



Bryant University

HONORS THESIS

Does the Decriminalization and the Legalization of Recreational and Medical Marijuana Affect Crime Rates? A Panel Data Analysis of the New England States

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**Does the Decriminalization and the Legalization
of Recreational and Medical Marijuana Affect
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Bryant University Honors Program

Honors Thesis

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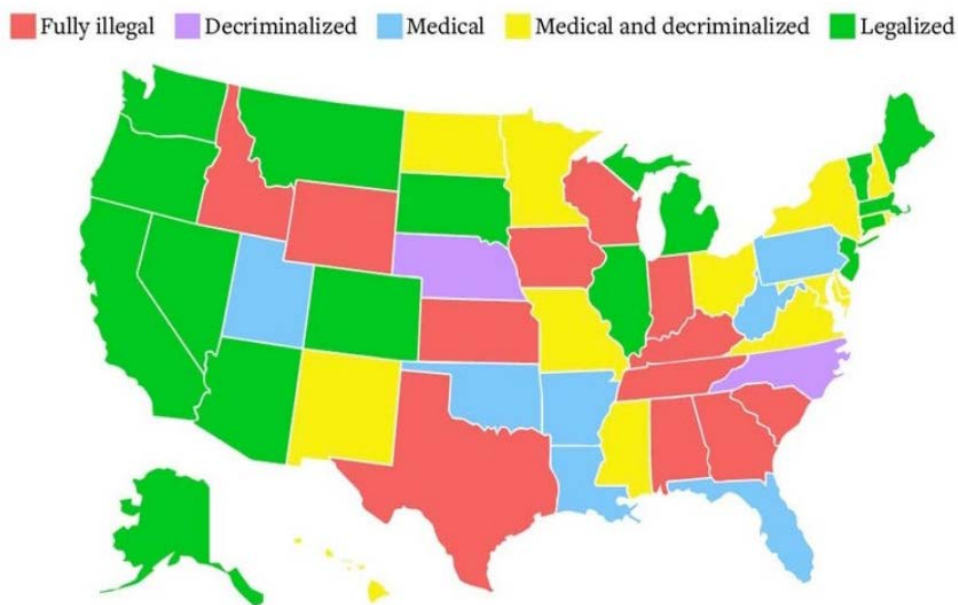
ABSTRACT

Marijuana laws and their impact is always a topic of controversy. The major marijuana laws are the legalization of recreational marijuana, the legalization of medical marijuana, and the decriminalization of marijuana. This paper looked at specifically their impacts on three types of crime rates: non-marijuana drug sale crime rates, non-marijuana drug possession crime rates, and non-drug crimes. This study used panel data for the six New England state from 2000-2019 and ran panel data regressions to determine the change of each type of crime rate from before to after each policy implemented. A total of nine regressions pairing each policy to each type of crime were run. The results were relatively consistent with the current expectations. The legalization recreationally resulted in a decrease in non-drug crimes, medical legalization did not have a significant effect on any crime and the decriminalization resulted in an increase of non-marijuana drug sale crime rates. The legalization of medical marijuana was shown to be insignificant to crime. The results provide insight into this issue but as it was only one region, this paper can provide another reference to the affects and aide policy makers when looking to implement these policies.

INTRODUCTION

The legal status of marijuana or cannabis is a topical, complex, and controversial issue in today's society. Although federal law in the United States prohibits the possession, use or sale of the substance, under the U.S. system of Federalism, there are three policies that state governments in the U.S. may put into place regarding cannabis. These policies are: (1) the legalization of medical marijuana; (2) the legalization of recreational marijuana; and (3) the decriminalization of marijuana. Figure 1 is a map that shows the current status of the recreational and medical marijuana policies across the United States. Each New England state has at least one of these policies in place, while some have two or all three. The three policies are ultimately the decisions of state lawmakers based on three major collateral damage factors associated with marijuana use: health, crime, and the economy.

