# Did Recreation Marijuana Legalization Increase Crime?

**Sunyoung Lee, Korea Labor Institute & Incheon National University, sylee@kli.re.kr**

***Selected Paper prepared for presentation at the 2022 Agricultural & Applied Economics Association Annual Meeting, Anaheim, CA; July 31-August 2***

Did Recreation Marijuana Legalization Increase Crime?

**Sunyoung Lee**[1]

## Abstract

Given that legalization of recreational marijuana legalization at the federal level has been considered, the effect of recreational marijuana legalization on different types of crime and the long run effects should be a valuable resource for policymakers. This paper provides evidence of the effects of recreational marijuana legalization on crime for multiple treated states across different dimensions using recent methodological improvement on Difference-in-differences design for staggered treatments. This study finds evidence that recreational marijuana legalization increases murder, larceny, and overall property crime in the long run.

***Keywords**:* Recreation Marijuana Legalization, Crime, Difference-in-differences with multiple time periods

[1] Korea Labor Institute, Incheon National University
E-mail: sylee@kli.re.kr

## 1. Introduction

Ever since Colorado (Measure 64) and Washington (Initiative 502) legalized marijuana for recreational use at the state level in 2012 for the first time in the U.S., legalization has spread across the U.S. As of 2021, 18 states and the District of Columbia have fully legalized marijuana (See Table A1). Such trend of legalization induces a variety of concerns regarding its social impacts, and the crime rate is not an exception.

Cannabis laws have a long history in the U.S. The first prohibition on Marijuana began in Massachusetts in 1911 and required a prescription for sale. In 1937, cannabis was prohibited at the federal level with the Marijuana Tax Act. Although medical use was still permitted, new fees and regulatory requirements significantly curtailed its use. Forty years later, this trend started to be reversed. Texas amended the law and classified possession of four ounces or less as a misdemeanor in 1973. In 1996, legalizing marijuana for medical use started in California followed by Nevada and Colorado in 2000. In 2012, Colorado and Washington became the first two states that introduced recreational marijuana laws in the U.S. Colorado Amendment 64 made possible the personal use of marijuana for adults of 21 and over, commercial cultivation, manufacture, and sale similarly regulating marijuana to alcohol. In 2016, California, Nevada, Maine, and Massachusetts joined the legalization of recreational cannabis. In 2019 and 2022, the U.S. House of Representatives passed the historic Marijuana Opportunity Reinvestment and Expungement Act (MORE Act, henceforth). Marijuana legalization became the matter of the federal level. House Speaker Nancy Pelosi said this legislation is one of most important criminal justice reform bills in recent history (NBC News 2022).

However, there is still uncertainty as to the impact of recreational marijuana legalization (RML, henceforth) on crime. The changes in crime rates after RML are different across affected states and the studies on the association between RML and crime rates are far from agreement.

Some believe RML increased in crime rates (Smart Approaches to Marijuana, 2018; The New Yorker, 2019) while others give credit to RML for decreasing crime rates in states where it was legalized (Drug Policy Alliance 2015). According to the Colorado Bureau of Investigation, the violent crime rate rose for fifth-straight years after legalization. Especially, the murder rate skyrocketed by 9.25% in 2016, 14.81% in 2017, and slightly dropped by 3.21% in 2018 (Colorado Crime Statistics 2018). Such reports raised serious concerns regarding public safety; and John Hickenlooper, the long-time governor of Colorado, even mentioned the possibility of banning marijuana again for this reason (Scott McLean and Sara Weisfeldt 2018). On the other hand, Washington experienced double-digit decreases around the time of RML and recorded a 40-year historic low in crime rates, and some advocates use these numbers to argue that RML has effects of decreasing crime rates (Drug Policy Alliance 2015).

Some evidence points to causal channels in which RML may deter crime. First, the legalization could reallocate police resources toward deterring crime instead of enforcing drug laws (Thrilling 2016), which may have incentived officers to make arrests for other types of offenses rather than marijuana-related offenses (Makin et al. 2019). RML can induce a significant increase in violent crime clearance rate (crime clearance rate is a measure of police performance and calculated by dividing the number of changed being laid by the total number of recorded crimes) though the beneficial impact disappears over time (Wu et al. 2022). Additionally, some suggest marijuana works as a substitute for alcohol and other controlled substitutes that are more closely related to violent behaviors (Crost and Guerrero 2012). Lastly, it is believed that by moving marijuana sales to a regulated market, it reduces crimes that are associated with the black market (McGinty et al. 2017).

On the other hand, other studies find RML has no effect on improving the crime clearance rate and raises violent behavior due to marijuana use. Jorgensen and Harper (2020) found little evidence on increasing the clearance rate since law enforcement are not preoccupied with

violations regarding marijuana. Some behavioral studies demonstrated that RML may induce more crime because of the relationship between marijuana use and violent behaviors (Phillips 2012) and suggested the odds of marijuana smokers offending are higher than the odds of non-smokers (Bennet et al. 2008).

Despite the ongoing controversies of the influence of RML, there is limited research on RML effect on crime rates. Prior work explore the state-level RML and crime rate are also inconclusive and have relatively weak evidence supporting the effect on either side of the debate. There are two main approaches to studying the influence of RML on crime rates. One uses geospatial data of marijuana dispensaries and studied its impact on crime rates in the local and neighboring reasons (Brinkman and Mok-Lamme 2019; Dragone et al. 2019; Freisthler et al. 2017; Hao and Cowan 2020; Hunt et al. 2018; Thacker et al. 2021); the others conduct comparative analysis exploiting state-year panel data with RML as a treatment (Lu et al. 2021; Furton 2018; Wu et al. 2020).

Prior studies using geo-spatial analysis explored the effects on crime in terms of the densities of marijuana dispensaries and neighboring regions of the states with RML and the conclusions are far from agreement. Freisthler et al. (2017) and Thacker et al. (2021) argued that marijuana outlets may induce higher crime rates of neighboring regions based on their findings of higher crime rates with the density of marijuana outlets in spatially adjacent areas. Hughes et al. (2020) examined crime rates with the locations of medical and recreational marijuana dispensaries in Colorado and found the increases in crime rates except for murder and auto vehicle crime rates using Bayesian spatiotemporal Poisson regression. Fisher et al. (2017) studied the relationship between marijuana outlets and crime rates in the transition period from medical marijuana law to recreational marijuana law and argued that the adjacent places to marijuana outlets experienced an increase in property crime rate in local areas of Denver, Colorado. On the contrary, Brinkman and Mok-Lamme (2019) found that an additional

dispensary may have led to a reduction in crime rates in a neighborhood by 19 percent. Dragone et al. (2019) examined the crime rate and RML in Washington and Oregon using Difference-in-Spatial-Discontinuity design and found reductions in rape and property crimes. Their results implied significant reductions in rape and property crimes in the Washington-Oregon border area. These studies manifest the impact of marijuana dispensaries in neighboring regions but has its limitation that it cannot evaluate the overall impacts of the state-level marijuana law changes at state level.

There are limited prior studies regarding the impact of state-level RML on the crime rate in the affected states. These studies mostly used the quasi-experimental setup that Colorado and Washington legalized marijuana for recreational use in 2012 (Lu et al. 2019; Maier et al. 2017) and concluded that the impact of RML on the crime rate is minimal. Lu et al. (2019) conducted a time series analysis using the data of Colorado and Washington during 1999-2016 and suggested that recreational marijuana law had at the most minimal effect on crime in Colorado and Washington state. Also, Maier et al. (2017) examined the impacts of changing marijuana law on crime in the states that decriminalized or legalized cannabis and found that there existed no significant relationship with crime rates in the year between 2010 and 2014. However, studies using the data of Oregon suggested different results. Wu et al. (2021) examined the impact of RML of Oregon on the crime rate and argued that recreational marijuana legalization and sale increased crime rates both violent and property crime rates unlike the studies mentioned above.

