

How Recreational Marijuana Legalization Affects Property Crimes in Colorado?

I. Introduction

This article examines the effects of recreational marijuana legalization on the property crimes in Colorado at the county level. Last century, marijuana (also referred to as cannabis) was classified as a Schedule I narcotic and made federally illegal under Roosevelt's Administration in the 1930s. However, in 1996, with the discovery of the medicinal use of marijuana on cancer patients to alleviate pain, and the approval of Proposition 215, medical marijuana started to legalize on a state level (Martin, 2016). Over 35 states, along with the District of Columbia and Guam, have enacted some form of medical marijuana law since then. Additionally, since 2012, eight states and the District of Columbia have legalized recreational marijuana use (Hao & Benjamin, 2020). This paper aims to explore how recreational marijuana legalization affects property crimes in Colorado. This paper adopts the difference in differences (Did) and the approach in Dills et al, and aims to analyze the impacts on property crimes in Colorado at the county-level.

This paper consists of seven parts. Section 2 reviews the literature, and elaborates on the methodologies I adopted from the literature to conduct my research. Section 3 dives into the conceptual model. Section 4 explains the sources of the data I used in this model, and summarizes the actual data and the linear models. Section 5 discusses the results from the data analysis. Section 6 explores the robustness checks. And finally,

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Section 7 concludes everything covered in this paper and discusses limitations and future research.

II. Literature Review

In 1985, Goldstein's tripartite conceptual framework suggests three potential ways for the recreational marijuana legalization to influence crimes: the economically compulsive, the psychopharmacological, and the systemic (Goldstein, 1985). The economically compulsive model shows a mixed result. On one hand it suggests that those addicted to the drug are more likely to participate in property crime, or other crimes that result in economic gain to fuel their drug habit. On the other hand, the model suggests a connection between prohibition of recreational marijuana and crimes. The risk of apprehension, or that arrests might affect one's ability to gain employment (Kilmer, 2014), together with the higher price of illegal marijuana, will all lead to the need for the drug users to commit the crimes mentioned (Shepard & Blackley, 2007).

Also, proponents and opponents of recreational marijuana have recently provided more reasons of how legalization might influence these crimes. From the proponents' side, recreational marijuana legalization will first decriminalize possession, production, and sales of recreational marijuana, and thereby reduce the crime rates (Mccall, 2019, October 8). Secondly, the legal sale of marijuana will snuff out the underground black markets for selling marijuana (Gettman & Kennedy, 2014). Last, marijuana legalization can shift allocate police to other, more serious crimes to increase the police

effectiveness (Makin et al., 2019).

From the recreational marijuana opponents' perspectives, first, as a "gateway drug", since the legalization of recreational marijuana will easily increase the use of marijuana, marijuana will further increase the use of other more serious drugs including heroin and cocaine (Secades-Villa, Garcia-Rodríguez, Jin, Wang, & Blanco, 2015).

Second, since recreational marijuana has not been legalized at the federal level, the transaction of recreational marijuana will be mostly cash-based instead of using the financial institutions. Thus, these people are more likely to be the targets of burglary and robbery (Freisthler et al., 2017).

Third, marijuana will influence users' cognitive ability negatively. Studies have shown that marijuana will reduce the users' self-control (Howard & Menkes, 2007) and that users will usually have a greater willingness to commit crimes (Goode, 2008).

When it specifically comes to recreational marijuana legalization, many scholars have observed that recreational marijuana legalization increased crime rate. For example, observing over 16,000 space-time units, Freisthler discovered that the higher the density of the marijuana dispensaries, the higher the property crime rate (Freisthler et al., 2017). Also, Hughes discovered that the placement of marijuana dispensaries, for both medical or recreational uses, will largely increase the crime rate in the surrounding neighborhood (Hughes et al., 2019).

It is worth noting that crime-reducing effects of recreational marijuana legalization are also observed. For instance, Brinkman and Mok-Lamme found that the addition of

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a marijuana dispensary will have a prominent reduction in crime rate in the local area (Brinkman & Mok-Lamme, 2019). Also, by observing crime on the Washington side of the border relative to the Oregon side, and comparing the crime rate before (2010–2012) and after (2013–2014) the legalization of recreational marijuana, the recreational marijuana legalization will lead to a strong decrease in property crimes and rape (Dragone et al., 2019).

To examine the net impacts created by the legalization, several approaches appeared. In 2017, Dills et al. started an estimating equation considering both medical and recreational marijuana legalization. Respondents' characteristics included individual respondent's race, age, sex and state-level measures of age groups, and fixed effects. The estimating equation was used to test several outcomes which all might relate to the legalization in some way (Dills et al. 2017). With a similar approach, Glenn started an empirical study to examine the effects of marijuana legalization on crime in Colorado. By creating a synthetic control for Colorado, Glenn observed that recreational marijuana legalization shows a strong impact on property crime in a positive way. Also, such impact is greater on the adults rather than on children, especially for property crime (Furton & Glenn, 2018).

