



Impact of recreational marijuana legalization on crime: Evidence from Oregon

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ABSTRACT

The legalization of recreational marijuana is a pivotal policy change, and its social consequences remain largely unknown. Central to the public concern is its impact on crime, about which competing views exist and empirical studies have yielded mixed results. Based on Uniform (UCR) data from 2007 to 2017, this study used Difference in Differences (DID) analysis to examine the impact of recreational marijuana legalization on the rates of a variety of serious crimes in Oregon, which passed its recreational marijuana law (RML) in late 2014. Results provide some evidence demonstrating a crime-exacerbating effect of recreational marijuana legalization, as reflected by substantial increases in the rates of multiple types of serious crimes as measured by the UCR in Oregon relative to non-legalized states following legalization, including property and violent crime overall, as well as other crimes such as burglary, motor vehicle theft, larceny, and aggravated assault.

1. Introduction

The last two decades saw dramatic changes in policies associated with marijuana use: over 30 states in the United States (U.S.) have legalized medical marijuana, and, more remarkably, there is a trend of legalizing recreational marijuana. Colorado and Washington State first legalized marijuana for recreational use in late 2012, and, to date, 11 states and the District of Columbia have also legalized marijuana for recreational purposes, which may include production, possession, and retail sale, although marijuana remains an illegal drug under the federal Controlled Substances Act. Notably, this pivotal policy change appears not to be restricted within the borders of the United States, but has global dimensions, shown by the recent recreational marijuana legalization in Canada and Uruguay.

As a social experiment, marijuana legalization, especially for recreational purposes, has generated concerns about its impact on public safety. Central to this is an ongoing debate on whether legalization increases or decreases crime rates (Lu et al., 2019). Opponents argue that marijuana legalization would increase crime not only because marijuana may be a gateway to more serious drugs such as cocaine and heroin that are closely associated with crime, but also because of the potential criminogenic effects of the increasing presence of marijuana dispensaries (Cleveland & Wiebe, 2008; Kepple & Freisthler, 2012).

Proponents assert that legalization would lead to lower crime rates given the decriminalization of this drug and the reduction in the underground marijuana market that tends to generate criminal activities (Trilling, 2016, September 23). Proponents also argue that legalization would have a crime-reducing effect because the police would be able to re-allocate resources and efforts to more serious crimes rather than focusing on marijuana possession arrests, which would in turn lead to increased crime clearance rates and deterrence effects (Makin et al., 2019). Despite these competing views about the impact of recreational marijuana legalization on crime and public safety, empirical studies using rigorous methodologies to examine this issue are few, yielding mixed results. While there is some evidence suggesting recreational marijuana dispensaries are associated with substantial increases in crime rates and disorder at the neighborhood level (Hughes, Schaible, & Jimmerson, 2019), other studies have either demonstrated a crime-reducing effect from marijuana legalization or the operation of marijuana dispensaries (Brinkman & Mok-Lamme, 2019; Dragone, Prarolo, Vanin, & Zanella, 2019; Wu, Boateng, & Lang, 2020) or found little to no impact of legalization on crime (Lu et al., 2019). Given the public concern about legalization's impact on crime, more studies based on rigorous research designs are needed to further examine the implications of recreational marijuana legalization for public safety.

The available limited prior studies on this issue have predominantly

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focused on Colorado and/or Washington State—the two states that first legalized recreational marijuana in the U.S. This is reasonable considering that an examination of a relatively longer post-legalization period would be helpful for revealing the prospective effects of legalization on such outcome variables related to public safety as crime rates and crime clearance rates. However, given that more states have legalized following Colorado and Washington State, and some of them have also implemented their recreational marijuana laws for a few years, it is now necessary to expand the examination to other states. For instance, although six years have passed since the passage of the recreational marijuana law (RML) in late 2014 in Oregon, it is difficult to find studies examining how legalization has affected crime in this state.

In effect, the impact of marijuana legalization on crime may vary across legalized states based on differential marijuana-related laws and regulations. For instance, although Colorado (CO), Washington State (WA), and Oregon (OR) have overall legalized marijuana for recreational purposes including production, possession, and sale, these three states differ in certain important aspects associated with the regulation of recreational marijuana. Specifically, for example, while CO and OR allow their residents over 21 to grow several marijuana plants for personal recreational use, it remains illegal in WA to grow recreational marijuana on private property for personal use. Also, these states differ in terms of the amount of marijuana concentrates that people can purchase—the maximum limits for CO, OR, and WA are 8 g, 7 g, and 5 g, respectively. Given these variations in marijuana-related policies across the legalized states, it is worthwhile to extend this line of research and examine how recreational marijuana legalization affects crime in states that have recently legalized marijuana such as Oregon. Moreover, prior relevant research has usually focused on a certain city or specific areas, which may limit generalizability of their findings (Brinkman & Mok-Lamme, 2019; Hao & Cowan, 2020; Hughes et al., 2019). It would be more informative to policy makers and the public to examine large geographical areas within a legalized state, thus examining the impact of recreational marijuana legalization on public safety for an entire state.

This study intends to address these important knowledge gaps. Specifically, it is a large-scale study using county-level Uniform Crime Report data that examines changes in rates of a wide range of serious crimes, including violent crime, property crime, robbery, aggravated assault, larceny, motor-vehicle theft, and burglary, in Oregon, relative to the 19 states¹ that have not legalized marijuana for recreational or medical purposes (until 2017). In addition, as a robustness check of the results, we have also conducted analyses using a control group consisting of five states² in which only medical marijuana is legal during the study period. This study not only offers an extended period of observation spanning from 2007 to 2017, but also involves analyses of crime data for all counties in the 25 states examined.

