

## Research paper

## Effects of recreational marijuana legalization on clearance rates for violent crimes: Evidence from Oregon

Guangzhen Wu<sup>a,\*</sup>, Yongtao Li<sup>b</sup>, Xiaodong (Eric) Lang<sup>c</sup><sup>a</sup> The University of Utah, Department of Sociology, 380 S 1530 E Rm301, Salt Lake City, UT 84112-0250, USA<sup>b</sup> Criminal Investigation Police University of China, Shenyang, Liaoning, China<sup>c</sup> Thomas Roney LLC in Dallas, Texas, USA

## ARTICLE INFO

## Keywords:

Recreational marijuana legalization  
Violent crime  
Clearance rate  
Impact  
Police effectiveness

## ABSTRACT

One important public concern about the impact of recreational marijuana legalization is how legalization may affect police performance in solving serious crimes. Based on Uniform Crime Reports (UCR) data from 2007 to 2017, this study used difference-in-differences (DID) analysis and the synthetic control method (SCM) to examine the effect of recreational marijuana legalization on the clearance rates for multiple types of violent crimes in Oregon (OR), a state that legalized recreational marijuana in late 2014. Results offer some evidence suggesting a beneficial impact of legalization on violent crime clearances, as manifested by significant increases in the clearance rate for overall violent crimes and that for aggravated assault in OR counties relative to those in the non-legalized states following legalization. Results also demonstrate that the positive effect of legalization on violent crime clearance rates appears to reduce over time.

## Introduction

Since Colorado (CO) and Washington State (WA) legalized recreational marijuana in 2012, the District of Columbia and 17 states have passed related laws that legalized marijuana for recreational purposes that may entail marijuana cultivation, supply, and possession. As a radical social experiment, marijuana legalization, especially for recreational use, has continued to generate controversies, and central to the public debate are its implications for public safety (Lu et al., 2019). Proponents of recreational marijuana legalization argue that it would improve public safety due to changing societal dynamics such as a diminishing underground marijuana market (given the well-documented association between the underground drug market and crime) and a greater availability of more affordable marijuana (given that reduced marijuana prices may demotivate consumers to commit predatory crimes to support their habit). Opponents assert that legalization would harm public safety given that marijuana may serve as a gateway to harder drugs such as heroin and cocaine (Trilling, 2016), and also given marijuana's alleged adverse impact on individuals' cognitive function and self-control (Howard & Menkes, 2007).

Related to this debate is the question of how recreational marijuana legalization may affect police effectiveness in solving violent crime. As Makin et al. (2019) noted, legalization supporters claimed that legalization would improve police performance in solving serious crimes, as police officers could reallocate their resources from marijuana pos-

session arrests to focus on more serious crimes, and would thus result in improved clearance rates for these crimes. This argument sounds reasonable. However, due to the lack of research, it is not clear how this policy change may affect police reallocation of resources. Although there is some evidence generally suggesting a positive connection between police resources and clearance rates (Doerner & Doerner, 2012; Stolzenberg, D'Alessio, & Eitle, 2004), it is far from conclusive; evidence remains elusive about the conditions under which police resources could translate to favorable outcomes as reflected by improved clearance rates.

An overview of the literature reveals a substantial body of research (Borg & Parker, 2001; Brandl & Frank, 1994; Doerner & Doerner, 2012; Eck, 1983; Puckett & Lundman, 2003; Roberts, 2008; Sampson & Groves, 1989; Stolzenberg et al., 2004; Weisburd & Braga, 2019) showing that crime clearance rate is a function of dynamics at many levels: case (e.g., demographic characteristics of the victim, the relationship between the offender and the victim, seriousness of the offense, and the availability of a good lead), organizational (e.g., number of detectives, workload, organizational structure, agency size, training, and management style), and environmental (e.g., community size, extent of racial segregation, economic structure of the community, and mobility of residents). Highly relevant to the present study are prior research exploring the organizational factors, especially those emphasizing the effect of police resources. Overall, this line of research demonstrated a positive effect of police resources (e.g., number of sworn officers and law enforcement expenditures, see Doerner & Doerner, 2012) and investigative efforts

\* Corresponding author.

