*National ChengChi University*


*Casual Inference IMES – Term Paper*

# The Impact of Recreational Marijuana Legalization on Crime Rates in the US

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## Abstract

According to previous research articles on marijuana legalization, it can be found that there is already plenty of debate before the legalization; therefore, I use the Synthetic Control (SC) method in this article to establish that in most the states, because of the legalization of recreational marijuana, the crime rate (violent crime rate and property crime rate) rose to a great level. I further do the multiple treated units test, discover that the overall crime rate does increase significantly.

**Keywords:** Marijuana, Crime rate, Synthetic control

## 1 Introduction

The legalization of recreational marijuana is already a global trend. But while the people are enjoying the haze, one of the greatest concerns is the side effects associated with drug abuse and the social costs which are often the rise in crime rates. Before the first legalization (2012), many scholars had already debated this issue ferociously. As *Becker, Gary S and Murphy, Kevin M* [1] mentioned that the legalization of cannabis has greatly reduced the cost of buying illegal drugs on the black market, so people no longer need to bear the excess cost to obtain cannabis, so the related crimes can be avoided intuitively. However, at the same time, there are also many advocacy groups, and *Reingle, Jennifer M, et al.* [4] argued that the use of marijuana is highly correlated with crime rates (identified as violent crimes in the study), which can be viewed as an important role to trigger crime.

To elaborate on the relationship between the legalization of marijuana and the crime rate, I will be based on the research of *Dragone, D. and Prarolo, G. and Vanin, P. and Zanella, G.* [2] and adjust my research to more aggregate perspective research. I will focus on the crime rate in the U.S. by states on recreational marijuana legalization to conclude a more comprehensive result on this critical issue. This study also has an advantage because we can acquire sufficient empirical data to analyze to measure the relationship and which of the above points is credible.

## 2 Data and Sample

In this study, we are using the data set of FBI Uniform Crime Reporting [1] to obtain criminal information in each state in the United States. As for the other explanatory variables, we get relevant data from the US Census Bureau[2] (including states' GDP, population and median household income...). These data cover 51 states in the United States. Because of the restrictions on the FBI crime database, the period we selected covers a total of 21 years, ranging from 1999 to 2019.

We then introduce the detailed variables we are using for our SC method. (Table 1)

| Variable name | Variable description |
|---|---|
| rate_vio | The case of violent crimes per capita. (Murder and non–negligent manslaughter, Rape, Robbery and Aggravated assault). |
| rate_pro | The case of property crimes per capita. (Burglary, Larceny–theft and Motor vehicle theft). |
| crime_rate | Sum of the above two types of crime rates. |
| dummy_real | The year when the legalization of recreational marijuana. |
| population | The population by states. |
| GDP | Gross domestic product by states. |
| income | Average income per capita by states. |
| case | The number to the cases of drug abuse by states. |
| Y18to24 | Population aging from 18 to 24 by states. |
| poverty | The poverty rate of the family by states. |

Table 1: Variable description

As for the part of the crime rate data, we found that after we divided the number of crime cases by the population (turned into crime rates data), the explanatory power and value of R–squared increased by a considerable range. We then decided to transfer the number of cases to rate (per capita) data. Here is just to enhance that the data above is all of the states' aggregate level, given all states and time (1999 to 2019).

The violent crimes and property crimes that we have selected are logically understandable. Because if we assume that the use of recreational marijuana is now illegal, the price trading on the black markets can be extremely high which may give rise to crime especially when people are addicted to it. However, if people could purchase marijuana through open and transparent channels, the cost compared to the previous case should become relatively low. So it is clearly believed that lowering the cost of buying cannabis can be logically and empirically related to the crime rates.

Regarding the other explanatory variables, people may face financial difficulties on purchasing illegal drugs, so we can focus on the states' level and individuals' economic status data, supplemented by education, population composition, and another possible explanatory variable as the reasonable explanation to this study.

After the data preparation, we can analyze the above data and choose them as prediction variables to infer whether the legalization can cause an effect on crime rates based on the SC method.

[1] https://www.fbi.gov/services/cjis/ucr

[2] https://www.census.gov/

## 3 Empirical Method

According to the problem to be analyzed in this topic, which is relating to a certain policy affecting aggregate state–level outcomes. And as for the form of this data set is panel data of aggregate level, and the impact of government policies on this data is to be discussed. According to these, the SC method is believed to be a suitable data–driven method for the topic. Therefore, I am using the SC method in this research which is convinced to be an appropriate choice.