Taken together, while experts point out mixed results for recreational marijuana legalization, theories and empirical studies both show recreational marijuana legalization will increase the number of crimes, especially property crimes, and such impact is stronger on the adults. However, since recreational marijuana has not been

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legalized for long, and the scholarly efforts in this area are still limited, more research is needed to further examine the impacts of it.

III. Conceptual Model and Hypothetical Experiment

The conceptual model for this research is

$$PropertyCrime = f(Demographics, Legalization)$$

Based on the literature review above. With two-year post-legalization data, Glenn observed that recreational marijuana legalization creates the most significant increase in property crime. Specifically, it shows that the crimes increase for the adult population and there is a smaller effect on the individuals 18 and under (Glenn, 2018). Thus, after the legalization of marijuana, the number of property crimes should be positively related to the elder population, and the coefficient for it should be larger than for the young population.

Ideally, the property crime rate in Arizona and Colorado should show a parallel trend. Besides, all the offenses, which is the property crimes specifically here, should be reported. Also, since recreational marijuana was legalized at the end of 2012, if I can collect monthly data instead of the annual data, I will be able to capture the short run impacts.

IV. Actual Data and Estimating Equations

Federal Bureau of Investigation (FBI)

Federal Bureau of Investigation data contains annual crime data at the county level. The FBI collects these data through the Uniform Crime Reporting (UCR) Program. The data shown in the table do not reflect county totals but are the number of offenses reported by the sheriff's office or county police department.

United States Census Bureau

United States Census Bureau data contains annual demographical data at the county level. Specifically, the data I used include the population whom poverty status is determined, under 18 years, from 18 to 64 years, and above 65 years, respectively.

With the actual data which is summarized in Table 1 to Table 4, I use the difference in differences (Did) and the estimating equation from Dills et al. Specifically, since Colorado and Arizona are similar states, they provide a natural environment where the Colorado is the treatment group and the Arizona is the control group. Also, for the estimating equation, I used the adjusted property crime rate out of 100,000 as my outcome, and the age groups as my respondent's characteristics.

Thus, the actual model I use to test whether the recreational marijuana legalization increases the number of property crimes is:

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$$\begin{aligned} \text{crimrate}_{st} = & \beta_0 + \beta_1 \times \text{under18p}_{st} + \beta_2 \times \text{from18to64p}_{st} + \beta_3 \times d_{13} + \beta_4 \times d_{state} \\ & + \beta_5 \times d_{state} \times d_{13} + \theta_c + \tau_t + \varepsilon_{st}, \end{aligned}$$

and the actual model I use to test whether the recreational marijuana legalization has a greater impact on the adults than that on the children is:

$$\begin{aligned} \text{crimrate}_{st} = & \beta_0 + \beta_1 \times \text{under18p}_{st} + \beta_2 \times \text{from18to64p}_{st} + \beta_3 \times \text{under18p}_{st} \times d_{13} \\ & + \beta_4 \times \text{from18to64p}_{st} \times d_{13} + \beta_5 \times d_{13} + \beta_6 \times d_{state} + \beta_7 \times d_{state} \times d_{13} \\ & + \theta_c + \tau_t + \varepsilon_{st} \end{aligned}$$

Specifically, *crimrate*, as the dependent variable, suggests the adjusted property adjusted crime rate out of 100,000 reported by the sheriff's office or county police department.

Furthermore, *under18p* suggests the percentage of population for whom poverty status is determined under 18 years and *from18to64p* suggests the percentage of population for whom poverty status is determined between 18 to 64 years. Since I also want to dig into how the impacts of legalization vary from age group to age group, I add an interaction between the demographics and the time dummy variable in the second model.

Moreover, d_{13} is the time dummy variable which is 1 when it is after the legalization and 0 when it is before the legalization and d_{state} is the state dummy variable which is 1 when it is in Colorado and 0 when it is in Arizona.

In these models, I also use the year fixed effects and county fixed effects to test the robustness of my models.

Table 1. Detailed Summary Statistics before legalization in Arizona.

Before the recreational marijuana legalization in Arizona								
VARIABLES	N	meanmin	max	p25	p50	p75	Var	sd
Property Crime Rate	24	24	3,267	408.9	652.9	1,129	596,057	772.0
Population under18	24	24	28.65	21.75	24.27	26.58	10.36	3.218
Population 18 to 64	24	24	65.97	56.05	57.36	61.44	12.95	3.599
Population above 65	24	24	25.54	13.68	15.93	21.30	24.90	4.990

Table 2. Detailed Summary Statistics after legalization in Arizona.