E-mail address: [guangzhen.wu@soc.utah.edu](mailto:guangzhen.wu@soc.utah.edu) (G. Wu).

(see Brandl & Frank, 1994) on crime clearance rates. However, scholars also noted that for a specific type of offense, the likelihood of clearance was more affected by the allocation of resources (the amount of resource allocated to investigate this type of crime) than the aggregated amount of resources used by the police (Borg et al., 2001).

Despite this body of research, few studies have explored how specific policy changes may affect crime clearance rate. Notably, notwithstanding growing scholarly interest in the impact of marijuana legalization on crime (Brinkman & Mok-Lamme, 2019; Dragone, Prarolo, Vanin, & Zanella, 2019; Freisthler, Gaidus, Tam, Ponicki, & Gruenewald, 2017; Hao & Cowan, 2020; Hughes, Schaible, & Jimmerson, 2020; Lu et al., 2019; Makin et al., 2019; Stohr et al., 2020; Wu, Boateng, & Lang, 2020; Wu, Wen & Wilson, 2021), studies exploring its effect on crime clearance rate are rare (see Jorgensen & Harper, 2020; Makin et al., 2019). Indeed, as mentioned previously, it seems reasonable that recreational marijuana legalization may affect police resource reallocation as the police need not to focus on marijuana-related law enforcement after legalization. The limited research has focused on CO and WA and has yielded mixed results. Makin et al. (2019) found a positive impact of legalization on crime clearance rates in these two states; on the other hand, Jorgensen and Harper (2020) found no meaningful changes in crime clearance rates in the two states following legalization. Given that prior research has suggested that the influence of marijuana legalization on public safety could differ across states (Hughes et al., 2020; Lu et al., 2019; Wu, Wen & Wilson, 2021), it is now necessary to expand this line of research to other states that recently legalized recreational marijuana like Oregon (OR; legalized in late 2014).

The effect of legalization on public safety including police effectiveness in solving crime may vary based on geographic scale. For example, Makin et al. (2019) and Jorgensen and Harper (2020) examined the same issue using police agency-level data and state-level data, respectively. Although both studies were based on rigorous quasi-experimental designs, they have produced results showing the differential effects of recreational marijuana legalization on crime clearances across geographic levels considered. Prior related studies examining the legalization's effect at the county-level are few (Hao & Cowan, 2020; Wu et al., 2020, 2021). In effect, given that an increasing number of states have moved to legalize, the study of county-level effects will become increasingly important for marijuana policy development, as most states follow an opt-out option for counties which do not wish to allow either commercial growing/processing or retail sales businesses to operate in their jurisdictions. The examination of county-level effects would be helpful for policy makers in counties within a legalized state to make informed decisions on cannabis regulation in their own jurisdictions.

The current study is to fill these gaps in prior research. Specifically, using county-level Uniform Crime Reports (UCR) data from 2007 to 2017 and a quasi-experimental research design that compares changes in clearance rates for overall violent crimes and a range of subtypes of violent crimes such as aggravated assault, robbery, and rape between counties in OR and those in the non-legalized states, both before and after legalization, this study allows us to see if counties in OR have experienced significant changes in violent crime clearance rates after legalization relative to those in the 19 states<sup>2</sup> where marijuana remained illegal for both recreational and medical purposes. As Moore, Trojanowicz, and Kelling (1988) noted, physical violence is the most important characteristic of offenses that shapes people's view of serious crime, and "society generally considers physical attacks – sexual and nonsexual – as far more serious than attacks on property" (p. 2). This suggests that if the police were able to reallocate their resources as a response to marijuana legalization, they would arguably allocate more resources to violent crimes, and would thus increase violent crime clearance rates.