In the SC method, we use crime rates data from other non–treated states (not open to legalization of recreational marijuana), through econometric model calculation (by using package *synth* of STATA), to synthesize (close enough to) a crime rate data before the legal time point to a treated state. By Using this weight, we can tell whether there was a significant difference in crime rates after marijuana legalization (treated state and synthetic state), to infer whether the treatment had a so–called causal effect on the crime rate data we were concerned about.

At the same time, because the SC method is a data–driven method, there will be an objective perspective (to minimize RMSPE) when selecting weights on the control group.

As we know that the goal of the SC method is to infer causal effect by synthesizing the counterfactual part of the potential outcome for the treated states in the pre–treatment periods. We can simplify this by the following equations.

$$\alpha_{it} = Y_{it}^{1} - Y_{it}^{0}, \quad \forall t \in 1, 2, ...T \quad \forall i \in states, i \tag{1}$$

$$\widehat{\alpha}_{it} = Y_{it}^{1} - \sum_{j=2}^{J+1} w_i^* Y_{it} \qquad where \quad \sum_{j=2}^{J+1} w_i = 1 \tag{2}$$

The $\alpha_{it}$ in equation (1) is the causal effect we are looking for. We then estimate alpha hat by observed outcome subtracted by synthetic outcome (weight average). Denoting $i = 1$ as treated unit, and $i = 2...J + 1$ as non–treated units.

The following are the procedure for establishing the SC method:

- Step1 : Identify explanatory variables for the outcome variable (crime rates).
- Step2 : Identify the donor pool (not legalized states) to synthesize the control state.
- Step3 : Generate the weights by using *synth* package in STATA.
- Step4 : Implement placebo tests to evaluate the significant results for the treated states.

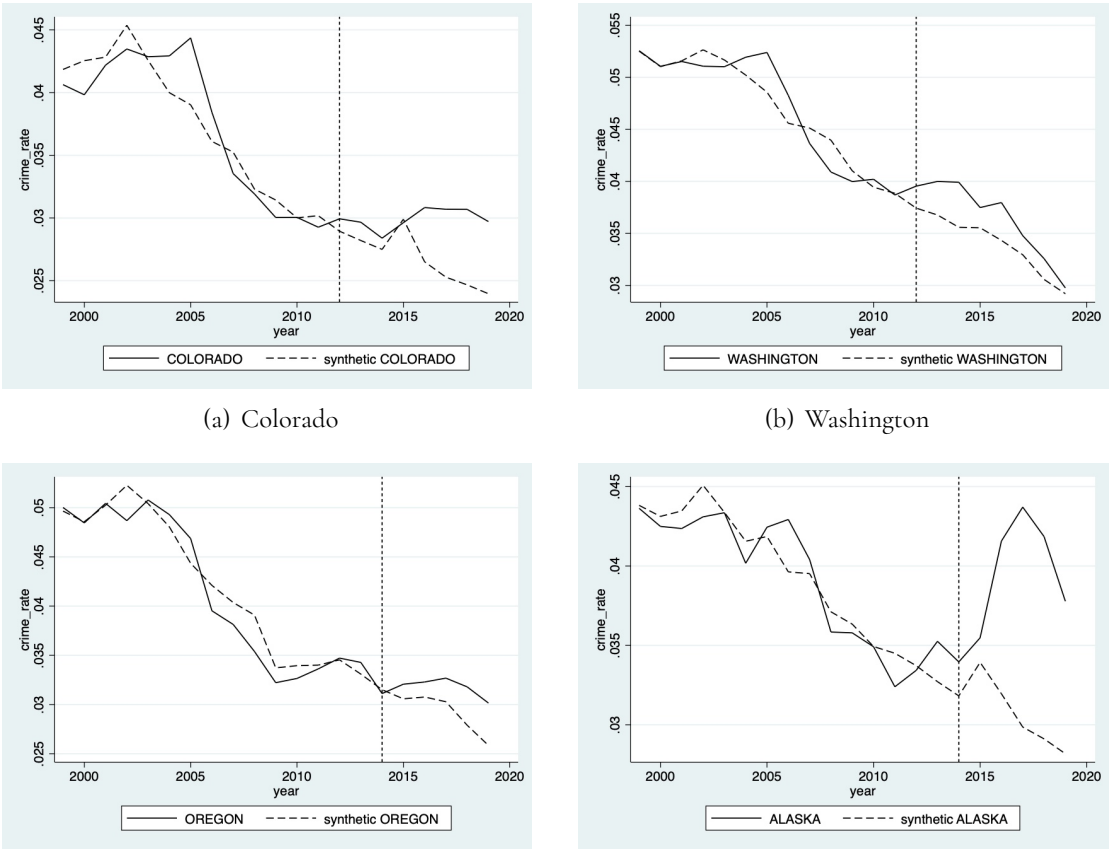
There are some important issues of using the SC method to be mentioned. In step1, we considering Kaul's questioning on using all the possible lagging terms would cause biasedness in the final model and the synthetic outcome path. This question was discussed in detail in the article of *Ferman, Bruno and Pinto, Cristine* [3], instead of using all lags, I chose all odd lags terms. Secondly, when discussing the post–treatment periods, if the difference between the treated outcome and its synthetic outcome is larger than the differences for most of the placebo states, we can state that there is strong evidence that the treatment had an effect.