After the recreational marijuana legalization in Arizona								
VARIABLES	N	meanmin	max	p25	p50	p75	Var	sd
Property Crime Rate	43	43	1,214	362.6	529.9	865.1	88,510	297.5
Population under18	43	43	28.16	18.43	23.01	25.25	14.38	3.792
Population 18 to 64	43	43	65.84	16.81	18.87	55.53	389.0	19.72
Population above 65	43	43	26.94	13.02	18.77	24.63	52.92	7.275

Table 3. Detailed Summary Statistics before legalization in Colorado.

Before the recreational marijuana legalization in Colorado								
VARIABLES	N	meanmin	max	p25	p50	p75	Var	sd
Property Crime Rate	71	71	2,142	246.2	437.9	708.5	184,509	429.5
Population under18	71	71	30.54	20.39	23.02	25.68	23.77	4.875
Population 18 to 64	71	71	77.38	59.12	62.60	66.33	26.03	5.102
Population above 65	71	71	34.33	9.985	12.96	17.02	33.94	5.826

Table 4. Detailed Summary Statistics after legalization in Colorado.

After the recreational marijuana legalization in Colorado								
VARIABLES	N	meanmin	max	p25	p50	p75	Var	sd
Property Crime Rate	297	297	9,471	218.3	419.3	696.2	1.063e+06	1,031
Population under18	297	297	33.53	18.44	21.55	24.65	18.72	4.327
Population 18 to 64	297	297	77.09	18.36	56.89	62.77	482.6	21.97
Population above 65	297	297	49.97	16.03	21.05	25.37	55.89	7.476

V. Results

The prerequisite for me to use Arizona and Colorado for the difference and differences is that before the treatment (i.e., legalization) is added, they show a parallel trend. From Figure 1, we can see that before 2012, especially between 2005 to 2012, the line charts for the number of property crimes in Arizona and Colorado are parallel. Also, I further use the regression as shown in Table 5, we can see the trends are close to parallel where Colorado crime is falling at a -156 trend and Arizona crime is falling at a -209 trend.

In Table 6 and Table 7, we can see that my observation is consistent with the theories. First, holding everything else the same, the change in average adjusted crime rate out of 100,000 led by the legalization is 701.9 higher in Colorado compared with that in Arizona. This shows that the recreational marijuana legalization did increase the property crime rate in Colorado, as indicated by the theory in the literature review. This is further demonstrated by the second half of Figure 1. In the second half of Figure 1, a closer look at the time period between 2012 to 2018 clearly reveals that the number of crimes in Colorado starts to increase in 2012, the time for the legalization of recreational marijuana. Along with the empirical study, we can easily see that the recreational marijuana legalization continuously increases the number of crimes in Colorado.

Second, in the Table 7, the coefficient for the percentage of population from 18 to 64 years after the marijuana legalization is larger than that for the percentage of

population below 18 years. It clearly reveals that the impact of the legalization is greater on the adults than that on the children. Also, since this research covers the data from 2010 to 2019, the consistent results show that this theory can be further applied to the long run situation, or at least for the future six years.