2. Perspectives on the relevance of marijuana legalization to crime

Although there seems to be a trend toward marijuana legalization, as manifested by the majority of U.S. states that have legalized medical marijuana and the increasing number of states legalizing recreational marijuana, the issue still generates controversy (Freisthler, Gaidus, Tam, Ponicki, & Gruenewald, 2017). As mentioned above, opposing perspectives exist regarding legalization's implications for public safety, and, central to this discussion, is its impact on crime. This is not surprising given the longstanding perceptions about the connection between drugs, especially illicit drugs, and crime (Allen, 2005). Those

against marijuana legalization emphasize its potential adverse repercussions on crime, and make several arguments: First, marijuana is a “gateway” drug, and its increased availability and accessibility as a result of legalization would lead to an increase in not only the use of marijuana, but also the use of more serious drugs such as heroin and cocaine (Secades-Villa, Garcia-Rodríguez, Jin, Wang, & Blanco, 2015; Williams, 2020), although evidence on the gateway sequence is mixed and dynamics underlying the sequence are not well understood.³ This means there would be more illicit drug users who may need to commit crimes to finance their substance use (Morris, TenEyck, Barnes, & Kovandzic, 2014). Second, marijuana use impairs individuals' cognitive functions. Specifically, marijuana use may increase violent behavior, not only because cannabis intoxication may negatively affect individuals' cognitive abilities and reduce their self-control (Howard & Menkes, 2007), but also because marijuana users tend to have a lifestyle involving more tolerance for deviance and greater willingness to take risks compared to non-users (Goode, 2008). In a similar vein, legalization would increase rates of driving under the influence of marijuana (Bedard, 2019, June 25). Third, there is also a concern about the criminogenic effects of marijuana retail outlets. As marijuana use is still illegal at the federal level, marijuana retailers largely cannot use financial institutions and, thus, primarily rely on cash sales. Given that the business is cash-based, marijuana dispensaries and customers (who need to carry large amounts of cash to buy marijuana) are likely to be the targets of property and violent crimes such as burglary and robbery (Freisthler et al., 2017; Hughes et al., 2019). Community members and police officials have additional concerns that marijuana dispensaries may have deleterious social and cultural effects on neighborhoods where these dispensaries operate and, as a result, may increase crime (Freisthler et al., 2017).

However, from the perspectives of legalization supporters, marijuana legalization would reduce crime rather than the opposite. Specifically, the proponents of marijuana legalization argue that legalization would decrease crime in several ways. First, the legalization of marijuana for recreational purposes itself would decriminalize the activities associated with possession, production, and retail sale of marijuana, which, as a result, would reduce crime (McCall, 2019, October 8). Second, marijuana legalization would influence police allocation of resources and efforts in a way that may increase police effectiveness in dealing with more serious crimes (Makin et al., 2019). That is, without the need to focus on marijuana possession arrests after legalization, the police could reallocate their resources, both human and material, to more serious violent and property crimes, and this resource reallocation would arguably improve crime clearance rates and strengthen crime deterrent effects. Third, a diminished underground marijuana market likely parallels marijuana legalization (Gettman & Kennedy, 2014). Given the well-established connection between the black drug market and crime, a shrinking black marijuana market as a

³ It needs to be noted that the gateway hypothesis has been subjected to criticism. For instance, as Van Gundy and Rebellon (2010) noted, although there existed substantial evidence suggesting a temporal order and an association between the use of so-called “gateway” drugs such as marijuana and the use of “hard” substances such as heroin or cocaine, the causal link between marijuana use and other illicit drug use has not been well-established—research has typically failed to eliminate rival explanations. According to Van Gundy and Rebellon (2010), the observed association between early marijuana use and the subsequent use of other illicit drugs may be “due to common sources such as genetic predisposition, family environment, or social contextual factors” (p. 244). In a more recent marijuana research report by the National Institute on Drug Abuse (NIDA, 2020), it was reported that most people who used marijuana did not go on to use other harder illicit drugs. In addition, scholars have also pointed out that the gateway hypothesis may need to be abandoned because of its oversimplification of the dynamics associated with drug progression (Arnold & Sade, 2020). As Secades-Villa et al. (2015) noted, the dynamics of progression from marijuana to other illicit substances was still largely unknown.

¹ These 19 states are: Alabama, Georgia, Idaho, Indianan, Iowa, Kansas, Kentucky, Mississippi, Nebraska, North Carolina, Oklahoma, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Wisconsin, and Wyoming.

² These five states are: Hawaii, Montana, New Mexico, Rhode Island, and Vermont.

result of legalization means a reduction in crime, especially violent crime.

3. Empirical evidence on the impact of marijuana legalization on crime

In the last two decades, there has been growing scholarly attention paid to the impact of marijuana legalization on crime (Brinkman & Mok-Lamme, 2019; Chu & Townsend, 2019; Contreras, 2016; Dragone et al., 2019; Freisthler et al., 2017; Freisthler, Ponicki, Gaidus, & Gruenewald, 2016; Kepple & Freisthler, 2012; Hao & Cowan, 2020; Hughes et al., 2019; Lu et al., 2019; Makin et al., 2019; Morris et al., 2014; Shepard & Blackley, 2016; Wu et al., 2020). Given that the legalization of marijuana for recreational purposes is still a relatively recent phenomenon, previous scholarly efforts have predominantly focused on medical marijuana legalization (Chu & Townsend, 2019; Contreras, 2016; Freisthler et al., 2017; Freisthler et al., 2016; Kepple & Freisthler, 2012; Morris et al., 2014; Shepard & Blackley, 2016). Studies examining the impact of recreational marijuana legalization, although increasing, remain few (Brinkman & Mok-Lamme, 2019; Hao & Cowan, 2020; Hughes et al., 2019; Lu et al., 2019; Stohr et al., 2020). A review of the extant literature suggests that research findings related to the effects of medical marijuana legalization on crime are mixed and inconclusive (Chu & Townsend, 2019; Hughes et al., 2019). This is also true for the results of the limited number of studies examining the effects of recreational marijuana legalization. In other words, the available evidence does not show clear and consistent patterns in changes of different forms of crimes within the context of marijuana legalization.

3.1. Effects of medical marijuana legalization on crime

Scholars have examined the impact of medical marijuana legalization on crime at the national (Chu & Townsend, 2019), state (Morris et al., 2014; Shepard & Blackley, 2016), and neighborhood (Contreras, 2017; Freisthler et al., 2016; Freisthler et al., 2017; Kepple & Freisthler, 2012) levels. Some studies found that the legalization of medical marijuana either had no effect on crime rates or reduced rates of certain types of crimes (Chu & Townsend, 2019; Gavrilova, Kamada, & Zoutman, 2017; Morris et al., 2014; Shepard & Blackley, 2016), while other studies, especially those conducted at the neighborhood level, have demonstrated a crime-exacerbating effect of medical marijuana legalization or the placement of medical marijuana dispensaries (Contreras, 2017; Freisthler et al., 2017; Freisthler et al., 2016; Holmes, 2014). For instance, using U.S. state panel data, Morris et al. (2014) found no evidence that medical marijuana laws (MML) increased rates of homicide, rape, robbery, assault, burglary, larceny, and auto theft—the most serious offenses as classified by the FBI. Interestingly, this study showed a possible crime-reducing effect of MML for homicide and assault. A recent study by Gavrilova et al. (2017) focusing on U.S.-Mexico border areas also found that MML decreased violent crime in states that border Mexico. Similarly, using data from 11 states in the Western United States, Shepard and Blackley (2016) found no exacerbating effect of medical marijuana laws on property and violent crimes. Rather, their results suggest a substantial reduction in rates of violent crime in states that have legalized medical marijuana.