## Data and methods

### Data

The data for this study were compiled from multiple sources, addressing the outcome variables—violent crime clearance rates—and covariates including county poverty level, median household income, and unemployment rate. Information about clearance rates for different types of violent crimes was derived from UCR data for the period of 2007–2017, which we acquired from the Institute for Social Research at the University of Michigan (ICPSR) database. Specifically, we calculated yearly clearance rates for each type of violent crime (violent crime overall, aggravated assault, rape, and robbery) based on the number of offenses cleared by arrest and the total number of offenses. The UCR employs the hierarchy rule that requires police to count only the most serious offense when multiple offenses occurred within a single incident. For example, if an incident included a rape and a homicide, only the homicide was reported to FBI because it is the more serious crime. Given the underreporting issue (crime rates being biased downward) due to the hierarchy rule, crime clearance rates presented in this study tend to be higher than the actual ones. Also, as UCR data are based on police agencies' voluntary reporting of crime information to the FBI, there may be police agencies in certain counties that did not provide crime data or failed to provide crime data for certain months. In the case of incomplete reporting by police agencies, data were imputed based on crime reported in other months by that agency and crimes in comparable jurisdictions in the month(s) of missing data. Overall, the county-level crime data showed a high level of completeness, as reflected by the fact that approximately 83.3% of all the counties involved in this study had a coverage indicator (CI, with values ranging from 0 to 100, higher values indicating higher completeness of data) greater than 80, and the mean CI for all the counties was as high as 88.1. To ensure the results were based on data with minimal imputation, we used a high value of CI ( $\geq 80$ ) for analysis.<sup>3</sup> In 2017, counties examined in this study have a population of approximately 108.5 million in total. Counties with a population of over 50,000 account for 28.4% of the sample, and those with a population of over 100,000 account for 25.4% of the sample.

Prior research has demonstrated the relevance of social disorganization variables to police performance in solving crime (Roberts, 2008; Sampson & Groves, 1989). Hence, this study took into account the potential influence of county poverty level, county median household income, and county unemployment rate. Data for these variables were acquired from the U.S. Census Bureau's Small Area Income and Poverty Estimates from 2007 to 2017 (for *county poverty level* and *median household income*) and the Bureau of Labor Statistics (under U.S. Department of Labor)'s Local Area Unemployment Statistics. To address potential multicollinearity issues (the correlation coefficient between poverty level and median household income is above 0.70), a *concentrated disadvantage* index was created based on these three variables ( $\alpha = 0.82$ ) and was included in the regression analysis as a covariate.

### Estimation strategy

We used a difference-in-differences (DID) design to estimate the effects of recreational marijuana legalization on clearance rates for different forms of violent crimes. The DID analysis relies upon observations collected from two groups (treatment group and control group) differentiated by the exposure factor (e.g., legalization) within two time periods (pre-treatment period and post-treatment period). For the current study, the treatment group consists of counties in the legalized state of OR, and

<sup>2</sup> These 19 non-legalized states are Alabama, Georgia, Idaho, Indiana, Iowa, Kansas, Kentucky, Mississippi, Nebraska, North Carolina, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Wisconsin, and Wyoming.

<sup>3</sup> To check the robustness of the results, analyses based on differing CIs such as  $CI \geq 50$  and CI with no restrictions (meaning all cases were involved in the analysis) were also conducted. These additional analyses produced results that were overall consistent with the primary results using  $CI \geq 80$ , which are displayed in the Appendix Tables A1 and A2.

**Table 1**  
Effects of recreational marijuana legalization on clearance rates for specific violent crimes in Oregon (2007–2017).

	Aggravated Assault Clearance	Rape Clearance	Robbery Clearance	Violent Crime Clearance
<i>Legalization</i>	5.920*** (0.915)	.752 (1.011)	1.889 (1.030)	4.499*** (0.792)
<i>N</i>	14,073	12,396	11,159	14,174
County Dummies	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
Covariates	YES	YES	YES	YES

Note. \*\*\* $p \leq 0.001$ .