Figure 1. Annual property crime rate summary over years

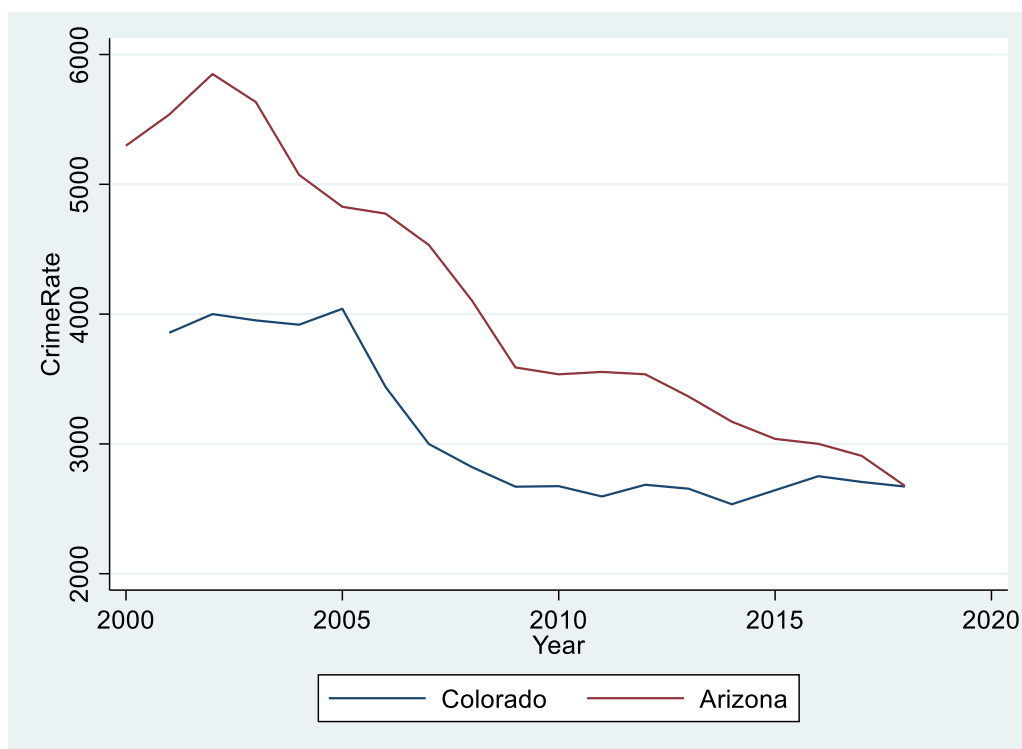


Table 5. Regression Result for the parallel trend

VARIABLES	Crime Rate
state	-106,930* (-1.728)
Year	-209.4*** (-10.23)
coyear	52.70 (1.708)
Constant	531,524*** (5.638)
Observations	25
R-squared	0.932
Adjusted R-squared	0.923
F	96.30
RSS	1.601e+06

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6. Regression results for the difference in differences

	No Fixed Effects	Year Fixed Effects	County Fixed Effects	Both Fixed Effects
VARIABLES	Crime Rate	Crime Rate	Crime Rate	Crime Rate
Percentage of Population under 18 Years	-16.93* (-1.729)	-14.86 (-1.493)	-82.70*** (-3.289)	-82.67*** (-3.015)
Percentage of Population from 18 to 64 Years	-0.0384 (-0.0175)	3.307 (0.554)	0.299 (0.154)	14.91** (2.448)
After Legalization	-323.5 (-1.354)		-481.2** (-2.283)	
In Colorado	-355.1* (-1.676)	-335.7 (-1.453)	-568.2 (-0.932)	-701.9 (-1.136)
After Legalization in Colorado	406.4 (1.574)	350.9 (1.265)	539.7** (2.386)	438.0* (1.782)
Constant	1,277*** (3.881)	957.4* (1.942)	3,383*** (3.352)	2,517** (2.359)
Year Fixed Effects	NO	YES	NO	YES
County Fixed Effects	NO	NO	YES	YES
Observations	443	443	443	443
R-squared	0.013	0.029	0.393	0.409
Adjusted R-squared	0.00152	0.00153	0.271	0.276
F	1.134	1.056	3.216	3.085
RSS	3.430e+08	3.370e+08	2.110e+08	2.050e+08

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7. Regression results for how the impact varies from age group to age group

	No Fixed Effects	Year Fixed Effects	County Fixed Effects	Both Fixed Effects
VARIABLES	Crime Rate	Crime Rate	Crime Rate	Crime Rate
Percentage of Population under 18 Years	-28.72 (-1.384)	-32.31 (-1.501)	-90.29*** (-3.048)	-85.01*** (-2.716)
Percentage of Population from 18 to 64 Years	-23.22 (-1.173)	-24.90 (-1.245)	-10.26 (-0.528)	0.693 (0.0346)
Percentage of Population under 18 Years after Legalization	13.45 (0.570)	19.66 (0.807)	10.51 (0.491)	2.857 (0.127)
Percentage of Population from 18 to 64 Years after Legalization	23.46 (1.178)	30.64 (1.461)	10.58 (0.545)	14.72 (0.753)
After Legalization	-2,016 (-1.410)		-1,350 (-0.971)	
In Colorado	-274.7 (-1.217)	-213.7 (-0.870)	-544.1 (-0.888)	-657.3 (-1.056)
After Legalization in Colorado	322.4 (1.190)	197.0 (0.660)	507.9** (2.118)	369.5 (1.409)
Constant	2,925** (2.090)	3,062** (2.098)	4,201** (2.523)	3,435** (2.008)
Year Fixed Effects	NO	YES	NO	YES
County Fixed Effects	NO	NO	YES	YES
Observations	443	443	443	443
R-squared	0.016	0.034	0.393	0.410
Adjusted R-squared	0.000315	0.00235	0.267	0.274
F	1.020	1.074	3.124	3.005
RSS	3.410e+08	3.350e+08	2.110e+08	2.050e+08

t-statistics in parentheses

*** p<0.01, ** p<0.05, * p<0.1

VI. Robustness Checks

My robustness checks start with the selection of fixed effects. I noticed that when I do not add the fixed effects, the regression result is much less statistically significant compared with the one with fixed effects, especially county fixed effects. I include both the county fixed effects and the year fixed effects in my final models.

Also, I drew the maps of Colorado and Arizona at the county level to avoid outlier counties. Since the number of counties is not big, if the number of property crimes in one county varies greatly due to non-legalization reasons, it might largely influence my results. In Figure 3 and Figure 4, we can easily observe that there is no outlier county (if the area is white, it represents that the data is missing instead of there is no crime). Thus, the results above are valid.

Figure 3. The number of property crimes in Colorado counties in 2013 and in 2018.