Notwithstanding these studies suggesting a null effect or a crime-reducing effect of medical marijuana legalization, there is some evidence showing crime rates do increase following legalization at the state level, or with the increasing density of medical marijuana dispensaries at the neighborhood level. For example, based on the FBI's Uniform Crime Report (UCR) data, Holmes (2014) found that legalizing medical marijuana from 2000 to 2010 led to an increase in rates of both violent and property crime, though no such increase in crime rates was detected for the period of 1995–2010. In examining the relationship between the density of marijuana dispensaries and crime, Freisthler et al. (2016) observed a differential effect of the density of medical marijuana

dispensaries on crime between local and adjacent areas. Specifically, they found that, although density of medical marijuana dispensaries did not influence violent and property crime in local areas, it was indeed positively correlated with the rate of violent crime in spatially adjacent areas. In line with the research focusing on the effects of medical marijuana dispensaries, Contreras (2017) found that medical marijuana dispensaries might be criminogenic in that the placement of these dispensaries was associated with an increase in multiple types of crimes, including violent crime, homicide, robbery, aggravated assault, larceny, and motor vehicle theft.

Scholars have also examined the impact of medical marijuana laws on adolescent marijuana use, other drug use, and traffic crashes (Anderson, Hansen, & Rees, 2013; Anderson, Hansen, Rees, & Sabia, 2019; Chu, 2015; Cook, Leung, & Smith, 2020). While it was proposed that MMLs may increase adolescent use due to increased social acceptance, availability and accessibility (Hopfer, 2014), evidence on this issue is mixed. For example, using National Survey on Drug Use and Health data from 2003 to 2011, Schuermeyer et al. (2014) found that medical marijuana legalization in Colorado was associated with a decrease in adolescent perceptions of marijuana risk in the state. By contrast, Chu (2015) found that although MML was associated with an increase in marijuana consumption it did not lead to an increase in cocaine and heroin usage. In addition, Anderson et al. (2019) detected no increases in marijuana use among youth after medical marijuana legalization. In terms of the impact of MML on traffic fatalities, Anderson et al. (2013) observed that legalization reduced traffic fatalities by 8–11%. Similarly, in a more recent study, Cook et al. (2020) found that MML had a negative effect on fatal traffic crashes for both males and females.

3.2. Effects of recreational marijuana legalization on crime

Studies examining the impact of recreational marijuana legalization on crime are few, despite a growing scholarly interest in this issue. However, several relevant studies deserve noting (Brinkman & Mok-Lamme, 2019; Dragone et al., 2019; Freisthler et al., 2017; Hao & Cowan, 2020; Hughes et al., 2019; Lu et al., 2019; Makin et al., 2019). Some scholars observed that legalization of marijuana for recreational purposes increased crime rates, especially when considered at the neighborhood level (Freisthler et al., 2017; Hughes et al., 2019). For instance, in examining the impact of the density of marijuana outlets in Denver, Colorado on crime, Freisthler et al. (2017), based on observations of over 16,000 space-time units, found that the density of recreational marijuana dispensaries was positively associated with the rate of property crime in spatially adjacent areas over time, though the effect was not detected for local areas where the dispensaries operated. Similarly, in another study also focusing on cannabis effects at the neighborhood level in Denver, Hughes et al. (2019) found that the placement of recreational marijuana dispensaries was linked to significant increases in rates of crime and disorder at the neighborhood level, and this was also true for the presence of medical marijuana dispensaries. A more recent study by Hao and Cowan (2020) specifically examined the spillover effect of recreational marijuana legalization in Colorado and Washington State on neighboring states, and found that border counties of neighboring states had experienced a substantial increase in marijuana possession arrests relative to non-border counties in these states.

In contrast to these studies showing a positive relationship between recreational marijuana legalization or the density/presence of marijuana outlets and crime, there exists research suggesting a crime-reducing effect of recreational marijuana legalization. For example, emphasizing the impact of marijuana legalization on neighborhood crime, Brinkman and Mok-Lamme (2019) found that the placement of an additional dispensary in a neighborhood was associated with a significant reduction in crime rate in the local area, while such a reduction was not observed for spatially adjacent neighborhoods. Another study

by Dragone et al. (2019) found that the legalization of marijuana for recreational use led to a significant decrease in property crimes and rapes on the Washington side of the border relative to the Oregon side, when comparing the crime rates between pre-legalization (2010–2012) and post-legalization (2013–2014) periods (Washington State legalized in 2012). A more recent study by Wu and his colleagues (2020) with a focus on the spillover effect of legalization has revealed that recreational marijuana legalization in Colorado resulted in significant reduction in property crime and larceny in the border counties of neighboring states (Wu et al., 2020). In addition, scholars also examined the effect of legalization on crime clearance rates and found that marijuana legalization in Colorado and Washington State increased the clearance rates of certain types of crime, and the positive effects were more pronounced for Colorado (Makin et al., 2019).

It is worth noting that recreational marijuana legalization has significant economic implications within communities and legalizing states. For example, a growing cannabis industry post-legalization resulted in job growth and opportunities for businesses throughout the supply chain from grower to retailer (Cheng, Mayer, & Mayer, 2018). Available data suggest that marijuana sales and associated tax revenues continue to increase in Washington State. In 2019, aggregate marijuana tax revenues in Washington were approximately \$395.5 million (including about \$390.4 million from cannabis sales taxes and \$5.2 million from licensing fees). Moreover, these tax revenues were \$172 million more than that of from liquor sales (Washington State Liquor and Cannabis Board, 2019). Since 2014 when retail sales of recreational marijuana began in the State of Colorado, total state revenue from the legal marijuana industry surpassed \$1 billion by mid-2019 (Rosenbaum, 2019, June 13). As Cheng et al. (2018, p. 1588) has noted, municipal and county governments also significantly benefited from the increased tax revenues from marijuana legalization. Additionally, as discussed earlier, legalization may result in more cost-effective law enforcement if resources are re-allocated to more serious crimes rather than marijuana possession arrests (Makin et al., 2019). However, it has also been argued that the economic costs to society as a result of legalization may far outweigh the potential tax revenues generated (Rocky Mountain HIDTA, 2017), because of legalization's adverse effects on public health and public safety (e.g., potential increases in marijuana-related hospitalizations, emergency room visits, and marijuana-related impaired driving) and possibly overall human development. As mentioned previously, marijuana businesses in local communities may have an exacerbating effect on crimes in these communities as they provide attractive targets (e.g., cash-based businesses) for potential criminals.