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. Oregon's ballot Measure 91 (Legalizing recreational marijuana) was approved in November 2014 and took effect on July 1, 2015.

The covariates included in the models are concentrated disadvantage and county lagged violent crime rate.

the control group involves counties in the 19 non-legalized states.<sup>4</sup> For decades, the DID method has been commonly used by scholars as a useful tool to evaluate policy outcomes. As a quasi-experimental research design that involves the consideration of pre- and post-intervention periods and the use of a control group, the DID method allows for the identification of causal relationships by accounting for changes due to factors other than intervention (Meyer, 1995).

Using the DID approach that considers multi-level clustering (counties nested within states), we specified the regression model for each of our outcome variables (violent crime clearance rate, aggravated assault clearance rate, robbery clearance rate, and rape clearance rate) as:

$$Y_{ist} = \theta_i + \beta DT_{it} + \gamma DP_{it} + \delta(DT_{it} \times DP_{it}) + X_{ist} + \varepsilon_{st} + \xi_{ist} \quad (1)$$

where  $Y_{ist}$  (the outcome variable) represents the clearance rates for different forms of violent crimes such as violent crime overall, aggravated assault, robbery, and rape in county  $i$  of state  $s$  in year  $t$ .  $DT_{it}$  is an indicator variable for the group-specific component, equal to 1 if  $Y_{ist}$  is an observation from the treatment group (counties in OR) and equal to 0 otherwise.  $DP_{it}$  is the dummy variable for the time-specific component, equal to 1 if the observation is from the post-treatment (legalization) period and equal to 0 otherwise. Our key independent variable is  $DT_{it} \times DP_{it}$ , which is an interaction term capturing the policy impact on violent crime clearance rates, which represents the object of our interest. The vector  $X_{ist}$  includes county-level controls for concentrated disadvantage and violent crime rate (lagged).  $\theta_i$  is the time fixed effect, which is used to capture time-invariant unobserved factors.  $\varepsilon_{st}$  is the unobserved state-level effect in the error term (standard errors adjusted for clusters in each state).  $\xi_{ist}$  is the idiosyncratic error.

## Findings

Table 1 presents the effects of recreational marijuana legalization on specific violent crime clearance rates in OR. As it shows, with multiple types of violent crime clearances examined, legalization in OR has led to significant increases in the clearance rates for violent crime overall ( $p \leq 0.001$ ), and aggravated assault ( $p \leq 0.001$ ). Specifically, on average, following legalization, counties in OR experienced an increase of approximately 4.5% in the clearance rate for violent crimes in general and approximately 5.92% in aggravated assault clearance rate relative to the counties in the non-legalized states. However, no significant positive effect was observed for the clearance rates of the other two subtypes of violent crime: rape and robbery.<sup>5</sup> We also ran the DID models based

<sup>4</sup> Although the primary analysis of this study is at the county level, we have also conducted state-level analysis to examine the legalization's impact on violence crime clearance. Specifically, the data were aggregated to state level, and DID was applied. The results of the state-level analysis were presented in Appendix Table A3.

<sup>5</sup> We also conducted analysis for murder clearance. Because of the poor match in murder clearance rate between OR counties and those in the nonlegalized states (the application of the synthetic control method yielded substantially im-

balanced synthetic control and treated groups), the results for murder clearance were not robust and were not shown here.

on other levels of coverage indicators, and the results from these additional analyses (see Appendix Tables A1 and A2) were largely consistent with the primary results as presented above.