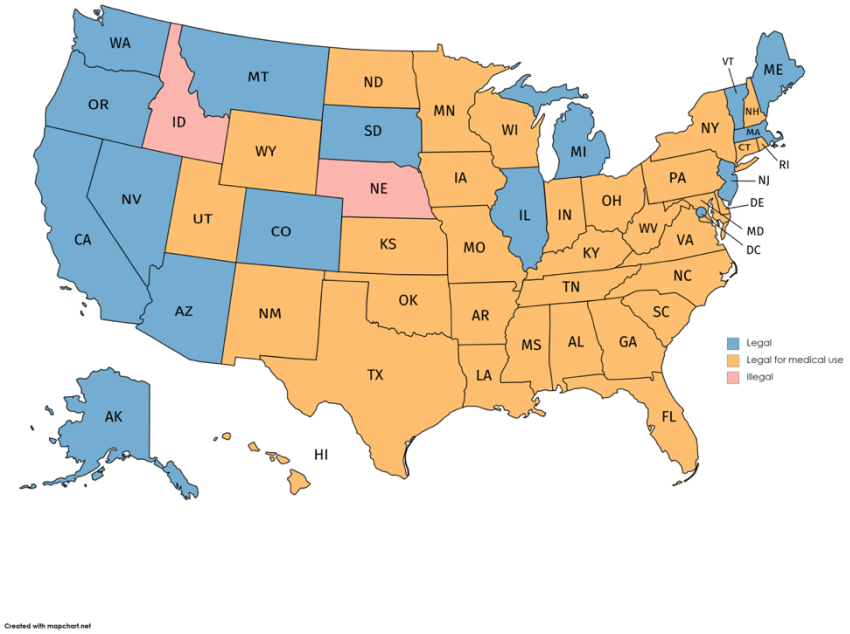
Although it has been 10 years since state-level recreational marijuana legalization started, there are few works about the long-term effect of RML on crime. Among the related research, Lu et al. (2021) suggested that marijuana legalization had minimal effect on the crime rate in Colorado and Washington. They explored the long-term effects of RML and used the data up to the year 2016. Given that the first state-level marijuana legalization occurred in late 2012,

the panel might not be long enough to show the dynamics. Furton (2018) studied the effect of RML in Colorado using the synthetic control method and found some evidence about the increase in Colorado post the legalization. The synthetic control approach has its benefit in that it can display the long-term effect of treatment and relax parallel trend assumption, which is often violated in the state-level crime rate context. Nevertheless, the synthetic control method relies on a single treated unit and does not show the dynamic effect of RML in general for all the affected states (Abadie et al. 2010). Therefore, there is a lack in discussing the general impacts of RML for multiple states in the long run even though we face federal-level discussion of marijuana legalization.

Given little academic attention on state-level long-term RML effects on crime rates and ongoing debate over federal level marijuana legalization, this study aims to explore the effects of RML on different types of crime and long run effects. To this end, the current study applies the Difference-in-differences for multiple time periods methodology (Callaway and Sant'Anna 2021). This approach allows multiple treatment groups with multiple treatment periods and provides heterogeneous treatment effects across treatment groups (groups formed by the time of treatment), calendar time, and event time (the length of exposure to treatment). This study found evidence on the causal effects of RML on the increases in property crime types and murder. Among property crimes, the increases in overall property crime and larceny last in the long run while the statistical significances on burglary and auto vehicle thefts disappear within 1 or 2 years after legalization. In particular, the increase in murder is noticeable. The murder rate of all groups for all periods was up by 14.7%, and the impact was there in the long run showing fluctuations. The impacts on other types of violent crime are not found.

The remainder of the paper proceeds as follows: Section 2 describes the data. Section 3 explains the model and section 4 presents the results. Section 5 concludes.

**Figure 1 U.S. Cannabis legality map**




*Note:* U.S. cannabis legality as of 2021. The map is created based on the information on cannabis legality is gathered from Wikipedia and state government websites

## 2. Data

The crime data used in this study is obtained from publicly available data on the Federal Bureau of Investigation website (FBI), which collects U.S. crime data through the Uniform Crime Reporting Program (UCR). The FBI annually announces the crime statistics based on the voluntary reports from law enforcement on the number of crimes happening in their jurisdictions every month. The FBI classifies crimes into two broad categories—violent and property crimes. Violent crime includes aggravated assault, forcible rape, murder, and robbery; property crime includes arson, burglary, larceny-theft, and motor vehicle theft. However, rape and arson are excluded from this study because the definition of rape was revised in 2013 and the degree of reporting arson varies by agency. The panel data consists of 51 units including

50 states and the District of Columbia for 14 years (2006-2019). Each crime rate is measured per 100,000 people.

Figure 1 visualizes cannabis legality as of 2021. Table A1 presents the year of recreational marijuana legalization by states and reports treated and controlled units used in this study. Please note this study considers states that legalized marijuana for recreational use by 2015 as a treated group, and late adoption units are excluded from the analysis due to the tradeoffs between the length of dynamic and the number of states in treated groups.

Table 1 provides summary statistics of crime rates for treated and control states. The control group is restricted to the states that had not implemented RML until 2019. Table 1 reports that treated states have higher rates of crime for all categories ($p < 0.01$) except for burglary. The burglary rate is higher in the control group, but the difference is not statistically meaningful.

Table 1. Summary statistics

| Variable | Treated | Control | Difference | P-value |
|---|---|---|---|---|
| Violent Crime | 590.347 | 376.940 | 207.146 | 0 |
| Murder | 8.220 | 4.670 | 2.575 | 0 |
| Robbery | 184.087 | 90.628 | 93.267 | 0 |
| Assault | 343.764 | 246.678 | 91.157 | 0 |
| Property Crime | 3723.775 | 2924.218 | 717.563 | 0 |
| Burglary | 601.131 | 614.900 | -37.174 | 0.228 |
| Larceny | 2629.339 | 2058.245 | 562.648 | 0 |
| Vehicle | 493.307 | 251.075 | 192.095 | 0 |
| Unemployment | 6.5 | 5.568 | -0.932 | 0 |

Source: Federal Bureau of Investigation Uniform Crime Reporting Program
Note: Crime rates per 100,000 people; Unemployment in percent

For robustness check, I also use unemployment rate data to control for economic decline which may influence the crime rate. The unemployment rate is higher for the states in treated groups (6.5%) compared to the control group (5.568%).

## 3. Model

This study uses the Difference-in-differences with multiple time periods model borrowed from Callaway and Sant'Anna (2021). This approach allows multiple treatment groups and multiple treatment periods, which overcomes the limitations of heterogeneous treatment effects across groups and time periods that DID estimates using TWFE regression models suffer from (Sun and Abraham 2020; de Chaisemartin and D'Haultfoeuille 2020b; Callaway and Sant'Anna 2021). In addition, this staggered DID setup provides causal effects for different dimensions including the year of treatment, calendar time, and event time (the length of exposure to treatment). Therefore, this paper provides the impact of RML on crime across the year of RML, calendar time, and the duration of RML on top of the overall RML effect. While previous research on the dynamics in the effects of RML on crime included one or two treated states (Lu et al. 2021; Furton 2018), this study includes multiple regions that adopted RML by 2015 rather than focusing on the effects of one or two states that may or may not be generalized to the other regions in the U.S.

Formally, let $Y_t$ be the crime rate at year *t*, and define the following variables: $L_\ell = 1$ if state $i$ belongs to group $\ell$ (i.e., $L_\ell = 1$ if state $i$ legalized marijuana at year $\ell$); $Y_{\ell-1}$ is crime rate at the year before legalization; $C = 1$ if state *i* is in the control group (i.e., state *i* had not legalized recreational marijuana until 2019). Using the methodology, the treated states are grouped according to the year of RML. For example, Colorado and Washington are in group 2012, as these two states legalized marijuana in 2012.

Following Callaway and Sant'Anna (2021), this model assumes the followings. First, this model assumes *Irreversibility of Treatment*, which means a state keeps RML until the last of period of the analysis once the law is adopted.

$$L_1 = 0\ a.s., for\ t\ =\ 2,\ldots,\mathcal{T},\ \ L_{t-1} = 1\ implies\ that\ L_{t-1} = 1\ a.s.$$

Second, this model assumes random sampling. $\{Y_{i,t}, Y_{i,t}, \ldots, Y_{i,\mathcal{T}}, X_{i,t}, L_{i,1}, \ldots, L_{i,\mathcal{T}}\}_{i=1}^{n}$ is independent and identically distributed.