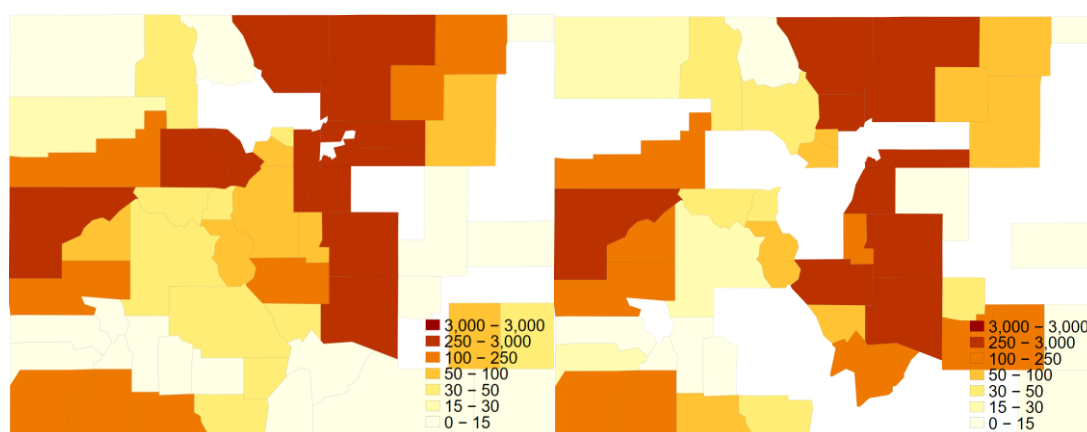
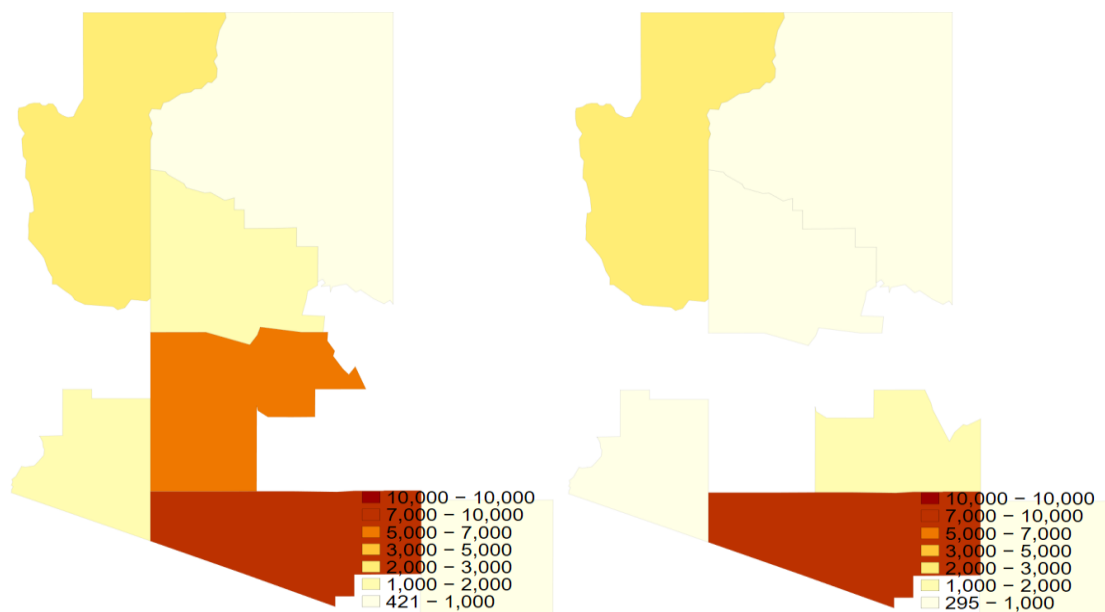


Figure 4. The number of property crimes in Arizona counties in 2013 and in 2018.



Finally, I checked the residual plot of my final model and double check the outliers. Since I noticed that for both models, most of the points aggregates around the zero-residual line, my models are generally valid. However, in Figure 5 to Figure 8, we can observe that there are still some outliers: specifically, Arapahoe, Bent, and El Paso, which are all in Colorado. Except these outliers, I believe my models are good to predict the real situation in Colorado after the recreational marijuana legalization.