Figure 1: Marijuana Laws in the United States



Source: Marijuana Policy Project

Figure 1 represents a map of the United States and is color-coded based on marijuana policy that has been enacted in each state. It is updated as of April 1st, 2021. More and more states will be pass new legalization regarding marijuana legality in the coming years. For example, since this graph was created, New York legalized recreational marijuana and Connecticut pushed legalization through to legalize recreational marijuana. This was something that was

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on the table before the Covid-19 pandemic but the priorities within the state regarding its response to the pandemic pushed the decision to early April 2021.

Something important to note when it comes to marijuana policy is that states labeled in green have recreational marijuana legalized but not all of the green states allowed recreational marijuana to be sold in licensed dispensaries. For example, in New England, Massachusetts, Maine, Vermont, and now Connecticut have legalized recreational marijuana, but only Massachusetts as of 2016, allowed for the sale of recreational marijuana.

On Friday December 4, 2020 Congress officially passed legislation through the House of Representatives that would, "...decriminalize marijuana and expunge nonviolent marijuana related convictions" (Edmondson 2020). This decision was a bipartisan decision, and it was the first time the endorsement of cannabis came from either chamber of Congress. This bill, "...would remove the drug (marijuana) from the Controlled Substances Act and authorize a 5 percent tax on marijuana that would fund community and small business grant programs to help those most impacted by the criminalization of marijuana" (Edmondson 2020). As public perception of marijuana and its criminality has shifted, this bill would give power to the states to enforce their own policies. The bill also requires federal courts to release offenders serving sentences for nonviolent, marijuana-related offenses. Lastly, the bill allows physicians in the Department of Veteran Affairs to recommend medical marijuana to their patients for the first time. This bill is a major step in the relationship between marijuana and the government. Now, the bill is passed to the Senate and will be voted on to potentially become law in the coming months. As the policies towards marijuana change so will marijuana's impact on health, crime, and the economy. As this paper looks at specifically at marijuana legislations impact on crime, this recent legislation could affect the relationships discovered in the results of this paper for future years.

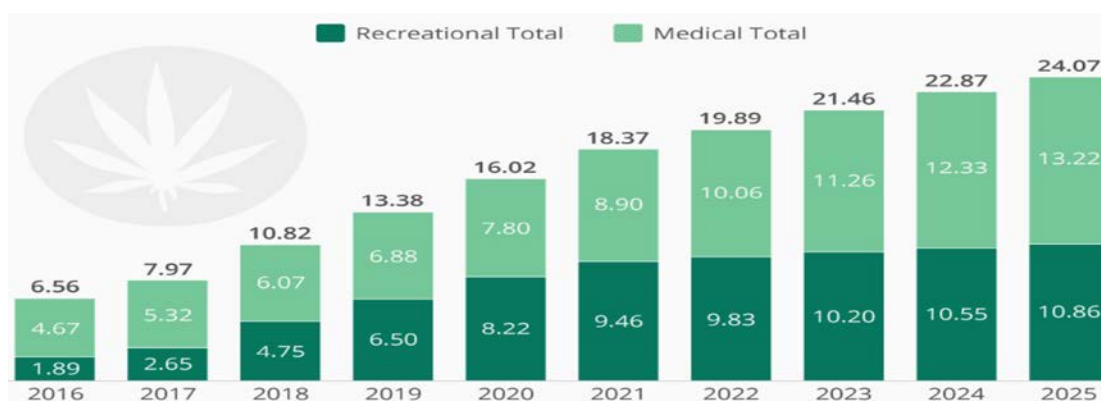
The terms and conditions regarding decriminalization of marijuana vary from state to state. Generally speaking, decriminalization means, "...no arrests, prison time or criminal record for the first-time possession of a small amount of marijuana for personal consumption...[and]

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...these offenses are treated like minor traffic violations” (norml.org 2020). The amount of marijuana in a person’s possession that triggers legal consequences varies from state to state. This factor is important for the decriminalization of marijuana’s impact on marijuana related crimes. These crimes are generally associated with possession of recreational marijuana.