I use unconditional parallel trend assumption based on the never-treated group. For each $t \in \{2, \ldots, \mathcal{T}\}, \ell \in L$ such that $\ell \leq t$,

$$E[Y_t(0) - Y_{t-1}(0)|L_\ell = 1] = E[Y_t(0) - Y_{t-1}(0)|C = 1] \; a.s. \tag{1}$$

The unconditional group-time ATT for the never treated group is:

$$ATT(\ell, t) = E[Y_t - Y_{\ell-1}|L_\ell = 1] - E[Y_t - Y_{\ell-1}|C = 1] \tag{2}$$

$ATT(\ell, t)$ is the group-time average treatment effect and represents the average treatment effect on the crime rate of group $\ell$ at year $t$ in this article. The key assumption is, roughly speaking, that the pretreatment trends of treated and untreated groups are parallel unconditionally. Under the parallel trend assumption, the second part of the right-hand side of the equation (2) is the path that states in group $\ell$ would have experienced if RML had not been implemented.

Different aggregations of $ATT(\ell, t)$ show the different summary measures of the causal effects— event-time effects, calendar time effects, and group effects.

To show the dynamic effect that varies with duration of the treatment period, event-time $(i.e., e = t - \ell)$ denotes the time elapsed since state $i$ adopt recreational marijuana law.

$$\theta_e^{bal}(e, e') = \sum_{\ell \in L} 1\{\ell + e' \leq \mathcal{T}\} P(L_\ell = \ell | L + e' \leq \mathcal{T}) ATT(\ell, \ell + e) \quad (3)$$

This calculates the average group-time treatment effect for units with at least some event time $e'$ where $0 \leq e \leq e' \leq \mathcal{T} - 2$. This indicates the average treatment effect of adopting the recreational marijuana law after $e$ years across all groups regardless of the calendar year of the legalization. The composition of groups may vary as the duration of treatment are different across groups. To address this, I set $e' = 4$ and restrict the groups that participating in the legalization at least for 5 years (event time from zero to four) to see enough dynamic effects. Therefore, there are three treatment groups of 2012, 2014, and 2015 (no state adopted RML in 2013). A multiplicative wild Bootstrap procedure is used to estimate standard errors.

The average effect of RML on crime rate among states in group $\tilde{\ell}$ across all periods is:

$$\theta_\ell(\tilde{\ell}) = \frac{1}{\mathcal{T} - \tilde{\ell} + 1} \sum_{t=\tilde{\ell}}^{\mathcal{T}} ATT(\tilde{\ell}, t) \quad (4)$$

The calendar time effect is the estimate of the ATT for each period across all groups and is identified as below:

$$\theta_c(t) = \sum_{\ell \in L} 1\{t \geq \ell\} P(L_\ell = \ell | L \leq t) ATT(\ell, t) \quad (5)$$

Overall average treatment effects of all treated units participating in RML over the first $e'$ years of RML is:

$$\theta(e') = \frac{1}{e'+1}\sum_{e=0}^{e'} \theta^{bal}(e, e') \tag{6}$$

## 4. Results

Table 2 provides the main results from using DID for multiple periods method using never treated group as a comparison for each crime type, and the results are graphically illustrated in Figure 2. I assume unconditional parallel trends since no evidence was found against it for all crime types at 95% confidence level (the null hypothesis is that all pre-treatment effects are 0; see equation (1)). Each panel includes overall effect, group-time effects, calendar time effects, event time effects. The overall effect is the average ATT of all group-time effects weighted by group sizes; Group-time effects present the ATT of each group for the entire treated periods; Calendar time effect is the ATT of the treated groups at the specific calendar time; Event-time effect presents the impact of RML on crime rates across event time, which sets the year of RML to be 0 regardless of the calendar time of RML. In this study, the possible length of event time is up to e7 but restricted to be from e0 to e4 to keep the composition of groups balanced across event time, since the durations to exposure to RML are different across groups.

Overall, regression results suggest that recreational marijuana legalization increased property crime rates in RML states. Notably, the impacts on larceny and overall property crime are significant in the long run. Although are no statistically meaningful impact on overall violent crime, there happened to be a significant increase in the murder rate.

The most concerning part of the results is the increase in murder post RML. The results report that the treated groups experienced a 14.7% increase in murder post RML period. Disaggregated by treated groups, significant increases in murder rates ranged from 9.4% to 23.8%. At the year of the legalization (e=0), the murder rate is up by 10.2% ($p < 0.01$) and up

by 16.2% ($p < 0.01$) in the fifth year than it would have been if legalization had not occurred. However, results on the overall violent crime rates in early adopted states suggest that RML has no statistically significant influences. This is consistent with the previous point estimate findings of Maier et al. (2017) who argued there was no significant effect of legalization or decriminalization of RML on crime rates. Throughout the event times, no statistically meaningful changes appear except for the marginally significant decrease of 2.6% in the second year of adoption (e=1). The impact of RML on violent crime varies over groups: Group 2012 and Group 2014 did not experience significant changes in overall violent crime rates, but the rate of Group 2015 was 12.3% higher than it would have been if recreational marijuana had not been legalized.

Other than murder, there is no meaningful change in the types of violent crime. The results in the changes in robbery and assault rates do not display significant changes in these rates after legalization. However, Group 2015 experienced a statistically significant increase of 14.9% and 12.3% in robbery and assault, respectively.

The results also indicate that RML induced a higher property crime rate in the affected states. Table 2 Panel (e) reports the effects of recreational marijuana legalization on overall property crime. The results show that the overall property crime rate rises continuously after recreational marijuana legalization. The statistically significant increases in overall property crime rates are observed across groups, all calendar times, and all the event times. All treated groups display a statistically higher property crime rate by at least 12.2% than it would have been if they had not adopted the law change. Graph (e) clearly illustrates the rising tendency of property crime, and the increase is most dramatic for Group 2015. Also, the results by event time show its magnitude increases continuously as event time goes on. In the first period of the legalization, the property crime rate is higher by 5.4% ($p < 0.01$), in the second, and 19.8%, in the fifth.

Among property crime types, the increase in larceny is particularly noticeable. All treated groups show significantly higher larceny rates, and the increases are 11% ($p < 0.01$) for Group 2012, 11.2% ($p < 0.01$) for Group 2014, and 7.9% ($p < 0.01$) for Group 2015 than they would have been if recreational marijuana law had not been adopted. In addition, the statistically significant increases in larceny rate last in the long run. In the year after RML (e=1) the larceny rate is higher by 4.8% ($p < 0.01$), and the magnitude of the increase continuously becomes greater, and the larceny rate reaches 15.2% ($p < 0.01$) increases in the fifth year of RML (e=4).

For burglary and auto vehicle theft rates, there are observed increases across all the event times, but the statistical significances are short-lived. Increases in burglary across event times are significant for the first three periods, then became insignificant from the 4th event time (e=3). The burglary rate is higher by 12.2% ($p < 0.01$) and 13.9% ($p < 0.01$) at e=0 and e=1 respectively. There occurs a similar pattern for auto vehicle theft. The increase of auto vehicle theft rate over event time is 7.8% ($p < 0.01$) in the first event year (e=0), 11.6% ($p < 0.01$) in the second (e=1) than they would have been if RML had not occurred. The estimates become insignificant in later periods, but remain positive.

For robustness checks, I include the unemployment rate as a control variable. Given the impact of RML on property crime turned out to be significant, taking an economic index into account would be appropriate. Though parallel trends assumptions are violated after controlling for the unemployment rate, I use the estimates as robustness check. Table A2 presents the results of the robustness checks and supports the main results. After controlling for the unemployment rate, the increases in property crime and its subcategories are even more noticeable. For example, the increase in property crime is significant throughout all event times, and the magnitude becomes greater with event time. Property crime was up by 6.4% in the very year of RML (e=0) and was up by 22.7% in the fifth event time (e=4). The increase in larceny was not much and insignificant in the year of RML (e=0), but 4.8% higher in the second year

of RML and 15.0% higher in the fifth (e=4). For violent crime, there is no statistically meaningful change observed except for murder, which is the same as the main results.