Figure 5. The residual plot for the first final model with state names

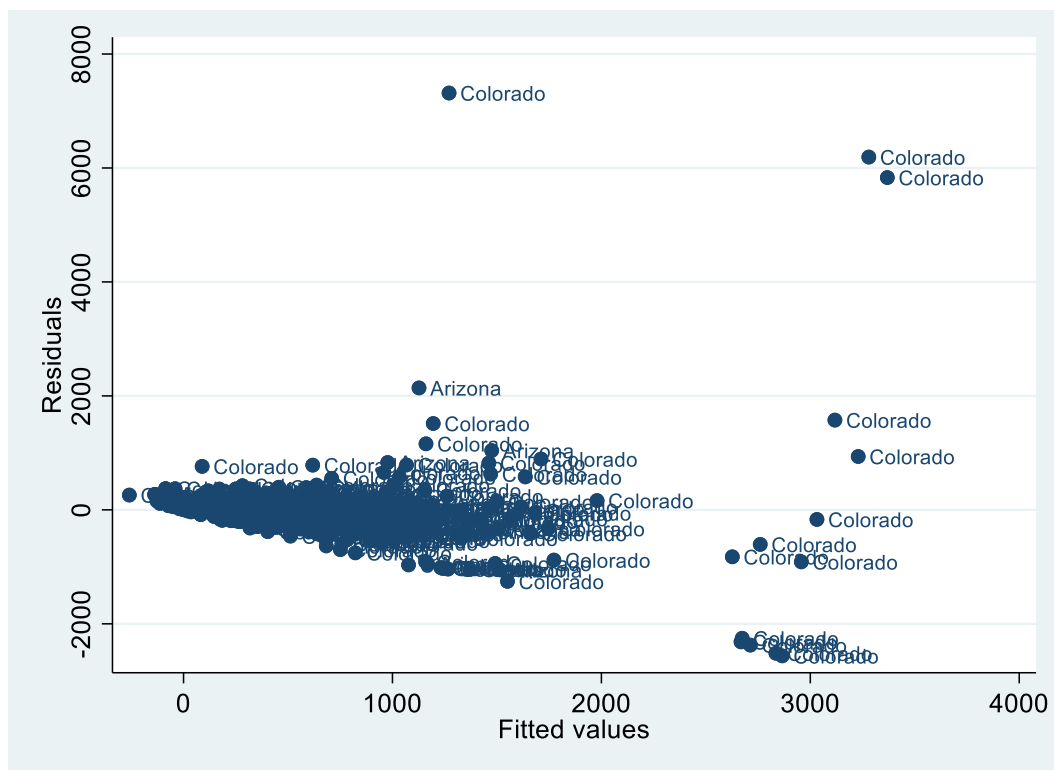


Figure 6. The residual plot for the first final model with county names