Taken together, theoretical perspectives on the impact of recreational marijuana legalization on crime are ambiguous and empirical research has yielded mixed and inconclusive results. Given the very limited scholarly efforts made toward this issue, more research is needed to further examine the extent to which recreational marijuana legalization has affected crime and the nature of the relationship.

4. Methods

4.1. Data

As the purpose of this study is to explore the potential effects of recreational marijuana legalization on crime in Oregon counties, and this examination involves the comparison of crime trends between Oregon and the 19 states that have not legalized marijuana for recreational or medical purposes, we used county-level crime data for Oregon and these non-legalized states. In addition, as a robustness check of the results, we also used county-level crime data for the five medical marijuana-only states (Hawaii, Montana, New Mexico, Rhode Island, and Vermont) and compared crime trends between Oregon and these five states. Specifically, crime data for this study was based on the FBI's Uniform Crime Report for the period of 2007–2017, which we obtained from the Institute for Social Research at the University of Michigan

(ICPSR) website. The UCR data contain crime information on most serious violent and property crimes, classified by FBI as Part I crimes including robbery, aggravated assault, burglary, larceny, and motor vehicle theft, for all counties in the states of interest. In cases where police agencies in certain counties did not report complete crime data, crime numbers for these agencies were imputed based on crime reported in other months by that agency and crimes in comparable jurisdictions in the month(s) of missing data. Accordingly, a coverage indicator (CI, ranging from 0 to 100) was provided for each county showing the extent of the coverage gap, with a high CI meaning a high coverage for that county.⁴ For the data, the mean CI is 84.1. Counties with CIs greater than 80 account for 78.7% of all the counties included in the dataset, and counties with CIs greater than 90 account for 73.6%, suggesting a high overall level of completeness in the crime data. The presence of crime information for all counties in the states being examined allows examination of the legalization effect on a larger scale. To ensure the results were based on high-quality data, we used a high value of coverage indicator (≥ 80) for analysis.⁵

County-level characteristics were also considered in this study as covariates, including county population size, percent below federal poverty level, median annual household income in dollars, and annual unemployment rate. Although synthetic control method, as that was used in the current study, was regarded as a useful analysis tool that “helps control for unobserved factors and for the heterogeneity of the effect of the observed and unobserved factors on the outcome of interest (Abadie, Diamond, & Hainmueller, 2015, p. 498)”, the inclusion of these covariates was able to address their potential effects more directly. In effect, county poverty level, median household income, and unemployment rates reflect county economic conditions, which have been found to have a significant influence on crime (Hooghe, Vanhoutte, Hardyns, & Bircan, 2010; Patterson, 1991; Sampson & Groves, 1989). According to social disorganization theory, poor economic conditions, as reflected by high income inequality, unemployment rates, and poverty levels, were indicators of social ills that would weaken informal social control and, as a result, increase crime (Shaw & McKay, 1942). Data for these three variables pertaining to county economic conditions come from two sources. Specifically, data on county poverty level and median household income were obtained from the U.S. Census Bureau's Small Area Income and Poverty Estimates from 2007 to 2017. Data on county annual unemployment rates come from the Local Area Unemployment Statistics provided by the U.S. Department of Labor's Bureau of Labor Statistics. Data about county population levels for each year from 2007 to 2017 were available in the main data set containing crime information that we acquired from the ICPSR website.

Table 1 presents the descriptive statistics for the full sample, counties in Oregon, and counties in the 19 non-legalized states, respectively. Given that Oregon passed the recreational marijuana law in November 2014, the entire observation period (2007–2017) was divided into a pre-legalization period of 2007–2014 and a post-legalization period of 2015–2017. As Table 1 shows, the full sample overall displays a downward trend in the rates of property-related crimes, as manifested by the lower averages in the rates of property crime, burglary, larceny, and auto theft in the post-legalization period than those in the pre-legalization period. This downward trend in property-related crimes as observed in the sample is in line with the national trend in that property

⁴ A detailed description of the imputation method can be found in the Uniform Crime Reporting Program Resource Guide, National Archive of Criminal Justice Data (NACJD) (https://www.icpsr.umich.edu/web/pages/NA_CJD/guides/ucr.html).

⁵ In order to check the robustness of the results, we have also run separate models using CI greater than 50, and with no restrictions to CI values. Results based on these additional CI values overall align with the primary results associated with CI greater than 80, which were presented in the Appendix Tables A1 and A2.

Table 1
Summary Statistics for Full Sample, Counties in Oregon (OR), and Counties in the Non-legalized States.

	Full Sample			Counties in Oregon			Counties in Non-leg. States		
	N	M	SD	N	M	SD	N	M	SD
2007–2017									
Violent Crime Rate	16,416	260.25	214.35	316	199.79	22.44	16,100	261.43	215.69
Property Crime Rate	16,416	2174.74	1307.99	316	2636.52	126.67	16,100	2165.67	1313.07
Robbery Rate	16,416	35.40	52.75	316	29.17	3.32	16,100	35.53	53.08
Aggravated Assault Rate	16,416	193.22	171.76	316	139.63	19.01	16,100	194.27	172.83
Burglary Rate	16,416	553.72	378.50	316	500.11	50.25	16,100	554.77	381.28
Larceny Rate	16,416	1491.40	945.40	316	1951.16	82.97	16,100	1482.38	947.51
Auto Theft Rate	16,416	129.60	107.99	316	184.71	33.19	16,100	128.52	107.12
2007–2014									
Violent Crime Rate	12,015	260.99	218.62	239	193.23	118.31	11,776	262.36	219.97
Property Crime Rate	12,015	2281.03	1369.90	239	2676.54	909.67	11,776	2273.00	1376.50
Robbery Rate	12,015	37.06	55.45	239	30.02	32.28	11,776	37.20	55.81
Aggravated Assault Rate	12,015	194.01	174.34	239	134.66	92.84	11,776	195.22	175.40
Burglary Rate	12,015	592.86	400.30	239	523.27	182.88	11,776	594.27	403.38
Larceny Rate	12,015	1557.41	986.42	239	1978.74	691.13	11,776	1548.86	989.66
Auto Theft Rate	12,015	130.68	111.29	239	174.03	124.54	11,776	129.80	110.84
2015–2017									
Violent Crime Rate	4401	258.23	202.21	77	220.17	93.66	4324	258.91	203.56
Property Crime Rate	4401	1884.56	1069.34	77	2512.29	881.80	4324	1873.38	1069.13
Robbery Rate	4401	30.88	44.23	77	26.51	24.85	4324	30.96	44.49
Aggravated Assault Rate	4401	191.06	164.52	77	155.06	75.23	4324	191.70	165.61
Burglary Rate	4401	446.88	285.21	77	428.20	157.21	4324	447.21	286.97
Larceny Rate	4401	1311.21	795.78	77	1865.55	684.71	4324	1301.34	794.19
Auto Theft Rate	4401	126.64	98.39	77	217.87	159.37	4324	125.02	96.21