Recreational marijuana is cannabis that is used for non-medical purposes. In states where medical and/or recreational marijuana is legal, it is primarily distributed by small business dispensaries licensed by the state government. The legalization of marijuana benefits state and local economies by creating small businesses and jobs and generating tax revenue. Figure 2 below graphs the future sales growth of this industry. The marijuana industry is expected to be \$24.07 billion by 2025. Though the economic benefits of the industry are not in dispute, there are some highly controversial and disputed public health and social concerns with marijuana’s legalization. This is especially true with respect to recreational use. These concerns relate to crime rates, cannabis dependency, escalation to harder drugs and creation of competing black-market sales. Some of these concerns also relate to medical marijuana, a much less potent version of recreational marijuana.

Figure 2: U.S Marijuana Market Projected Sales Growth (in billion U.S. Dollars)



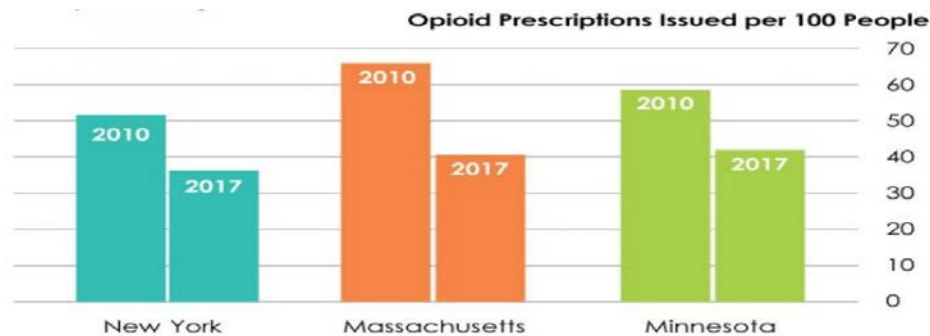
Source: The Cannabis Industry Annual Report

Medical marijuana is a less potent form of cannabis prescribed by medical professionals for the health and medicinal needs of their patients. The use of medicinal marijuana is a disputed issue as there are differing opinions regarding the actual health benefits of marijuana use. Many believe medical marijuana is a positive alternative to opioids. A 2014 study by National

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Institute on Drug Abuse found that from 1999 to 2010, “...states with medical cannabis laws experienced slower rates of increase in opioid analgesic overdose death rates compared to states without such laws” (NIDA 2020). That is an important trend in support of legalizing medical marijuana. Even as the opioid health crisis worsened in the U.S., Figure 3 from the CDC highlights that opioid prescriptions in New York, Massachusetts, and Minnesota, fell after these states legalized medical marijuana. Another disputed point about medical marijuana laws is its effect on crime. According to research from Victoria University of Wellington, there was very little change in crime rates nationwide between states allowing legal medical marijuana and those that do not (Chu 2018). As marijuana, medical and recreational, has gained more support among the people, the governments reaction to the drug has also shifted.

Figure 3: Opioid Prescription Rates Before and After Medical Marijuana Legalization



Source: CDC

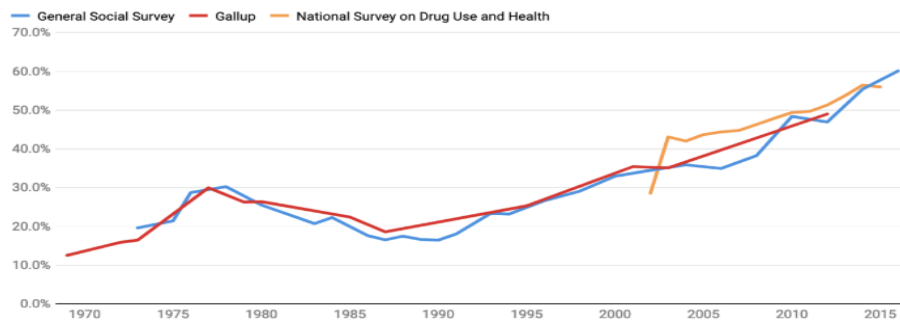
During the 2020 Covid-19 pandemic, businesses were shut down, but marijuana dispensaries stayed opened and were deemed essential businesses. During the weeks of the pandemic and economic shutdown, “...dozen states have agreed that while ‘nonessential’ stores had to close, pot shops and medical marijuana dispensaries could remain open — official recognition that for some Americans, cannabis is as necessary as milk and bread” (Levin 2020). These dispensaries followed the similar protocol as restaurants with online and orders and curbside pickup. On the onset of the pandemic, “...marijuana sales have soared in many states, including California, Colorado, Washington, and Pennsylvania, where Ilera Healthcare, a dispensary in the town of Plymouth Meeting, had its biggest week ever, according to Greg Rochlin, the company’s chief executive” (Levin 2020).