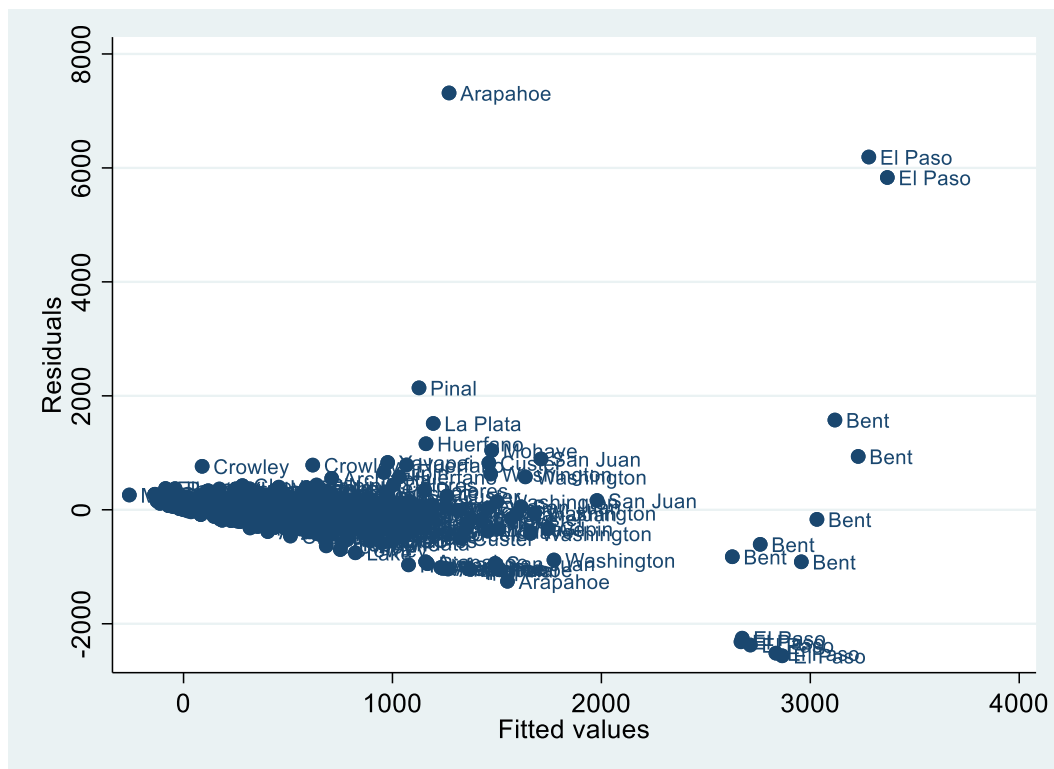


Figure 7. The residual plot for the second final model with state names

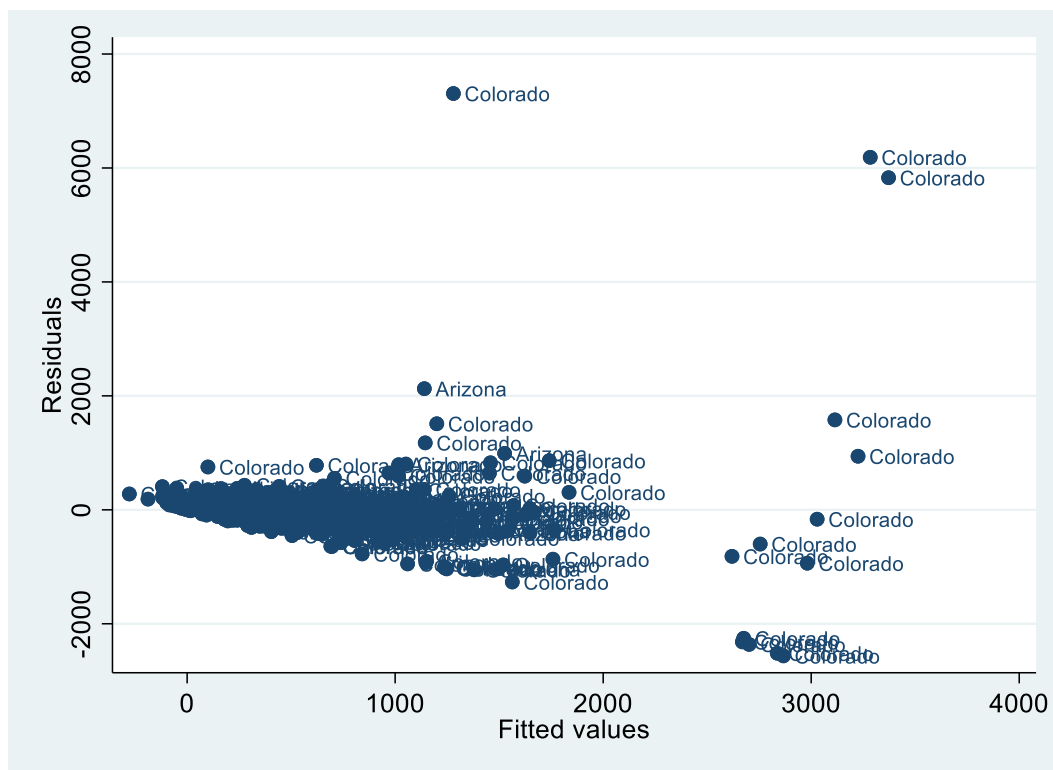
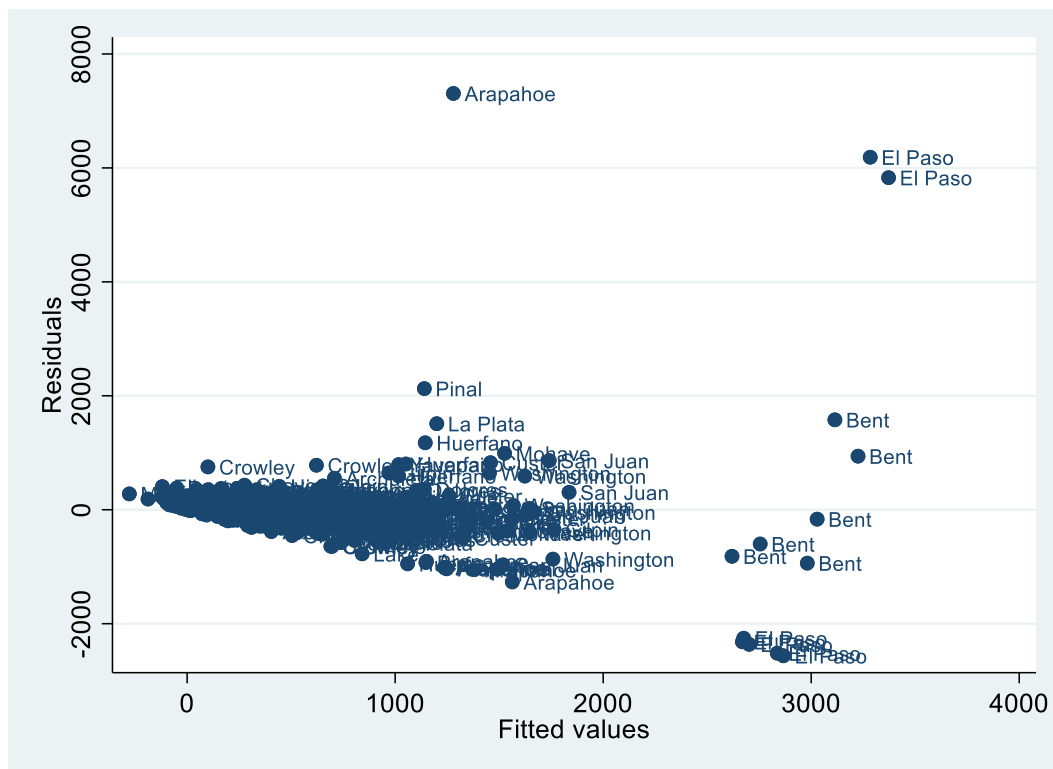