In sum, the current study gives a warning sign to public safety as it provides evidence on increases in crime in the long run with the newly updated data and advanced research design for long-term effect. The increases in overall property crime and larceny in the long run across event time are observed while the effects on burglary and motor vehicle theft rates are short-lived. Especially, the significant rise of murder rate in the long run was noticeable, though there is no observed significant changes, but mostly positive, in overall violent crime. While previous studies using state-level panel data mostly found no significant impacts on the crime rate in the long run, the current study found the long-term effects on murder and overall property crime.

## 5. Conclusion

Given that federal-level recreational marijuana legalization has been considered, the effect of RML on crime rates in general and in the long run should be a valuable resource for policymakers to take note of. To this end, this paper provides evidence on the effects of RML on crime for multiple treated states across different dimensions.

This study demonstrates that RML increases murder, larceny, and overall property crimes in the long run. For other subcategories of property crime rates—i.e., burglary and vehicle theft—significant and immediate increases appear in the first few years after RML, but significance disappears in later years, but remain positive. Little evidence is found on the statistically meaningful changes in overall violent crime, assault, and robbery. This study found no evidence that RML induced decreases in any crime type in the affected states.

Despite meaningful contributions, this study is not without limitations. The current results should not be interpreted as an overall effect if there exists a long-term systematic difference

between early RML adoption states (by 2015) and the late adoption states (after 2015). To show the long enough dynamic effects, I included the states that adopted recreational marijuana policy by 2015. In the case that late-adoption states are different from early adoption states, the current results can be a less reliable resource for the states considering RML or for federal level RML. Also, some states in the control group decriminalized marijuana. If the decimalization has similar effects on crime as RML, then there is a chance that the results are underestimated. Further studies to account for the effects of marijuana sales on crime rates would provide valuable resources for policymakers. State-licensed retail sales of marijuana usually take time after voters pass recreational marijuana. If further research can show separately the effects of RML itself and retail sales on crime rates, then it would provide more specific policy implications.

**Reference**


Abadie, A., Diamond, A., & Hainmueller, J. (2010). Synthetic control methods for comparative case studies: Estimating the effect of California's tobacco control program. *Journal of the American statistical Association*, *105*(490), 493-505.

Abadie, A., Diamond, A., & Hainmueller, J. (2015). Comparative politics and the synthetic control method. *American Journal of Political Science*, *59*(2), 495-510.

Aydelotte, J. D., Brown, L. H., Luftman, K. M., Mardock, A. L., Teixeira, P. G., Coopwood, B., & Brown, C. V. (2017). Crash fatality rates after recreational marijuana legalization in Washington and Colorado. *American journal of public health*, *107*(8), 1329-1331.

Brinkman, J., & Mok-Lamme, D. (2019). Not in my backyard? Not so fast. The effect of marijuana legalization on neighborhood crime. *Regional Science and Urban Economics*, *78*, 103460.

Callaway, Brantly, and Pedro HC Sant'Anna. "Difference-in-differences with multiple time periods." *Journal of Econometrics* 225.2 (2021): 200-230.

Cerdá, M., Wall, M., Feng, T., Keyes, K. M., Sarvet, A., Schulenberg, J., ... & Hasin, D. S. (2017). Association of state recreational marijuana laws with adolescent marijuana use. *JAMA pediatrics*, *171*(2), 142-149.

Cerdá, M., Mauro, C., Hamilton, A., Levy, N. S., Santaella-Tenorio, J., Hasin, D., ... & Martins, S. S. (2020). Association between recreational marijuana legalization in the United States and changes in marijuana use and cannabis use disorder from 2008 to 2016. *JAMA psychiatry*, *77*(2), 165-171.

Crost, B., & Rees, D. I. (2013). The minimum legal drinking age and marijuana use: New estimates from the NLSY97. *Journal of health economics*, *32*(2), 474-476.

Crost, Benjamin, and Santiago Guerrero. "The effect of alcohol availability on marijuana use: Evidence from the minimum legal drinking age." *Journal of health economics* 31.1 (2012): 112-121.

De Chaisemartin, C., & D'Haultfoeuille, X. (2020). Difference-in-differences estimators of intertemporal treatment effects. *arXiv preprint arXiv:2007.04267*.

Dragone, D., Prarolo, G., Vanin, P., & Zanella, G. (2019). Crime and the legalization of recreational marijuana. *Journal of economic behavior & organization*, *159*, 488-501.

Drug Policy Alliance (2017). Marijuana Facts. *Drug Policy Alliance*. report. Retrieved from https://www.drugpolicy.org/sites/default/files/dpa_marijuana_booklet_january2018_0.pdf

Drug Policy Alliance "Marijuana legalization in Washington after 1 year of retail sales and 2.5 years of legal possession" (2015). https://drugpolicy.org/sites/default/files/Drug_Policy_Alliance_Status_Report_Marijuana_Legalization_in_Washington_July2015.pdf

Freisthler, B., Gaidus, A., Tam, C., Ponicki, W. R., & Gruenewald, P. J. (2017). From medical to recreational marijuana sales: marijuana outlets and crime in an era of changing marijuana legislation. *The journal of primary prevention*, *38*(3), 249-263.

Furton, Glenn. "High Crimes? The Effect of Marijuana Legalization on Crime in Colorado." *The Effect of Marijuana Legalization on Crime in Colorado (October 23, 2018)* (2018).

Freisthler, B., Gaidus, A., Tam, C. *et al.* From Medical to Recreational Marijuana Sales: Marijuana Outlets and Crime in an Era of Changing Marijuana Legislation. *J Primary Prevent* **38,** 249–263 (2017). https://doi.org/10.1007/s10935-017-0472-9

Hansen, B., Miller, K., & Weber, C. (2020). Early evidence on recreational marijuana legalization and traffic fatalities. *Economic inquiry*, *58*(2), 547-568.

Hao, Zhuang, and Benjamin W. Cowan. "The cross-border spillover effects of recreational marijuana legalization." *Economic inquiry* 58.2 (2020): 642-666.

Hughes, L. A., Schaible, L. M., & Jimmerson, K. (2020). Marijuana dispensaries and neighborhood crime and disorder in Denver, Colorado. *Justice Quarterly*, *37*(3), 461-485.

Hunt, Priscillia, Rosalie Liccardo Pacula, and Gabriel Weinberger. "High on crime? Exploring the effects of marijuana dispensary laws on crime in California counties." (2018).

Jorgensen, C., Harper, A.J. Examining the effects of legalizing marijuana in Colorado and Washington on clearance rates: a quasi-experimental design. *J Exp Criminol* (2020). https://doi.org/10.1007/s11292-020-09446-7

Kepple, N. J., & Freisthler, B. (2012). Exploring the ecological association between crime and medical marijuana dispensaries. *Journal of studies on alcohol and drugs*, *73*(4), 523-530.

Lu, R., Willits, D., Stohr, M. K., Makin, D., Snyder, J., Lovrich, N., ... & Hemmens, C. (2019). The cannabis effect on crime: Time-series analysis of crime in Colorado and Washington State. *Justice Quarterly*, 1-31.

Maier, S. L., Mannes, S., & Koppenhofer, E. L. (2017). The implications of marijuana decriminalization and legalization on crime in the United States. *Contemporary Drug Problems*, *44*(2), 125-146.

Marcus, M., & Sant'Anna, P. H. (2021). The role of parallel trends in event study settings: An application to environmental economics. *Journal of the Association of Environmental and Resource Economists*, *8*(2), 235-275.

Mark Anderson, D., Hansen, B., & Rees, D. I. (2013). Medical marijuana laws, traffic fatalities, and alcohol consumption. *The Journal of Law and Economics*, *56*(2), 333-369.

Mark Anderson, D., Hansen, B., & Rees, D. I. (2015). Medical marijuana laws and teen marijuana use. *American Law and Economics Review*, *17*(2), 495-528.

McGinty, Emma E., et al. "Public perceptions of arguments supporting and opposing recreational marijuana legalization." *Preventive medicine* 99 (2017): 80-86.