M, Mean annual number of crimes per 100,000 population; SD, Standard Deviation.

crime offenses in the U.S. have continued to decrease in the last decade (FBI, 2019). Specific to the sample, the average number of property crimes (per 100,000 population) for the entire period for the full sample is 2175, with an average of 2281 before legalization (2007–2014), and 1884 after legalization (2015–2017). This overall downward trend in property-related crimes for the full sample was also reflected by declining rates in property crime, burglary, and larceny in counties in OR and those in non-legalized states. However, it is noteworthy that the rates of these crime types seem to decrease faster in counties of the 19 states that have not legalized than those in OR. For example, the average number of property crime for counties in OR in the pre-legalization period was 2677 (per 100,000 population), and 2512 (per 100,000 population) in the post-legalization period, suggesting a decline of 165 cases on average. In contrast, for counties in the non-legalized states, the cases of property crime on average have decreased by 400 (before legalization: 2273; after legalization: 1873), which was a much bigger decline than that of counties in OR. Similar patterns were also shown for burglary (a decrease of 95 for counties in OR vs. a decrease of 147 for counties in the non-legalized states) and larceny (a decrease of 113 for counties in OR vs. a decrease of 248 for counties in the non-legalized states). Regarding auto theft rates, the differential changes in OR and the non-legalized states were similarly large – although counties in OR experienced an increase of 44 cases of auto theft (per 100,000 population) on average after legalization, those in the non-legalized states have seen a decrease of 5 cases (per 100,000 population) on average after legalization.

For violent crimes, we can also see some differences in changes in the rates of aggravated assault and violent crime in general associated with legalization between counties in OR and those in the non-legalized states. For example, while the average number of overall violent crimes has increased by 27 (per 100,000 population) after legalization (before legalization: 193; after legalization: 220) in counties in OR, it has decreased by 3 (per 100,000 population) in those in the non-legalized states (before legalization: 262; after legalization: 259). For aggravated assault, in contrast to the situation in counties in OR that has seen an average increase of 20 cases (per 100,000 population) after legalization (pre-legalization period: 135; post-legalization period: 155), those in the non-legalized states has experienced a decrease of 4

cases on average after legalization (pre-legalization period: 195; post legalization period: 191).

4.2. Estimation strategy

We used Difference in Differences (DID) linear probability regression to examine the impact of recreational marijuana legalization on rates of different types of crime. Essentially, this method relies upon observations collected from two groups (treatment group and control group) differentiated by the exposure factor (i.e., legalization) within two time periods (pre-treatment period and post-treatment period). The treatment group is the one that is subjected to the treatment in the second period (post-treatment period), while the control group is the one that is not exposed to the treatment during both periods. As Li et al. (2012) further explained, “in the case where the same units within a group are observed in each time period, the average gain over time in the non-exposed (control) group is extracted from the gain over time in the exposed (treatment) group. This double differencing, the so-called ‘difference in difference’ method, removes biases in the second period comparison between the treatment and control groups that could be the result from permanent differences between those groups, as well as biases from comparison over time in the treatment group that could be the result of time trends unrelated to the treatment” (p. 368).

In the last few decades, the DID method has served as an effective tool for researchers to assess policy impacts. As a quasi-experimental research design that considers pre- and post-treatment periods with the addition of a control group, the DID model accounts for changes due to factors other than treatment, and therefore allows researchers to estimate causal relationships (Meyer, 1995). For the current study, DID is an appropriate modelling strategy given the longitudinal nature of the data that can be divided into a pre-treatment period (2007–2014) and a post-treatment period (2015–2017) for the treatment group (counties in OR that legalized recreational marijuana) and the control group (counties in the states that have not legalized either recreational or medical marijuana), and our intention to examine if legalization has led to substantial changes in the rates of a variety of crimes in the legalized state – OR relative to the non-legalized states.

Using the DID approach, the outcome Y_{it} is modeled by the following

equation:

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

where Y_{it} (the dependent variable) represents the rates of different types of crimes including violent crime, property crime, robbery, aggravated assault, simple assault, burglary, larceny, and motor vehicle theft) in county i of state s in year t , α is the constant, β is the specific group effect, γ is the time trend, and δ is the difference-in-differences estimator which estimates the policy impact on crime rates. DT_{it} is an indicator variable for the group-specific component, coded as 1 if Y_{it} is an observation from the treatment group (counties in OR) or 0 otherwise. DP_{it} is the dummy variable for the time-specific component, which is 1 if the observation is from the post-treatment (legalization) period and 0 otherwise. X_{it} is a vector of observed county-level characteristics including county population, poverty level, median household income, and unemployment rate. ε_{it} is an error term.

4.3. Measures

The outcome variables are rates of a variety of crimes including violent crime, property crime, robbery, aggravated assault, burglary, larceny, and motor vehicle theft. The rate for each crime type is measured per 100,000 people. The treatment indicator is defined on an annual basis, and measures exposure to recreational marijuana legalization. It was dichotomously coded as 0 = not exposed and 1 = exposed for that year. As previously mentioned, four county-level characteristics were included in the study as control variables: county population, poverty level, median household income, and unemployment rate. Poverty level is a continuous variable measured by the percentage of the county population of all ages living below the federal poverty line. Unemployment rate only considers county residents who are in the labor force, and is a continuous variable measured by the percentage of the county population in the labor force who were unemployed.