However, there exists a big disadvantage in using the SC method, that is, the asymptotic distribution of the method is not known, so the process of statistical inference will be hindered. Therefore, we will use the permutation method as an alternative to p–value.

$$p_{1t} = \frac{\sum_{j=2}^{J+1} \mathbf{1}\left\{\widehat{\alpha}_{jt} \geq \widehat{\alpha}_{1t}\right\}}{J} \tag{3}$$

## 4 Results

After establishing the empirical method and clarified the data set, we are now able to fit the above information into the model for detailed statistical inference. By utilizing the SC method analysis, we can finally reveal which of the debate is more likely to be correct and convincing. We then the have the following results:




(a) Colorado (b) Washington

(c) Oregon (d) Alaska

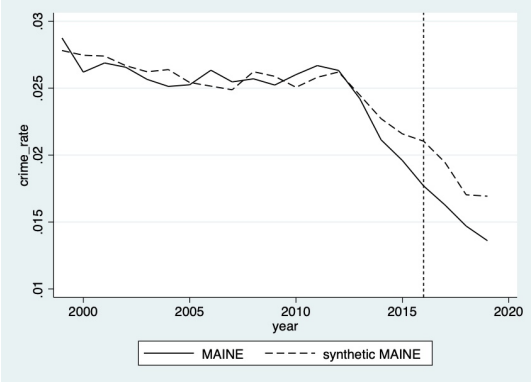
Figure 1: Main results of synthetic control by states in 2012 in first row and 2014 in second row.

The results in figure 1 show that the states which enacted the law in 2012 and 2014 were suffering from the increasing crime rates. We then have the results for states that enacted the law in 2016. (Figure 2)

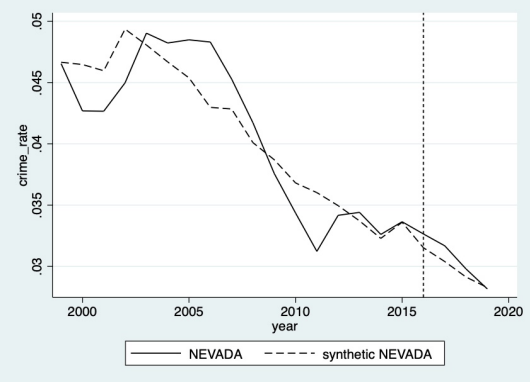
We sum up the results in Table 2 below. (Table 2)

In this table, with a brief view, we can discover that crime rates in most of the states with legal use of marijuana go up. We can further figure out that from the geographical perspective, the states located on the west will have higher crime rates after the law, but the states located on the east show opposite results. And the only two states with lowered crime rates are adjacent. Besides, the last column[3] indicates that if the states with original high–level crime rates (higher figure indicates higher crime rates originally) will increase; however, the states with good public security are benefiting from the legalization of marijuana. We conclude the result "UP" and "LOW" by P–value and STD P–value and define "NF" as not fitted when both values are too high (we set at around 0.3 for considering all the states are included for the calculation for placebo effects.