Miller, A. M., Rosenman, R., & Cowan, B. W. (2017). Recreational marijuana legalization and college student use: Early evidence. *SSM-Population Health*, *3*, 649-657.

Shabad, Rebecca. (2022). House Passes Landmark Marijuana Legalization Bill, NBC News, https://www.cnbc.com/2022/04/01/house-to-vote-on-bill-to-legalize-marijuana.html

Plunk, A. D., Peglow, S. L., Harrell, P. T., & Grucza, R. A. (2019). Youth and adult arrests for cannabis possession after decriminalization and legalization of cannabis. *JAMA pediatrics*, *173*(8), 763-769.

Scott McLean, Sara Weisfeldt (2018). Colorado governor won't rule out banning marijuana again. Here's why. article. *CNN*, Retrieved from https://edition.cnn.com/2018/04/20/us/colorado-marijuana-and-crime/index.html

Sun, L., & Abraham, S. (2021). Estimating dynamic treatment effects in event studies with heterogeneous treatment effects. *Journal of Econometrics*, *225*(2), 175-199.

Thacker, J., Martin, M. E., Cristy, Y., Rabideau, D., Shively, M., & Kling, R. (2021). Exploring the Neighborhood-Level Impact of Retail Marijuana Outlets on Crime in Washington State. *Journal of Quantitative Criminology*, 1-29.

Wang, G. S., Davies, S. D., Halmo, L. S., Sass, A., & Mistry, R. D. (2018). Impact of marijuana legalization in Colorado on adolescent emergency and urgent care visits. *Journal of Adolescent Health*, *63*(2), 239-241.

Wu, G., Boateng, F. D., & Lang, X. (2020). The Spillover Effect of Recreational Marijuana Legalization on Crime: Evidence From Neighboring States of Colorado and Washington State. *Journal of Drug Issues*, 0022042620921359.

Wu, G., Wen, M., & Wilson, F. A. (2020). Impact of recreational marijuana legalization on crime: Evidence from Oregon. *Journal of Criminal Justice*, 101742.

Table 2. The Effects of RML on Crime

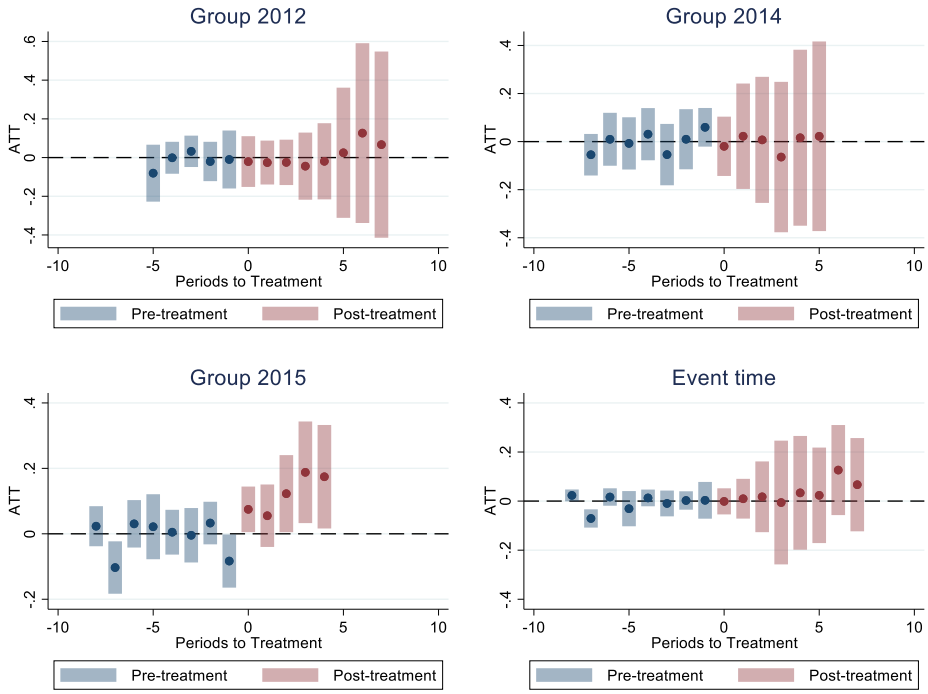
| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (a) Violent | ATT | | | | | | | |
| | 0.023 | | | | | | | |
| | (0.052) | | | | | | | |
| Group | **L2012** | **L2014** | **L 2015** | | | | | |
| | 0.010 | -0.003 | 0.123*** | | | | | |
| | (0.028) | (0.126) | (0.016) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | -0.021 | -0.026* | -0.022 | 0.006 | 0.006 | 0.009 | 0.095 | 0.071 |
| | (0.018) | (0.015) | (0.014) | (0.034) | (0.048) | (0.084) | (0.095) | (0.085) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | -0.021 | -0.026* | -0.022 | 0.006 | 0.006 | | | |
| | (0.018) | (0.015) | (0.014) | (0.034) | (0.048) | | | |
| (b) Murder | ATT | | | | | | | |
| | 0.147*** | | | | | | | |
| | (0.049) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.094*** | 0.238*** | 0.098*** | | | | | |
| | (0.035) | (0.085) | (0.027) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.113* | 0.096 | 0.055 | 0.191*** | 0.104** | 0.136 | 0.183*** | 0.227** |
| | (0.066) | (0.079) | (0.049) | (0.073) | (0.051) | (0.092) | (0.067) | (0.095) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.102** | 0.216*** | 0.083* | 0.075 | 0.162*** | | | |
| | (0.041) | (0.067) | (0.044) | (0.092) | (0.060) | | | |
| (c) Robbery | ATT | | | | | | | |
| | 0.061 | | | | | | | |
| | (0.085) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.039 | 0.055 | 0.149*** | | | | | |
| | (0.035) | (0.219) | (0.024) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.008 | -0.018 | -0.041 | 0.016 | 0.023 | 0.042 | 0.155 | 0.206* |
| | (0.015) | (0.039) | (0.041) | (0.053) | (0.079) | (0.140) | (0.149) | (0.120) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | -0.015 | 0.024 | 0.035 | 0.052 | 0.078 | | | |
| | (0.030) | (0.052) | (0.082) | (0.146) | (0.148) | | | |
| (d) Assault | ATT | | | | | | | |
| | 0.031 (0.041) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | -0.011 | 0.048 | 0.123*** | | | | | |
| | (0.024) | (0.086) | (0.016) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | -0.028 | -0.045** | 0.001 | 0.018 | 0.005 | 0.029 | 0.099 | 0.081 |
| | (0.023) | (0.021) | (0.025) | (0.039) | (0.043) | (0.062) | (0.064) | (0.064) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.029 | 0.015 | 0.016 | 0.011 | 0.048 | | | |
| | (0.026) | (0.030) | (0.044) | (0.067) | (0.070) | | | |
| (e) Property | ATT | | | | | | | |
| | 0.141*** | | | | | | | |
| | (0.025) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 0.136*** | 0.156*** | 0.122*** | | | | | |
| | (0.034) | (0.043) | (0.012) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.042*** | 0.091*** | 0.087*** | 0.092*** | 0.155*** | 0.159*** | 0.208*** | 0.196*** |
| | (0.007) | (0.011) | (0.028) | (0.023) | (0.033) | (0.054) | (0.050) | (0.048) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.054*** | 0.076*** | 0.139*** | 0.162*** | 0.198*** | | | |
| | (0.018) | (0.011) | (0.029) | (0.049) | (0.040) | | | |
| (f) Burglary | ATT | | | | | | | |
| | 0.182** | | | | | | | |
| | (0.090) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.156*** | 0.221 | 0.173*** | | | | | |
| | (0.029) | (0.237) | (0.022) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.075*** | 0.101*** | 0.151*** | 0.178*** | 0.160 | 0.162 | 0.248* | 0.263* |
| | (0.024) | (0.029) | (0.020) | (0.052) | (0.106) | (0.149) | (0.148) | (0.136) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.122*** | 0.139** | 0.170* | 0.176 | 0.226 | | | |
| | (0.022) | (0.057) | (0.103) | (0.148) | (0.147) | | | |
| (g) Larceny | ATT | | | | | | | |
| | 0.106*** | | | | | | | |
| | (0.017) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.110*** | 0.112*** | 0.079*** | | | | | |
| | (0.025) | (0.017) | (0.011) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.023** | 0.074*** | 0.059* | 0.061** | 0.127*** | 0.111*** | 0.158*** | 0.157*** |
| | (0.012) | (0.008) | (0.032) | (0.027) | (0.020) | (0.027) | (0.030) | (0.038) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.031 | 0.048*** | 0.103*** | 0.120*** | 0.150*** | | | |
| | (0.022) | (0.018) | (0.020) | (0.020) | (0.018) | | | |
| (h) Vehicle | ATT | | | | | | | |
| | 0.159 | | | | | | | |
| | (0.106) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.189* | 0.077 | 0.262*** | | | | | |
| | (0.105) | (0.239) | (0.024) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.085*** | 0.155*** | 0.129*** | 0.109* | 0.182 | 0.239 | 0.218 | 0.103 |
| | (0.015) | (0.021) | (0.040) | (0.064) | (0.120) | (0.193) | (0.189) | (0.175) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.078*** | 0.116*** | 0.191 | 0.217 | 0.231 | | | |
| | (0.019) | (0.043) | (0.116) | (0.181) | (0.175) | | | |