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This was a change to the daily business of dispensaries with the elimination of instore sales. As consumers prioritized purchases as statewide state at home orders were put into the place, marijuana was looked upon by consumers and state governments as consumer products like alcohol and cigarettes. Remaining open when so many small businesses had to close is largely due to the public perception shift of the drug.

Despite the strongly held views of many in American society, resistance to policies that legalize marijuana in U.S. states is decreasing. Figure 4 is a line chart showing how the views of marijuana legalization have changed over time. According to the General Social Survey, Gallup, and the NSDUH, in 1970, between 10% and 20% of Americans were in favor of the legalization of marijuana. As of 2015, however, 50% to 60% of Americans had a favorable view of legalizing marijuana, which is represented by the y-axis. Public opinion shows favorability towards legalizing and decriminalizing marijuana. American's views will continue to change as marijuana related policies effects the different social and economic aspects of society in a positive or negative way as more of sample size after legislation is available for analysis.

Figure 4: Views On Legalization of Marijuana in America



Source: pbs.org

TREND ANALYSIS

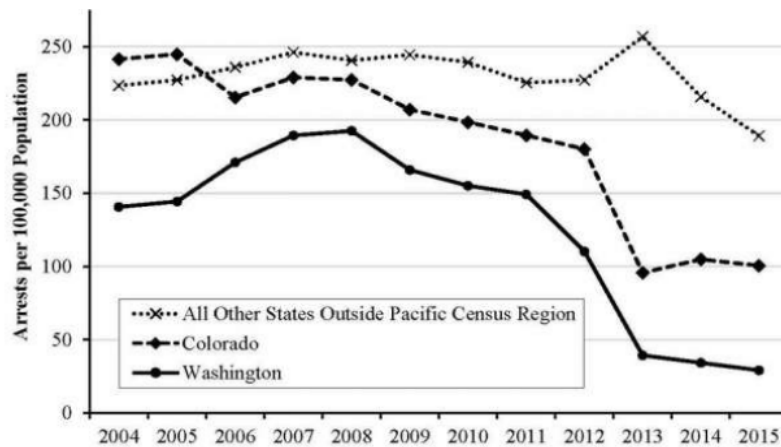
There are generally three mainstream interactions between decriminalizing marijuana and legalizing recreational and medical marijuana and society. These are the drug and its policies interactions with crime, health, and the economy. Crime is the factor that is discussed in this

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paper, but health and the economy are both important pieces of the marijuana narrative. This paper discusses relationship between crime and marijuana policy in the New England states specifically, but the other two factors of health and the economy are essential to highlight as they shape the whole issue of marijuana and marijuana policy's impact.

Some trends in crime from other areas of the country can be an indication of trends in other areas. As a comparative example, in the state of Washington, violent crime rates fell from 313.5 offenses per 100,000 city inhabitants to 284.4 offenses per 100,000 city inhabitants from 2010-2015 while recreational marijuana was legalized in Washington in 2012 (Santos 2017). This is one case where the legalization of recreational marijuana correlated with a decrease in crime. Figure 5 shows that in Colorado, Washington, and all other states outside the Pacific Census Region, the number of arrests have either flattened or fallen from 2004-2015 as states began to decriminalize or legalize marijuana. Colorado and Washington were two of the first states to legalize recreational marijuana, so this line graph shows strong indication that the legalization of recreational marijuana was accompanied by a reduction in arrests.