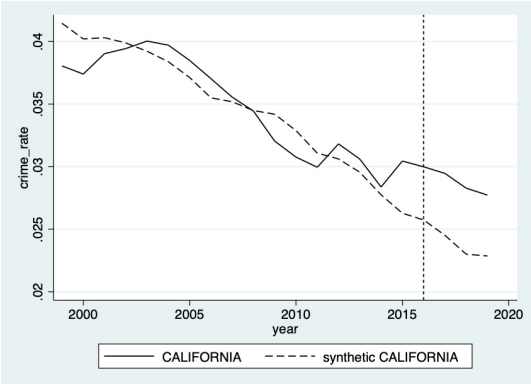
[3]https://www.usnews.com/news/best-states/rankings/crime-and-corrections/public-safety



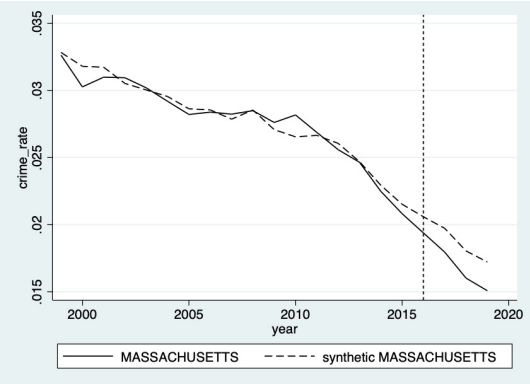

(a) Maine




(b) Nevada




(c) California




(d) Massachusetts

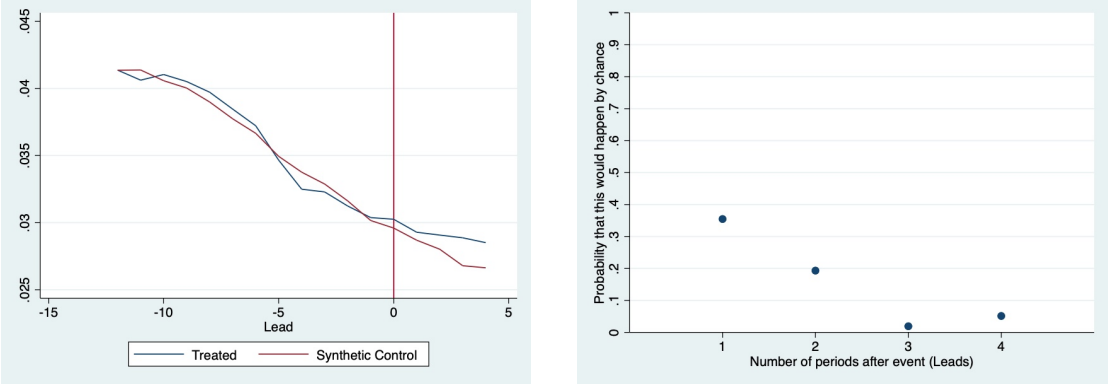
Figure 2: Main results of synthetic control by states 2016.

| State | Year | Geography | Crime rank | Estimates | P–value | STD P–value | result |
|---|---|---|---|---|---|---|---|
| COLORADO | 2012 | mid_west | 78% | 0.00459 | 0.14286 | 0.20408 | UP |
| WASHINGTON | 2012 | north_west | 68% | –0.00184 | 0.40816 | 0.55102 | (NF) |
| ALASKA | 2014 | north_west | 98% | 0.00782 | 0.00000 | 0.00000 | UP |
| OREGON | 2014 | north_west | 70% | 0.00175 | 0.46939 | 0.69388 | (NF) |
| CALIFORNIA | 2016 | west | 72% | 0.00457 | 0.06122 | 0.20408 | UP |
| MAINE | 2016 | north_east | 2% | –0.00339 | 0.14583 | 0.08333 | LOW |
| NEVADA | 2016 | west | 80% | –0.00227 | 0.28571 | 0.67347 | (NF) |
| MASSACHUSETTS | 2016 | north_east | 14% | –0.00207 | 0.35417 | 0.10417 | LOW |

Table 2: Summary results for treated states.

## 5 Overall Result

Figure 3 is the average treatment effect among all the 8 states I chose for the treatment group. We can discover that the trend lines for both groups are sloping downward, but the difference is significantly large enough to conclude the increase in the crime rates. Additionally, as the period moves away from the year (average) of the legalization, the more significant it is by the method of p-value permutation. After all, I list the weighting values for each state by using the SC method and all the data in the appendix page. (Table 4)




(a) Average treatment

(b) P–value after the treatment

Figure 3: Average treatment effect on multiple treated units

| | Estimates | P–values |
|---|---|---|
| T+1 | .0005917 | .354731 |
| T+2 | .0010526 | .193319 |
| T+3 | .0020798 | .0192 |
| T+4 | .0018738 | .05137 |

Table 3: Results of mutiple treated units.