In addition, we also examined the effects of recreational marijuana legalization on violent crime. This examination helps identify whether the observed changes in the clearance rate for violent crimes were a result of changes in reported crimes or due to the changes in number of arrests. The results of this analysis were presented in Table 2. As Table 2 shows, recreational marijuana legalization was associated with a marginally significant increase in overall violent crime ( $p \leq 0.1$ ) and aggravated assault ( $p \leq 0.1$ ) in the OR counties relative to counties in the non-legalized states. Results also show increases in rape, and robbery, but none of them reached statistical significance. Connected to the prior findings concerning the significant positive effect of legalization on the clearance rates for violent crime overall and aggravated assault, the results from these additional analyses of violent crime seem to suggest that the improvements in the clearance rate of violent crimes reflect increasing arrests made by the police after legalization (rather than a function of decreased violent crimes).

## Robustness check

The DID approach relies upon the common trend assumption, which requires that, absent the treatment itself, the average outcomes for the treatment and control groups would have followed the same trends. That is, for the current study, if counties in the non-legalized states differed substantially from OR counties in the trends of specific violent crime clearance rates in the pre-legalization period, it would raise doubt about the ability of the control group (counties in the non-legalized states) to serve as the “counterfactual” for the treatment group (OR counties). To assess the plausibility of the common trend assumption, we followed the approach suggested by Ryan, Burgess, and Dimick (2015). Specifically, we created an interaction term between the time trend and the treatment group and tested the significance of the interaction term for models associated with each outcome variable (clearance rates for different forms of violent crime) using data only for the pre-legalization period. If the linear trends for the treatment group (OR counties) and control group (counties in the non-legalized states) were similar prior to intervention/legalization, we would expect that the interaction term would be insignificant. We found that, for all the models corresponding to each of the outcome variables, the interaction term between the time trend and treatment group was not statistically significant. This finding is in line with a causal interpretation of our results about the legalization effect and supports the common trend assumption.

In addition, we used the synthetic control method (SCM) to further check the robustness of the results obtained from the DID analyses. Proposed by Abadie, Diamond, and Hainmueller (2010), the SCM constructs a control group as a weighted average of non-treatment units

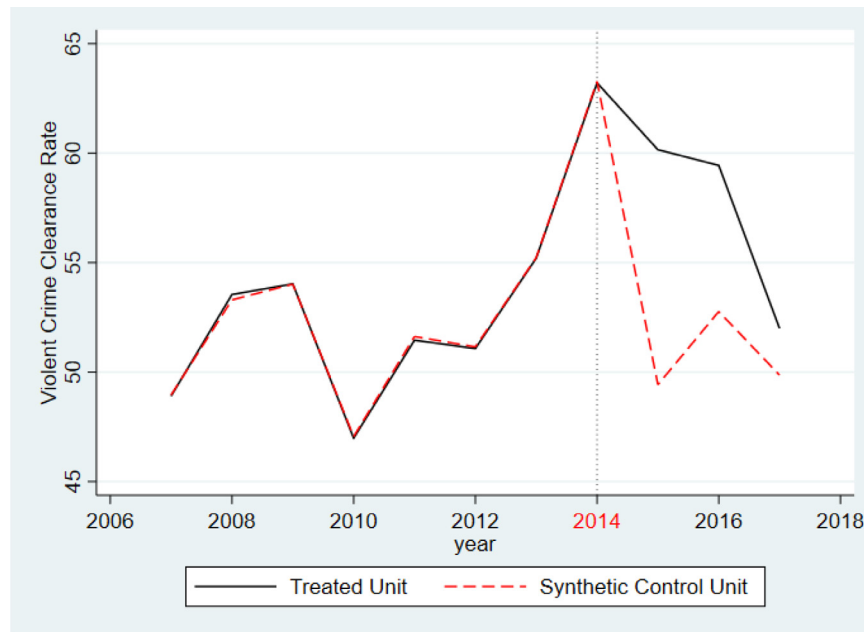
**Table 2**  
Effects of recreational marijuana legalization on the rates of violent crimes in Oregon (2007–2017).

	Aggravated Assault	Rape	Robbery	Violent Crime
<i>Legalization</i>	37.820† (21.449)	4.647 (3.853)	5.813 (5.865)	48.029† (26.079)
<i>N</i>	16,416	16,414	16,414	16,414
County Dummies	YES	YES	YES	YES
Year Dummies	YES	YES	YES	YES
Covariates	YES	YES	YES	YES

Note. † $p \leq 0.1$ .