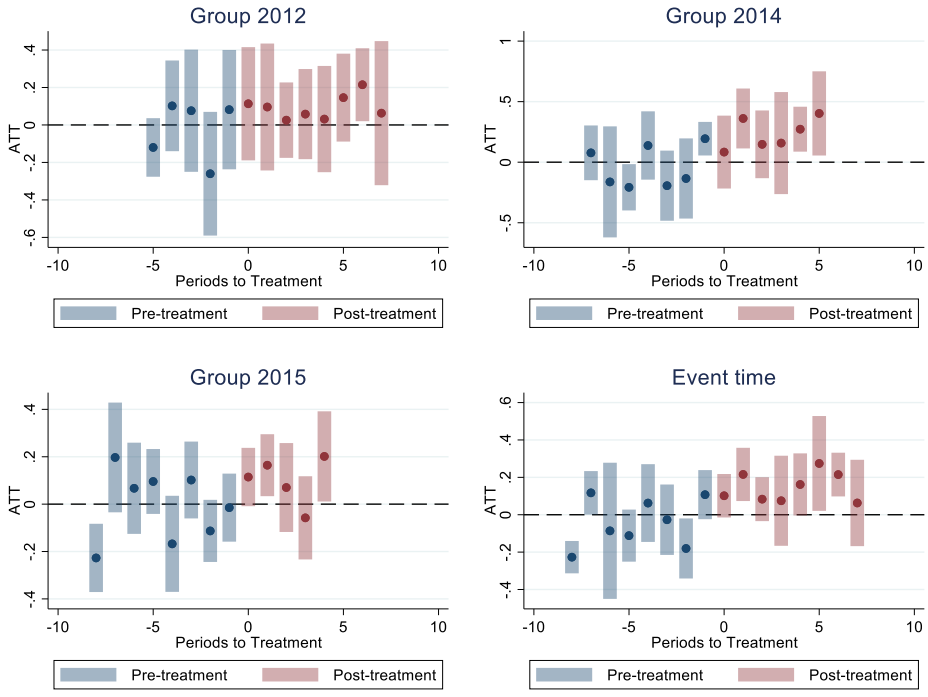
*Notes:* The table presents aggregated treatment effect parameters under the unconditional parallel trends assumption. The standard errors are clustered at state-level. ATT reports the overall treatment effect which is the average of all group-time weighted by group size. L indexes the year that a state legalized recreational marijuana; e indexes event time, which is the duration of exposure to RML.