We can have a clearer view from this table (Table 3) that the index column is the number of years after the treatment, and the estimates shows that the crime rates (cases of violent type and property type) increased by 0.0005917 per capita in the first year after the treatment overall for example. For this model, this is a rather satisfactory result. The results of this study, which claims a different tone from the previous studies, show that the overall crime rates increased significantly after the legalization of marijuana.

## 6 Discussions and Conclusion

Based on the above graphical and tabular results, we can conclude that there is a positive causal relationship between marijuana use and the crime rate. However, if we had access to a longer period of crime rate data, we could be able to fit the SC model in the pre–treatment period better. (enhancing the power of statistical explanation).

Here are several factors that are possible reasons that influence the crime rate in the United States due to the marijuana legalization, and there may be still omitted variable in this data set.

We can further discuss the possible causes for the result:

- Marijuana is a gateway drug to other illegal drugs.
- Medical use of marijuana can be effectively regulated compared to recreational use.
- People suffering from behavioral addiction to the use of cannabis.

After considering these reasons, it is logically convincing that the positive causal relationship is true.

As for future research on this topic, I suggest that the outcome variables be set separately outcome variables (through violent crime and property crime, or even detailed to each type of crime), which may contribute to detailed inferences. Additionally, the problem mentioned by Kaul is still a wide spectrum of opinions. This may be helpful for further detailed inferences.

## 7 Appendix

| | Colo. | Wash. | Ore. | Alaska | Maine | Nev. | Calif. | Mass. |
|---|---|---|---|---|---|---|---|---|
| Ariz. | 0.111 | 0.191 | 0.684 | 0 | 0 | 0 | 0 | 0 |
| Ark. | 0 | 0 | 0 | 0.166 | 0 | 0 | 0.017 | 0 |
| Conn. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.089 |
| Del. | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0.007 |
| Ga. | 0 | 0.367 | 0 | 0 | 0 | 0 | 0 | 0 |
| Hawaii | 0.402 | 0.173 | 0 | 0.314 | 0 | 0.249 | 0 | 0 |
| Idaho | 0.089 | 0 | 0.122 | 0 | 0.038 | 0 | 0 | 0 |
| Kan. | 0 | 0 | 0 | 0 | 0 | 0.064 | 0 | 0 |
| Minn. | 0 | 0 | 0 | 0 | 0 | 0.036 | 0 | 0 |
| Mont. | 0 | 0 | 0.022 | 0.194 | 0 | 0 | 0 | 0 |
| N.H. | 0 | 0 | 0 | 0 | 0.324 | 0 | 0 | 0.172 |
| N.J. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.253 |
| N.M. | 0 | 0.081 | 0 | 0 | 0 | 0 | 0 | 0 |
| N.Y. | 0.398 | 0.02 | 0.006 | 0 | 0 | 0 | 0.496 | 0 |
| Pa. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.365 |
| R.I. | 0 | 0 | 0 | 0 | 0.222 | 0 | 0 | 0 |
| S.C. | 0 | 0 | 0 | 0 | 0 | 0.299 | 0 | 0 |
| S.D. | 0 | 0 | 0.166 | 0 | 0.063 | 0 | 0 | 0 |
| Texas | 0 | 0.169 | 0 | 0 | 0 | 0.086 | 0.487 | 0.103 |
| Utah | 0 | 0 | 0 | 0 | 0 | 0.068 | 0 | 0 |
| W.Va. | 0 | 0 | 0 | 0 | 0.353 | 0 | 0 | 0 |
| Wis. | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.012 |
| Wyo. | 0 | 0 | 0 | 0.126 | 0 | 0.198 | 0 | 0 |

Table 4: Weighting values among all treated states.

(Omitting the control states with all zero weights.)

## References


[1] Gary S Becker and Kevin M Murphy. "Have we lost the war on drugs?" In: *Wall Street Journal* 4 (2013).

[2] Davide Dragone et al. "Crime and the legalization of recreational marijuana". In: *Journal of Economic Behavior Organization* 159.C (2019), pp. 488–501.

[3] Bruno Ferman and Cristine Pinto. *Revisiting the Synthetic Control Estimator*. MPRA Paper. University Library of Munich, Germany, Sept. 2016.

[4] et al. Reingle Jennifer M. "The Relationship between Marijuana Use and Intimate Partner Violence in a Nationally Representative, Longitudinal Sample." In: *Journal of Interpersonal Violence, U.S. National* (2012).