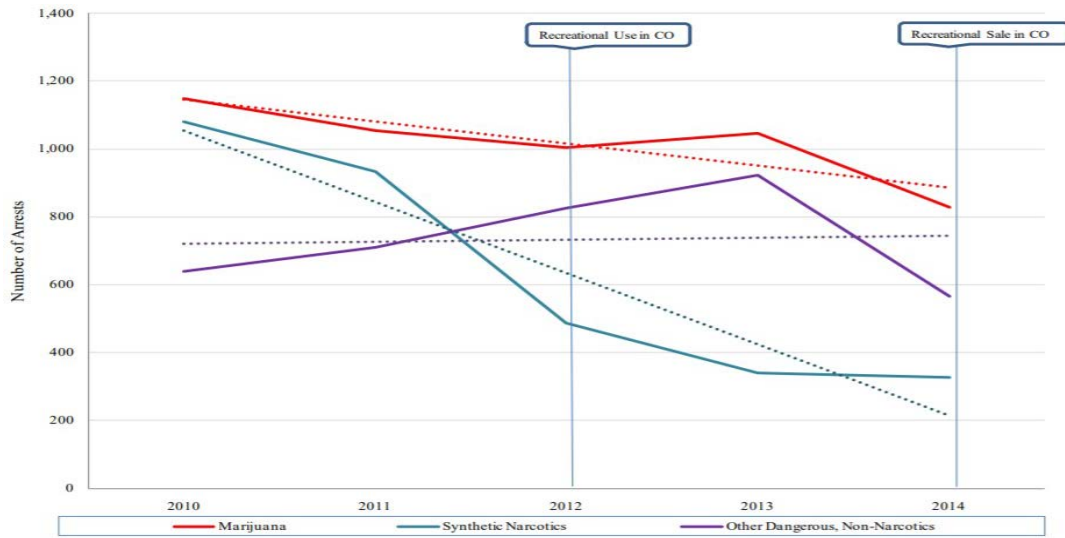
Figure 5: Marijuana Arrest Rates 2004-2015



Source: phys.org

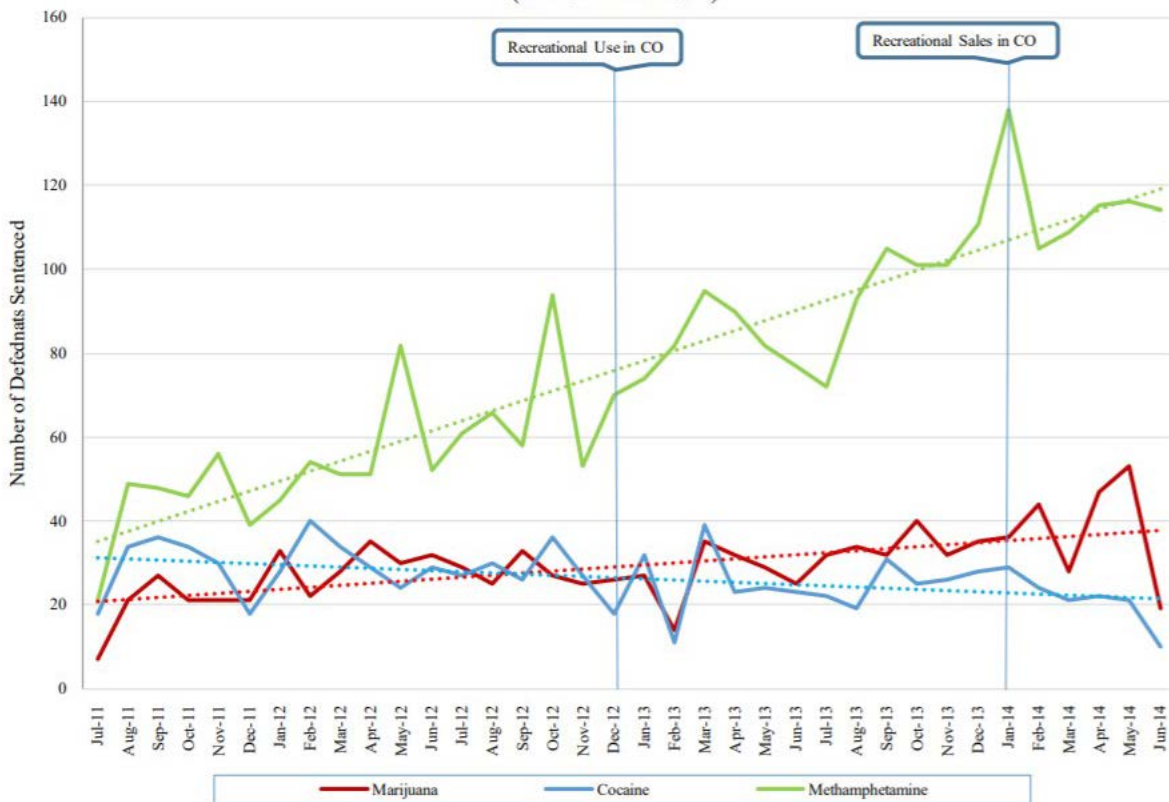
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Figure 6 : Number of Oklahoma Arrests for Drug Sales/Manufacturing (2010-2014)