Figure 2. The Effects of RML on Crime

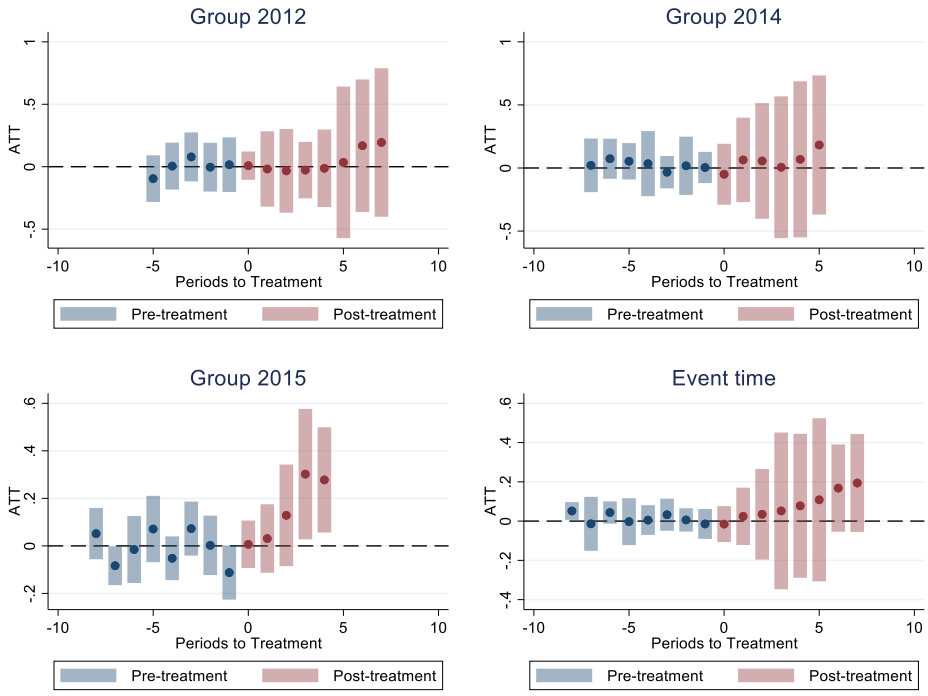
a. Violent Crime



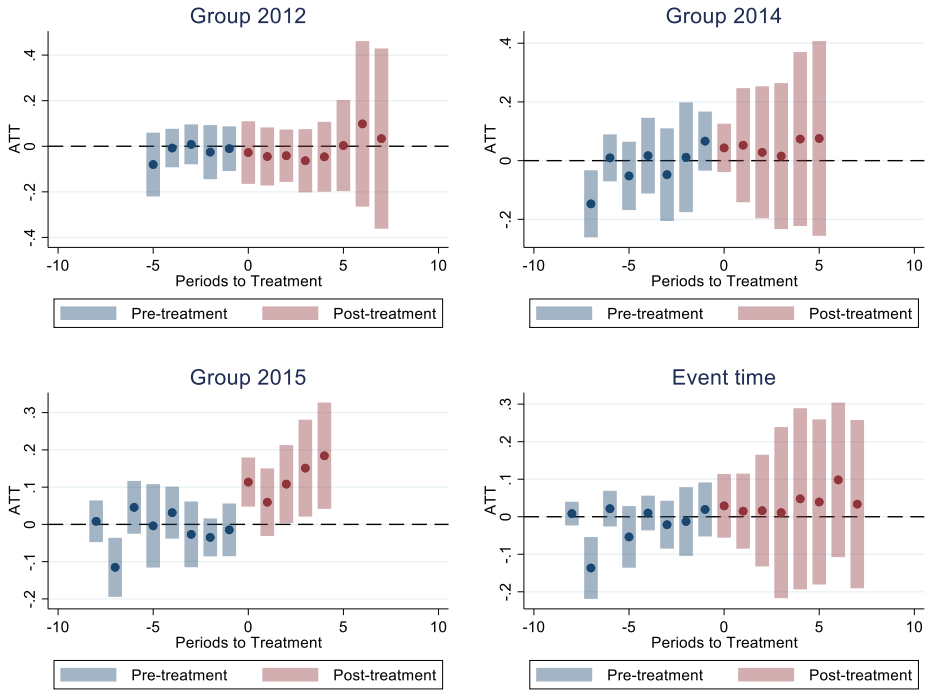

b. Murder



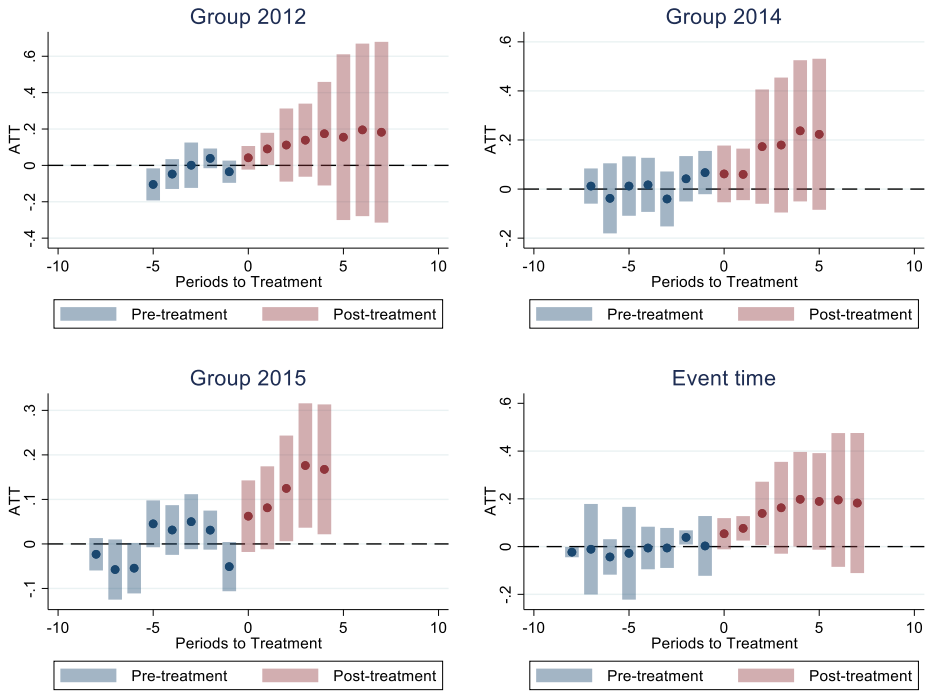
c. Robbery



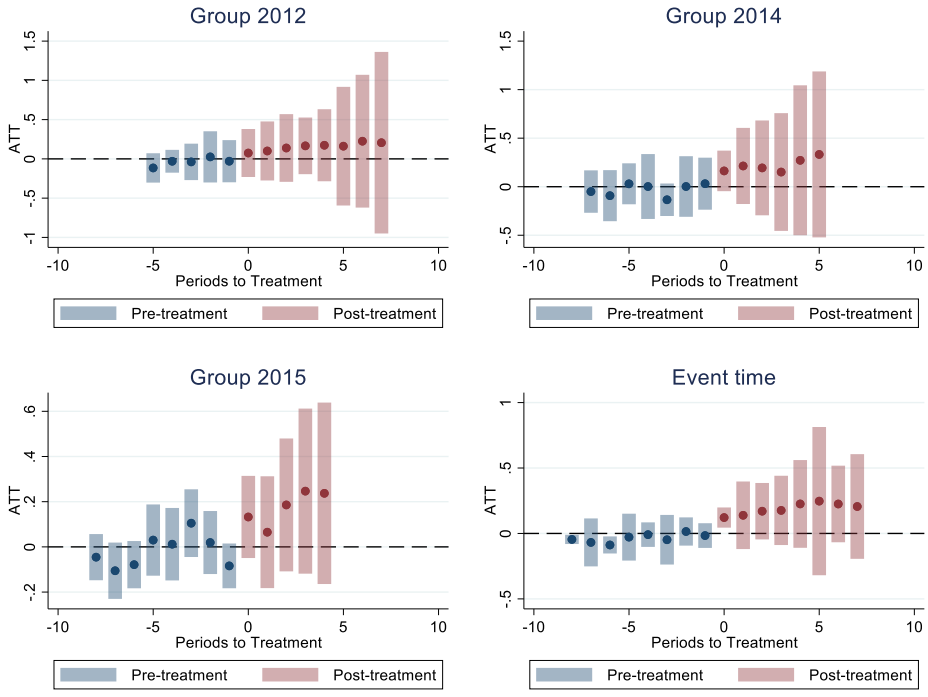

d. Assault



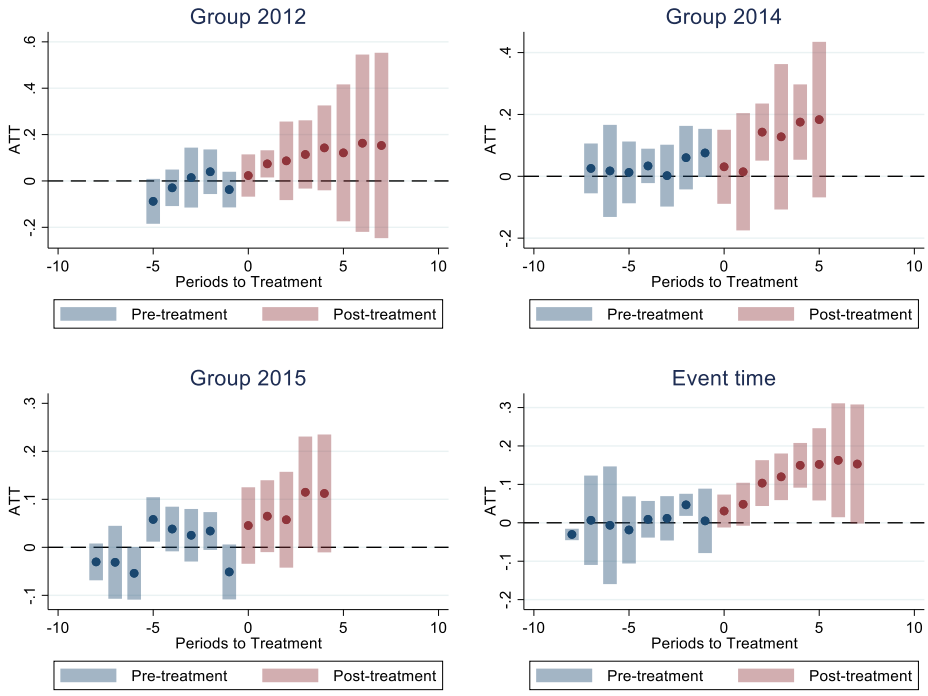
e. Property




f. Burglary



g. Larceny




h. Vehicle theft

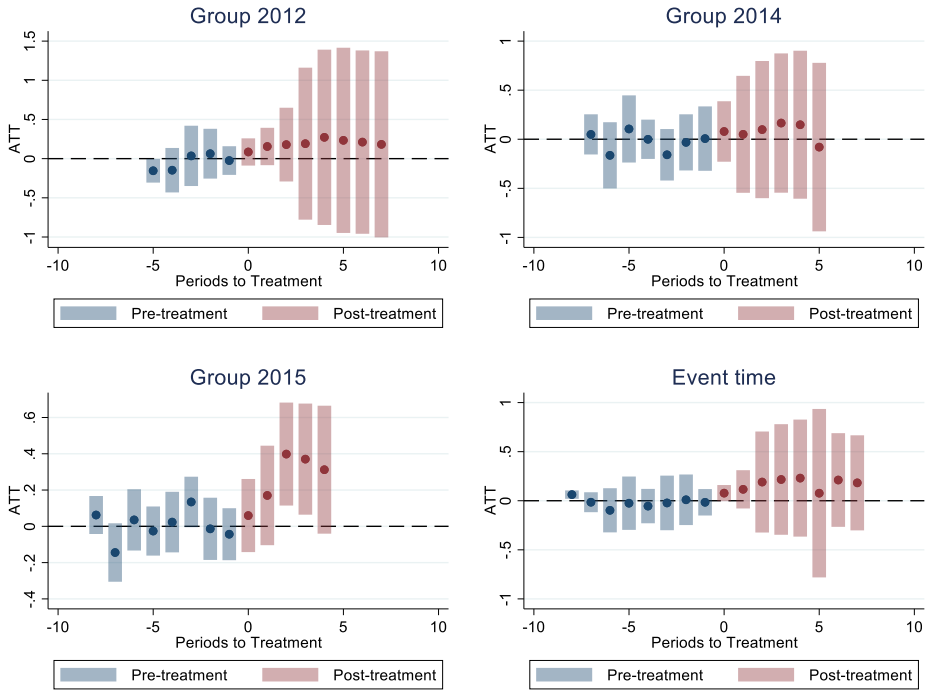


Table A1. Cannabis legality

| State | RML | Control (Never) | Treated |
|---|---|---|---|
| ALABAMA | | * | |
| ALASKA | 2014 | | * |
| ARIZONA | 2020 | * | |
| ARKANSAS | | * | |
| CALIFORNIA | 2016 | | |
| COLORADO | 2012 | | * |
| CONNECTICUT | 2021 | * | |
| DELAWARE | | * | |
| D.C. | 2014 | | * |
| FLORIDA | | * | |
| GEORGIA | | * | |
| HAWAII | | * | |
| IDAHO | | * | |
| ILLINOIS | 2019 | | |
| INDIANA | | * | |
| IOWA | | * | |
| KANSAS | | * | |
| KENTUCKY | | * | |
| LOUISIANA | | * | |
| MAINE | 2016 | | |
| MARYLAND | | * | |
| MASSACHUSETTS | 2016 | | |
| MICHIGAN | 2018 | | |
| MINNESOTA | | * | |
| MISSISSIPPI | | * | |
| MISSOURI | | * | |
| MONTANA | 2020 | * | |
| NEBRASKA | | * | |
| NEVADA | 2016 | | |
| NEW HAMPSHIRE | | * | |
| NEW JERSEY | 2020 | * | |
| NEW MEXICO | 2021 | * | |
| NEW YORK | 2021 | * | |
| NORTH CAROLINA | | * | |
| NORTH DAKOTA | | * | |
| OHIO | | * | |
| OKLAHOMA | | * | |
| OREGON | 2015 | | * |
| PENNSYLVANIA | | * | |
| RHODE ISLAND | | * | |
| SOUTH CAROLINA | | * | |
| SOUTH DAKOTA | | * | |
| TENNESSEE | | * | |
| TEXAS | | * | |
| UTAH | | * | |
| VERMONT | 2018 | | |
| VIRGINIA | 2021 | * | |
| WASHINGTON | 2012 | | * |
| WEST VIRGINIA | | * | |
| WISCONSIN | | * | |
| WYOMING | | * | |

Table A2. Robustness check

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (a) Violent | ATT | | | | | | | |
| | 0.055 | | | | | | | |
| | (0.042) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.037* | 0.043 | 0.141*** | | | | | |
| | (0.021) | (0.098) | (0.022) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | -0.018 | -0.012 | 0.000 | 0.030 | 0.038 | 0.049 | 0.143* | 0.114 |
| | (0.017) | (0.016) | (0.014) | (0.026) | (0.038) | (0.070) | (0.079) | (0.071) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.011 | 0.030 | 0.046 | 0.033 | 0.075 | | | |
| | (0.018) | (0.024) | (0.042) | (0.076) | (0.078) | | | |
| (b) Murder | ATT | | | | | | | |
| | 0.156*** | | | | | | | |
| | (0.052) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.065 | 0.286*** | 0.138*** | | | | | |
| | (0.047) | (0.050) | (0.028) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.074 | 0.062 | 0.053 | 0.200** | 0.112** | 0.164*** | 0.228*** | 0.231** |
| | (0.067) | (0.104) | (0.045) | (0.078) | (0.056) | (0.062) | (0.082) | (0.101) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.099*** | 0.222*** | 0.097** | 0.114* | 0.183* | | | |
| | (0.033) | (0.079) | (0.044) | (0.066) | (0.094) | | | |
| (c) Robbery | ATT | | | | | | | |
| | 0.123* | | | | | | | |
| | (0.068) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.098*** | 0.131 | 0.187*** | | | | | |
| | (0.021) | (0.176) | (0.029) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.023** | 0.014 | 0.002 | 0.056 | 0.078 | 0.130 | 0.247** | 0.286*** |
| | (0.012) | (0.042) | (0.035) | (0.041) | (0.063) | (0.114) | (0.124) | (0.100) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.007 | 0.059 | 0.091 | 0.128 | 0.157 | | | |
| | (0.017) | (0.042) | (0.070) | (0.124) | (0.127) | | | |