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. Oregon's ballot Measure 91 (Legalizing recreational marijuana) was approved in November 2014 and took effect on July 1, 2015.

The covariates included in the models are concentrated disadvantage and county population.



**Fig. 1.** Synthetic control model for violent crime clearance rate in Oregon counties.

where weights are chosen to best approximate the treated unit in the pre-treatment period. As such, the SCM allows for a systematic selection of the best comparison units in comparative case studies and consequently relaxes the common trend assumption of the DID method. One important advantage of SCM is that it “accounts for endogeneity bias due to omitted variables by accounting for the presence of time-varying unobservable confounders” (Olper, Curzi, & Swinnen, 2018, p. 395). This feature of SCM addresses the limitation of traditional panel models (e.g., fixed effects) that only account for time-invariant unobservable confounders.

We applied the SCM to the two types of crime clearance that were shown to be significantly influenced by recreational marijuana legalization in the DID analyses, namely the clearance rate for overall violent crimes and the aggravated assault. Following the approach described by Abadie et al. (2010), we constructed the synthetic control region (based on counties in the non-legalized states) that best reproduced the values of predictors for each outcome variable of interest, namely, violent crime clearance rate and aggravated assault clearance rate. Specifically, the predictors for each outcome variable included the corresponding crime clearance rate for the years in the pre-legalization period. The effects of legalization on the outcome variables were estimated as the difference in each outcome variable between the treated region (OR counties) and its synthetic versions in the years after the passage of the recreational marijuana law in OR.

The trends for violent crime clearance rate and aggravated assault clearance rate for OR counties and the synthetic control region are

shown in Figs. 1 and 2.<sup>6</sup> As Fig. 1 displays, the synthetic control region very closely tracks the OR trajectory of violent crime clearance rate during the pre-treatment years. The two trend lines begin to diverge noticeably immediately after treatment/legalization. The difference demonstrates that had OR not legalized recreational marijuana, the clearance rates for violent crime would have been approximately 11%, 7%, and 2% lower in the post-legalization years of 2015 ( $p \leq 0.01$ ), 2016 ( $p \leq 0.05$ ), and 2017 ( $p \leq 0.05$ ), respectively. While these results show that legalization has in general led to a significant improvement in violent crime clearance rate in OR counties, this positive effect seems to reduce over time (as reflected by the decreasing differences in violent crime clearance rate over the post-legalization years).

The synthetic control model for aggravated assault clearance rate produced results showing a similar pattern to that for violent crime clearance rate. As Fig. 2 shows, the synthetic control region tracks the

<sup>6</sup> Information on the weights of donor pool units for the models of overall violent crime clearance and aggravated assault clearance is presented in Appendix Tables A4 and A5. Overall, the donor weights vary within a relatively small range and there are no extreme scores. However, as an additional effort to check the robustness of the SCM results, we removed the donor counties with the greatest weight (e.g., Miami county in KS) and redo the analysis, the results were largely similar to those obtained from the original SCM models. Figs. A3 and A4 show the trends for violent crime clearance rate and aggravated assault rate, respectively, based on the donor pool from which counties with the largest weights were removed.