Figure 8. The residual plot for the second final model with county names



VII. Conclusion

The conclusion for my research is consistent with the theories. First, recreational marijuana legalization increases the number of property crimes in Colorado. Second, such impact is greater on adults than that on children. The limitations of my research are thus: First, the trends in Colorado and Arizona are not perfectly parallel before 2012. It might make my difference in differences coefficient not that accurate. Second, I only got the access to the annual data. I believe if I am able to get the monthly data, it will be more helpful for me to capture the immediate impacts led by recreational marijuana legalization. Third, I am not sure whether the police department in Arizona and Colorado is able to report accurately on the amounts of crimes committed. If the number of crimes reported has a huge difference with the status quo, that might make my research result not persuasive. Also, the property crime data is missing for some certain counties. This might negatively influence my results. However, it is worth noting that recreational marijuana has only been legalized in Colorado for 10 years. In the future, I think it will be important to make more research for the long-run impact led by recreational marijuana legalization. Lastly, it may be helpful if there was a better set of control variables in the models.

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Reference:

Brinkman, J., Mok-Lamm, D.. Not in my backyard? Not so fast. The effect of marijuana legalization on neighborhood crime. *Regional Science and Urban Economics*, 78 (2019), pp. 1-23

Dills, Angela, K., Sietse, Goffard, and Jeffrey, Miron. “The Effects of Marijuana Liberalizations: Evidence from Monitoring the Future.” NBER, September 11, 2017.

Dragone, D., Prarolo, G., Vanin, P., Zanella, G.. Crime and the legalization of recreational marijuana. *Journal of Economic Behavior & Organization*, 159 (2019), pp. 488-501

Freisthler, A. Gaidus, C. Tam, W.R. Ponicki, P.J. Gruenewald. From medical to recreational marijuana sales: Marijuana outlets and crime in an era of changing marijuana legislation. *The Journal of Primary Prevention*, 38 (3) (2017), pp. 249-263

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

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

Gettman, J., Kennedy, M.. Let it grow—The open market solution to marijuana control. *Harm Reduction Journal*, 32 (2014), pp. 1-9

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Professor Gary Krueger
ECON 381 Introduction to Econometrics
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Goldstein, P.. (1985). The drug/violence nexus: A tripartite conceptual framework. *Journal of Drug Issues*, 14, 493–506.

Goode, E.. *Drugs in American society*. (7th ed.), McGraw-Hill, Boston, MA (2008)

Hao, Zhuang, and Benjamin, W. Cowan. "The cross-border spillover effects of recreational marijuana legalization." *Economic inquiry* 58, no. 2 (2020): 642-666.

Howard, R.C., Menkes, D.B.. Changes in brain function during acute cannabis intoxication: Preliminary findings suggest a mechanism for cannabis-induced violence. *Criminal Behaviour and Mental Health*, 17 (2) (2007), pp. 113-117

Hughes, L.A., Schaible, L.M., Jimmerson, K.. Marijuana dispensaries and neighborhood crime and disorder in Denver, Colorado *Justice Quarterly* (2019), pp. 1-25

Kilmer, B.. (2014). Policy designs for cannabis legalization: Starting with the eight Ps. *The American Journal of Drug and Alcohol Abuse*, 40, 259–261.

Makin, D.A., Willits, D.W., Wu, G., DuBois, K.O., Lu, R., Stohr M.K., ..., Lovrich, N.P.. Marijuana legalization and crime clearance rates: Testing proponent assertions in Colorado and Washington State *Police Quarterly*, 22 (1) (2019), pp. 31-55

Martin, Scott C.. *Marijuana in the United States: How Attitudes Have Changed*. April 20, 2016

Zefan Qian
Professor Gary Krueger
ECON 381 Introduction to Econometrics
12 March, 2021

Mccall, R.. Does legalizing pot increase crime rates? It hasn't in Colorado and Washington, a study has found. Retrieved from <https://www.newsweek.com/legalizing-pot-increase-crime-rates-colorado-washington-1463622> (2019, October 8)

Secades-Villa, R., Garcia-Rodríguez, O., Jin, C.J., Wang, S., Blanco, C.. Probability and predictors of the cannabis gateway effect: A national study. *International Journal of Drug Policy*, 26 (2) (2015), pp. 135-142

Shepard, E. M., Blackley, P. R.. (2007). The impact of marijuana law enforcement in an economic model of crime. *Journal of Drug Issues*, 37, 403–424.