5. Findings

Table 2 presents the effects of marijuana legalization on specific crime rates in Oregon using the control group of 19 non-legalized states. As it shows, recreational marijuana legalization in OR has led to significant increases in the rates of not only property crime overall ($p = .021$), but also subtypes of crimes such as burglary ($p = .020$) and motor vehicle theft ($p = .000$) in the state, relative to the non-legalized states following legalization in OR. In addition, an increase, having marginally statistical significance, has been observed for violent crime in general ($p = .057$) and two subtypes of crimes including aggravated assault ($p = .066$) and larceny ($p = .079$).

Specifically, on average, following legalization, Oregon experienced an increase of 365.4 cases of property crime (per 100,000 population) relative to the non-legalized states, and an increase of 103.6 cases of burglary, 56.2 cases of motor vehicle theft, 49.4 cases of violent crime, 39.4 cases of aggravated assault, and 205.3 cases of larceny per 100,000 population relative to the non-legalized states. As Table 2 shows, for the seven crime types considered, we found significant or marginally significant increases for six of them in Oregon following legalization, relative to the non-legalized states. Therefore, the results overall suggest a crime-exacerbating effect of recreational marijuana legalization. These results also find their support from the analyses based on other levels of coverage indicator (see Appendix Tables A1 and A2). In fact, as Appendix Table A2 shows, when all counties in the states of interest were included in the analysis, Oregon has experienced significant or marginally significant (only for robbery rate) increases in the rates for all these seven types of crimes examined.

In addition, we also examined the short-term retail sales effect using the control group consisting of 19 non-legalized states. The retail sales of recreational marijuana in Oregon began on October 1, 2015. The

operation of recreational marijuana dispensaries increases availability and accessibility of recreational marijuana, and may have a more direct impact on the underground marijuana market, all of which may affect crime in the legalized state. In the examination of the potential retail sales effect, we used the pre-sales period of 2007–2014 and post-sales period of 2016–2017. We omitted the year of 2015 to isolate the potential legalization effect. The results about the retail sales effect were overall consistent with the legalization effects (see Appendix Table A3), although the effects on the rates of aggravated assault and larceny have reduced to be non-significant (they were “marginally significant” in the primary results associated with legalization effects).

5.1. Robustness check

We used a synthetic control design as a robustness check on whether counties in the 19 non-legalized states serve as an appropriate control group for counties in OR in our DID analyses. This check is necessary given that the DID framework relies upon the parallel trend assumption requiring that, in the absence of treatment, the “treatment” group would have experienced similar changes in the outcome of interest as the average of the “control” group. That is, specific to the current study, if counties in OR and those in the non-legalized states had different trends in the crime rates considered in the pre-legalization period, it would call into question whether recreational marijuana legalization is, in fact, responsible for our results. The synthetic control method, developed by Abadie and his colleagues (Abadie, Diamond, & Hainmueller, 2010; Abadie & Gardeazabal, 2003), addresses this concern by constructing a control group as a weighted average of non-treatment units where weights are chosen to best approximate the treated unit in the pre-treatment period. As Powell (2018, p.2.) noted, “while an unweighted average of other units may not be an appropriate control, a subset of units with non-uniform weights may provide a proper counterfactual. A major benefit of this approach is that it allows for estimation of a specification with interactive fixed effects which nests more traditional additive fixed effects models.” We applied synthetic control design to the six crime types that were found to be significantly or marginally significantly affected by the legalization of recreational marijuana in OR, namely: property crime, burglary, auto theft, violent crime, aggravated assault, and larceny. The “donor pool” consists of counties in the 19 non-legalized states.

Using the approach provided by Abadie et al. (2010), we created the synthetic control region that best produces the values of predictors for each outcome variable of interest (crime rates for the six crime types) in the pre-treatment/pre-legalization period. Specifically, the predictors for each outcome variable include the corresponding crime rates for the years in the pre-treatment period.⁶ We estimated the effects of recreational marijuana legalization on the outcome variables as the difference in each outcome variable between the treated region (counties in OR) and its synthetic versions in the years after recreational marijuana was legalized in OR. Fig. 1 displays the trends in the rates of property crime (Fig. 1A), burglary (Fig. 1B), auto theft (Fig. 1C), violent crime (Fig. 1D), aggravated assault (Fig. 1E), and larceny (Fig. 1F) for counties in OR and the synthetic control region. As these graphs show, the synthetic control region very closely tracks the pre-treatment trajectory of each outcome variable in treated counties (counties in OR). For these six outcomes, the two lines begin to diverge noticeably immediately after treatment/legalization. Specifically, the post-treatment trend lines for counties in OR are higher than those for the synthetic control counterparts,

⁶ Given that the outcome variables may also be influenced by other factors related to county characteristics, we have also estimated models with the addition of such predictors as county population, poverty level, median household income, and unemployment rate. The inclusion of these additional predictors yielded synthetic control groups that were very similar to those used in the paper.

Table 2
The Effects of Recreational Marijuana Legalization on Crime in Oregon (control group: 19 non-legalized states; 2007–2017).

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
<i>Legalization</i>	49.435 [†] (25.994)	365.404* (158.141)	6.961 (5.795)	39.426 [†] (21.423)	103.572* (44.583)	205.324 [†] (116.856)	56.182*** (12.728)
<i>N</i>	16,416	16,416	16,416	16,416	16,416	16,416	16,416
<i>R</i> ²	0.161	0.166	0.311	0.113	0.209	0.129	0.208
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

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

The covariates included in the models are county population, county poverty level, county employment rate, and county median household income.

[†] $p \leq .1$.

* $p \leq .05$.

*** $p \leq .001$.

suggesting substantially higher rates of property crime, burglary, auto theft, violent crime, aggravated assault, and larceny in counties in OR following legalization relative to the synthetic controls. The results obtained through the synthetic control method provide further support for those based on the DID analyses.

As an additional effort to check the robustness of the results based on the comparison between Oregon counties and counties in the 19 states that have not legalized either form of marijuana (medical or recreational), we also conducted DID analyses based on a control group consisting of five states in which only medical marijuana was legal during the period of 2007–2017. As mentioned previously, these five states are: Hawaii, Montana, New Mexico, Rhode Island, and Vermont. As Table 3 shows, the results based on this control group comprising medical marijuana-only states were substantively similar to the those that we obtained using the control group of 19 non-legalized states (that have not legalized marijuana for recreational or medical marijuana). Specifically, consistent with the primary results based on the 19 non-legalized states, counties in Oregon were also found to have experienced significant increases in rates for the six crime categories – violent crime ($p = .020$), property crime ($p = .009$), aggravated assault ($p = .111$), burglary ($p = .027$), larceny ($p = .056$), and auto theft ($p = .020$) – following recreational marijuana legalization, relative to the five medical marijuana-only states. In addition, we examined the retail sales effect using the control group of the five medical marijuana-only states, and the results were largely similar to those obtained using the control group of the 19 non-legalized states as well (see Appendix Table A4).