| (d) Assault | ATT | | | | | | | |
| | 0.049 | | | | | | | |
| | (0.035) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.005 | 0.076 | 0.129*** | | | | | |
| | (0.021) | (0.065) | (0.020) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | -0.028 | -0.034 | 0.016 | 0.039 | 0.033 | 0.047 | 0.124** | 0.095* |
| | (0.021) | (0.022) | (0.028) | (0.036) | (0.037) | (0.053) | (0.053) | (0.056) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.037 | 0.033 | 0.036 | 0.032 | 0.071 | | | |
| | (0.029) | (0.030) | (0.037) | (0.061) | (0.060) | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| (e) Property | ATT | | | | | | | |
| | 0.165*** | | | | | | | |
| | (0.020) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.160*** | 0.181*** | 0.145*** | | | | | |
| | (0.025) | (0.030) | (0.015) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.050*** | 0.098*** | 0.096*** | 0.119*** | 0.182*** | 0.188*** | 0.235*** | 0.230*** |
| | (0.006) | (0.013) | (0.033) | (0.024) | (0.028) | (0.047) | (0.042) | (0.043) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.064*** | 0.094*** | 0.159*** | 0.191*** | 0.227*** | | | |
| | (0.021) | (0.013) | (0.027) | (0.041) | (0.033) | | | |
| (f) Burglary | ATT | | | | | | | |
| | 0.226*** | | | | | | | |
| | (0.082) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.204*** | 0.262 | 0.210*** | | | | | |
| | (0.018) | (0.217) | (0.038) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.095*** | 0.135*** | 0.166*** | 0.213*** | 0.206** | 0.213 | 0.299** | 0.336*** |
| | (0.029) | (0.035) | (0.022) | (0.048) | (0.098) | (0.140) | (0.139) | (0.122) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.134*** | 0.171*** | 0.205** | 0.222 | 0.280** | | | |
| | (0.021) | (0.052) | (0.097) | (0.139) | (0.138) | | | |
| (g) Larceny | ATT | | | | | | | |
| | 0.118*** | | | | | | | |
| | (0.017) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.123*** | 0.123*** | 0.092*** | | | | | |
| | (0.021) | (0.028) | (0.009) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.035*** | 0.084*** | 0.061* | 0.079*** | 0.140*** | 0.125*** | 0.169*** | 0.171*** |
| | (0.008) | (0.008) | (0.036) | (0.029) | (0.020) | (0.025) | (0.028) | (0.037) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.039 | 0.062*** | 0.113*** | 0.135*** | 0.162*** | | | |
| | (0.024) | (0.021) | (0.022) | (0.016) | (0.017) | | | |
| (h) Vehicle | ATT | | | | | | | |
| | 0.228*** | | | | | | | |
| | (0.083) | | | | | | | |
| Group | **L2012** | **L2014** | **L2015** | | | | | |
| | 0.245*** | 0.164 | 0.325*** | | | | | |
| | (0.086) | (0.175) | (0.040) | | | | | |
| Calendar time | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** |
| | 0.097*** | 0.186*** | 0.167*** | 0.183*** | 0.265*** | 0.325** | 0.300* | 0.184 |
| | (0.017) | (0.021) | (0.052) | (0.051) | (0.092) | (0.161) | (0.159) | (0.152) |
| Event study | **e0** | **e1** | **e2** | **e3** | **e4** | | | |
| | 0.108*** | 0.178*** | 0.260*** | 0.299** | 0.311** | | | |
| | (0.030) | (0.026) | (0.092) | (0.149) | (0.145) | | | |

*Notes:* The table presents aggregated treatment effect parameters under the unconditional parallel trends assumption. The standard errors are clustered at state-level. ATT reports the overall treatment effect which is the average of all group-time weighted by group size. L indexes the year that a state legalized recreational marijuana; e indexes event time, which is the duration of exposure to RML.