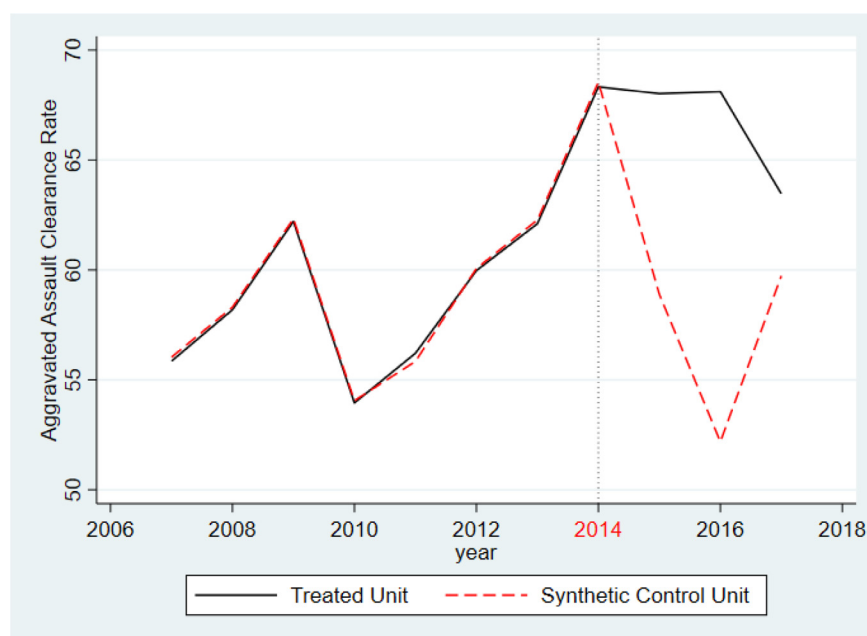


Fig. 2. Synthetic control model for aggravated assault clearance rate in Oregon counties.

actual OR trajectory closely in the pre-legalization period and begins to diverge after legalization. These improvements in aggravated assault clearance rate in Oregon counties are statistically significant for all 3 years of the post-legalization period ( $p \leq 0.001$  for 2015,  $p \leq 0.05$  for 2016 and 2017). Specifically, the results of the SCM suggest that recreational marijuana legalization in OR led to significant increases in aggravated assault clearance rate in its counties by around 9%, 16%, and 4% for the post-legalization years of 2015, 2016, and 2017, respectively. As observed in the SCM analysis of violent crime clearance, here we also see a substantial reduction in the improvement of aggravated assault clearance rate in the third year after legalization (2017).

Given the concern that results from the SCM models may change if the donors and predictors were reordered (Klößner, Kaul, Pfeifer, & Schieler, 2018), as a further step to check the robustness of the results, we randomly reordered the donor counties and changed the order of predictors when applying the SCM. Specifically, we generated a random number for each observation within the dataset and then sorted these numbers in ascending order. As such, counties were ordered by these random numbers generated, rather than by state, year, and county name as was done in the original dataset. Using this dataset with a new data structure, we largely reproduced the results from the SCM models based on the original dataset, as reflected by no substantial changes in the trend lines for violent crime clearance overall and aggravated assault clearance after the implementation of reordering of donors and predictors (though weights for some donor counties were slightly different from the original ones). The trends of violent crime clearance and aggravated assault clearance based on the newly sorted data were shown in Figs. A1 and A2. Overall, the results obtained from the synthetic control models for the clearance rates of overall violent crimes and aggravated assault provide further support for those based on the DID analyses.

## Discussion

Based on a rigorous quasi-experimental research design that included both DID and SCM analysis, this study examined the impact of recreational marijuana legalization on violent crime clearance in OR. The results demonstrate that legalization in OR has likely resulted in significant increases in the clearance rate for violent crime overall. It also significantly increases that for aggravated assault, a subtype of violent

crime. The results also reveal that the positive effect of legalization on violent crime clearance seems to reduce over time. Overall, this study provides some evidence suggesting a beneficial impact of recreational legalization on police performance in solving violent crimes.