6. Discussion

We used a rigorous quasi-experimental research design and county-level crime data to examine the impact of marijuana legalization on serious crimes as measured by the UCR in Oregon. We examined violent and property crime in general, and a set of specific crimes such as burglary, larceny, motor vehicle theft, robbery, and aggravated assault. Overall, the results reveal that legalization in Oregon has likely led to substantial increases in most crime types examined relative to states that have not legalized. Furthermore, our analysis suggests that legalization of retail sales of marijuana similarly resulted in an increase in property crimes. Our study provides evidence suggesting an exacerbating effect of recreational marijuana legalization on crime.

This finding challenges the notion that legalization would reduce crime due to factors such as the increased availability of more affordable recreational marijuana compared to pre-legalization (it has been argued that legalization would decrease the price of marijuana, see Hall & Lynskey, 2016a), demotivating marijuana users to resort to predatory crime to support their drug use, as well as increased crime deterrence as a result of police reallocation of resources away from possession arrests to the control of more serious crimes including property crime (Shepard & Blackley, 2007). In effect, it remains unclear how legalization affects

police resource allocation and the related potential deterrent effect, and the impact of marijuana price decreases, if any, may be complex and requires further scrutiny. It is likely that increased availability and affordability of marijuana in the context of legalization may lead to an increase in drug use, which may in turn motivate rather than demotivate drug users to commit predatory crime to support their habits (Cleveland & Wiebe, 2008). It is noteworthy that the findings of our study also contrasts with those from prior research that reported either a crime reducing effect or minimal to no effect of marijuana legalization on major crimes in Colorado and Washington State (for example, see Dragone et al., 2019; Lu et al., 2019). Given that some of these prior studies were also based on rigorous research designs, the inconsistent results concerning the impact of legalization seem to suggest that the impact of recreational marijuana legalization on crime may vary across states, perhaps due to differential state policy and law enforcement environments. As mentioned previously, although states such as CO, WA, and OR, have legalized marijuana for recreational purposes, there remain substantial differences across these states regarding specific policies regulating marijuana retail businesses and individuals' behaviors related to recreational marijuana. These inconsistencies in research findings further demonstrate the need to examine the implications of marijuana legalization to public safety for specific states in order to understand the relevance of differential policy contexts to the impact of marijuana legalization.

Despite competing views regarding the potential impact of marijuana legalization on crime, the results of our study reveal that recreational marijuana legalization increased serious crimes in Oregon relative to non-legalized states. This is not surprising given that scholars have commonly observed a positive link between the placement of marijuana dispensaries and neighborhood crime (Freisthler et al., 2017; Hughes et al., 2019). The findings of our study suggest that the criminogenic effect of marijuana legalization may also be reflected at the county or state level if the data used have a sufficient coverage of the geographical areas within the state of interest. In effect, one important reason that the proponents of legalization have offered about the expected crime-reducing effect of legalization was that a regulated marijuana market would diminish the underground marijuana market, which is associated with crime (Cohen & McGowan, 2012; Gettman & Kennedy, 2014). However, prior research suggests that legal marijuana may increase or maintain the size of illegal markets rather than the opposite – the illegal market for marijuana has persisted in the states that have legalized the drug (Fertig, 2019; Song, 2019; Stohr et al., 2020). Such developments associated with underground marijuana markets provide a context that helps explain why we did not observe a crime-reducing effect of legalization.

This study sheds light on the effects of recreational marijuana legalization on crime. However, it is not without limitations. First, although the most recent available data were used with the intent to have extended coverage of the post-legalization period, the post-

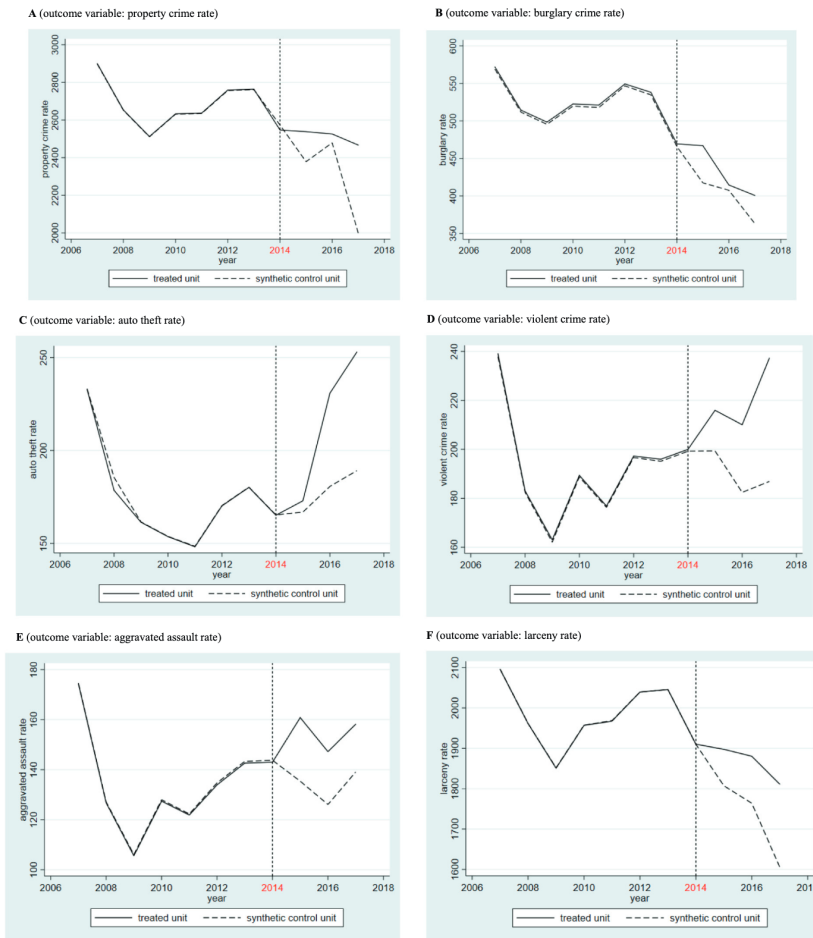


Fig. 1. The Effects of Recreational Marijuana Legalization on Crime in OR (Synthetic Control Method).

legalization periods for Oregon (2015–2017) is still relatively short. This issue is caused by the recency of the legalization year—late 2014. We acknowledge that observations based on a 3-year post-legalization period may be insufficient to identify the lagged effect of legalization on crime rates. Given this, the effects of legalization revealed in this study for Oregon are essentially short-term effects. Future research is suggested to continue the examination of the impact of legalization on crime when additional years of data are available. It is possible the magnitude of legalization effects varies across time. Second, notwithstanding the use of a quasi-experimental research design that helps identify the causal effect, this is just one study exploring the implications of legalization on crime. Therefore, we caution against over-interpretation of the results. Given the limited extant literature, more

research is needed to study the aggregate and contextual impact of recreational marijuana legalization on crime.

