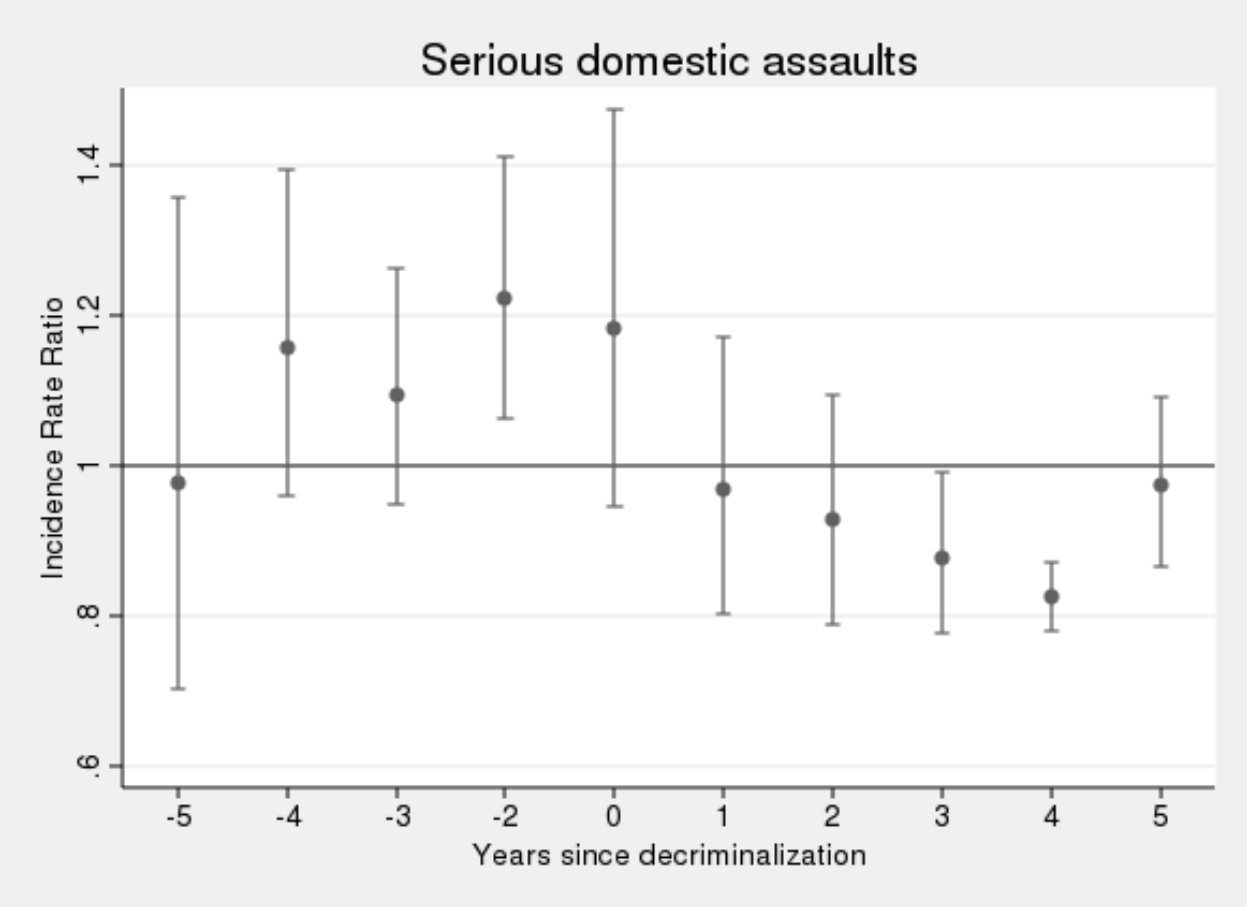
	Racial Sub-groups			Situational Sub-groups		
	White Victims	Black Victims	Hispanic Victims	Home (Proportion)	Offender Alcohol Involvement	Weapon Assault
$exp(\hat{\beta})$	.821**	.820	.696*	.950	.616***	.786**
p	.009	1.20	.0378	.144	.000	.001
[CI]	[.735, .917]	[.663, 1.014]	[.552, .876]	[.914, .987]	[.557, .682]	[.699, .884]
N	300	300	300	300	300	300

Note: For each set of models, the following covariates are included: All models are estimated using population weights.

Table 6: Event study for Decriminalization

Year	$exp(\hat{\beta})$	$se(\hat{\beta})$	p	[CI]
-5	.977	.164	.889	[.704, 1.356]
-4	1.157	.110	.126	[.960, 1.395]
-3	1.095	.080	.218	[.948, 1.264]
-2	1.225	.089	.005	[1.063, 1.411]
0	1.182	.1336	.139	[.947, 1.475]
1	.970	.094	.750	[.802, 1.172]
2	.930	.077	.382	[.791, 1.094]
3	.878	.054	.035	[.779, .991]
4	.826	.0233	.000	[.782, 874]
5	.974	.057	.649	[.868, 1.092]
Observations = 300				
Note: Reference year = -1.				

Figure 1: Event Study of Effects of Decriminalization on Serious Domestic Assaults



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