The finding largely aligns with the argument made by the proponents of marijuana legalization that legalization would improve police effectiveness in addressing serious crimes, and as a result would increase clearance rates and generate a crime deterrence effect (Trilling, 2016). Although the effects of marijuana legalization on police resource reallocation still need further examination, the results of this study do suggest some improvements in violent crime clearances in OR relative to the non-legalized states following legalization. In addition to the possible function of police reallocation of resources due to legalization, the substantial increases in the clearance rate for violent crimes may be a result of police officers' responses to the unchanged performance metrics, which still emphasize arrest rates after legalization. As Makin et al. (2019) reasoned, marijuana legalization essentially removed an important source of arrests for officers (e.g., officers were not able to make arrests for marijuana possession under a certain amount after legalization). In cases where police agencies continued to use "number of arrests" as a key measure of individual officer performance, officers were likely motivated to make more arrests for other offenses to meet existing performance requirements, resulting in increased clearance rates.<sup>7</sup>

Notwithstanding an overall positive effect of legalization on violent crime clearance rate, it is worth noting that the positive effect seems to decrease over time. While this decline may be a function of a myriad of factors, one potential explanation might be related to the rising violent crimes possibly connected to the increasing marijuana use and sales. That is, in the initial period after legalization (e.g., the first year following legalization), the police may respond to legalization by simply reallocating resources away from marijuana possession arrest toward more serious crimes, resulting in substantial increases in violent crime

<sup>7</sup> Officers routinely use discretion (e.g., whether or not to make an arrest) when doing their jobs. Scholars have noted that police discretion to arrest was reflected in not only misdemeanor but also felony-level offenses (Hall, 2005). The pressure to meet existing performance requirement that emphasizes arrest rates after legalization may motivate officers to decide to make more arrests in felony-level violent offenses in their use of discretionary powers.

clearances. The related context is that marijuana sales and use have not increased much in the first year after legalization (note retail sales of recreational marijuana in OR began on October 1, 2015). But thereafter, as legal marijuana sales increase and total marijuana consumption rises, violent crimes rise, which diminishes the positive effect of legalization on clearance rate. In fact, OR's statewide marijuana sales have continued to increase since its adult-use market began taking shape and have reached approximately \$46.8 million in December 2017, up from \$7.4 million in December 2016 (Oregon Liquor Control Commission, 2019). Our analysis of crime data does suggest that violent crimes overall in OR counties have increased after legalization relative to those in the non-legalized states. It should be noted that the effect observed in this study is essentially a short-term effect of legalization on violent crime clearance, as the post-legalization period covers only 3 years. Considering that the extent and nature of the legalization effect may vary across time, it would be worthwhile to further examine this issue when more years of data associated with the post-legalization period are available.

Indeed, the finding of the current study aligns with a prior study by Makin et al. (2019), who also found a positive influence of marijuana legalization on the clearance rates for certain types of crimes in CO and WA. But it is inconsistent with another study (Jorgensen & Harper, 2020) detecting no meaningful effect of legalization on crime clearance rates in the two legalized states. While these mixed results may be attributable to differential research designs (e.g., the use of different levels of data and different pre- and post-legalization periods), they also seem to suggest that the impact of legalization on crime clearance rates may differ across states because of differences in state policy regulating marijuana and law enforcement environments. This inconsistency in research findings demonstrates the need to focus on specific states in examining the implications of marijuana legalization for crime clearance rates to reveal the influence of state-specific contexts.

**Limitations.** First, as mentioned previously, although the post-legalization period covers until 2017, which reflects the most recent available data, it is still relatively a short period of time (2015–2017). As a result, the effect identified in this study is largely a short-term effect. Given that the impact of recreational marijuana legalization on crime clearance may change over time (Hall & Lynskey, 2016), it is necessary to further examine this issue when additional years of crime clearance data are available to reveal the long-term effect of marijuana legalization. Second, while this study is based on a quasi-experimental design with a combination of DID and SCM that helps identify the causal relationship, it is not a true experiment. Therefore, we caution against overinterpretation of the results. Considering the very limited literature on this subject, more research using rigorous impact assessment methodologies is needed to accumulate evidence unveiling the implications of recreational marijuana legalization for crime clearance.

## Declarations of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

The authors thank the editor Dr. Peter Reuter and anonymous reviewers for their comments and suggestions.

## Supplementary materials

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2021.103528.

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