7. Conclusion

The results of this study provide evidence suggesting a crime-exacerbating effect of recreational marijuana legalization, manifested by substantial increases in a variety of major crimes as measured by the UCR in Oregon counties relative to non-legalized states following legalization. Given that the findings of this study are inconsistent with those obtained in some prior studies focusing on Colorado and Washington State, this suggests a need to examine legalization impact with consideration of the specific social and policy contexts within legalizing

Table 3

The Effects of Recreational Marijuana Legalization on Crime in Oregon (control group: five medical marijuana-only states; 2007–2017).

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
<i>Legalization</i>	131.536 ⁺ (56.445)	562.559 ⁺⁺ (214.294)	−0.493 (4.414)	112.114 [†] (70.236)	171.531 ⁺ (77.373)	354.708 [†] (185.320)	81.075 ⁺ (34.727)
<i>N</i>	1628	1628	1628	1628	1628	1628	1628
<i>R</i> ²	0.121	0.087	0.286	0.089	0.074	0.060	0.079
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. The control group consists of 5 states in which only medical marijuana were legal during the period of 2007–2017, namely, Hawaii, Montana, New Mexico, Rhode Island, and Vermont. Oregon's ballot Measure 91 (Legalizing recreational marijuana) was approved in November 2014 and took effect on July 1, 2015.

The covariates included in the models are county population, county poverty level, and county median household income.

[†] $p \leq .1$.

⁺ $p \leq .05$.

⁺⁺ $p \leq .01$.

states. Recognizing that the full effect of legalization on public safety may take years to manifest (Hall & Lynskey, 2016b), and that the effect may change over time as a function of the changing societal environment (i.e., the development of regulations related to marijuana), further

state-specific research is vitally needed on this issue in order to adequately examine how marijuana legalization affects public safety in the long term.

Appendix A. Appendix

Table A1The Effect of Recreational Marijuana Legalization on Crime in OR (coverage indicator ≥ 50 : control group: 19 non-legalized states)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
<i>Legalization</i>	47.148 [†] (25.729)	341.749 ⁺ (146.002)	7.473 (5.280)	37.959 [†] (21.667)	105.032 ⁺⁺ (41.454)	179.897 [†] (107.720)	56.903 ⁺⁺⁺ (11.707)
<i>N</i>	17,981	17,981	17,981	17,981	17,981	17,981	17,981
<i>R</i> ²	0.139	0.172	0.319	0.092	0.215	0.133	0.206
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. The covariates included in the models are county population, county poverty level, county employment rate, and county median household income.

[†] $p \leq .1$.

⁺ $p \leq .05$.

⁺⁺ $p \leq .01$.

⁺⁺⁺ $p \leq .001$.

Table A2

The Effect of Recreational Marijuana Legalization on Crime in OR (coverage indicator: no restrictions; control group: 19 non-legalized states)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
<i>Legalization</i>	81.079 ⁺⁺ (27.062)	534.827 ⁺⁺⁺ (146.919)	8.926 [†] (4.811)	64.280 ⁺⁺ (23.224)	157.090 ⁺⁺⁺ (46.781)	286.499 ⁺⁺ (102.946)	91.617 ⁺⁺⁺ (11.390)
<i>N</i>	19,712	19,712	19,712	19,712	19,712	19,712	19,712
<i>R</i> ²	0.134	0.165	0.318	0.093	0.198	0.130	0.191
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Legalization effect was examined based on the pre-legalization period of 2007–2014, and post-legalization period of 2015–2017. The covariates included in the models are county population, county poverty level, county employment rate, and county median household income.

[†] $p \leq .1$.

⁺⁺ $p \leq .01$.

⁺⁺⁺ $p \leq .001$.

Table A3

The Effects of Retail Sales on Specific Crime Rates in Oregon (control group: 19 non-legalized states; 2007–2017)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
<i>Legalization</i>	49.748 [†] (30.961)	380.982 ⁺ (188.454)	8.113 (6.901)	36.664 (25.545)	108.322 ⁺ (53.283)	199.862 (139.041)	72.557 ⁺⁺⁺ (15.174)
<i>N</i>	14,922	14,922	14,922	14,922	14,922	14,922	14,922

(continued on next page)

Table A3 (continued)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
R^2	0.162	0.167	0.312	0.114	0.210	0.129	0.209
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The retail sales effect was examined based on the pre-sales period of 2007–2014, and post-sales period of 2016–2017. Retail sales in Oregon began on October 1, 2015. The year of 2015 was omitted to isolate the potential legalization effect.

[†] $p \leq .1$.

^{*} $p \leq .05$.

^{***} $p \leq .001$.

Table A4

The Effects of Retail Sales on Specific Crime Rates in Oregon (control group: five medical marijuana-only states; 2007–2017)

	Violent Crime	Property Crime	Robbery	Aggravated Assault	Burglary	Larceny	Auto Theft
<i>Legalization</i>	142.104 [*] (67.571)	648.753 ^{**} (253.154)	−0.540 (5.175)	112.341 (83.568)	168.646 [†] (92.701)	382.555 [†] (221.016)	100.553 ^{**} (40.763)
<i>N</i>	1480	1480	1480	1480	1480	1480	1480
R^2	0.122	0.084	0.284	0.091	0.072	0.057	0.082
County Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The retail sales effect was examined based on the pre-sales period of 2007–2014, and post-sales period of 2016–2017. Retail sales in Oregon began on October 1, 2015. The year of 2015 was omitted to isolate the potential legalization effect.

[†] $p \leq .1$.

^{*} $p \leq .05$.

^{**} $p \leq .01$.

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