Source: Justice Research and Statistics Association

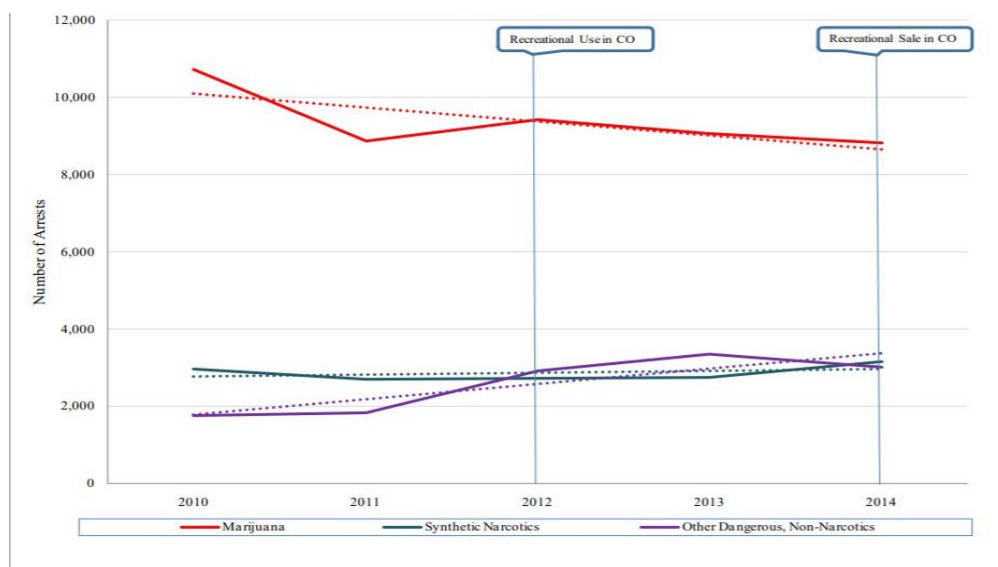
Figure 7: Number of Kansas Defendants Sentenced for Drug Possession (2010-2014)



Source: Justice Research and Statistics Association

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Figure 8: Number of Oklahoma Drug Possession Arrests (2010-2014)



Source: Justice Research and Statistics Association

Continuing the theme of marijuana policy and crime, figures 6, 7, and 8 are graphs from the Farley et al. (2019) article titled, “Measuring the Criminal Justice System Impacts of Marijuana Legalization and Decriminalization Using State Data”. The results shown in these charts were used as a part of developing the hypothesis and expectations for the results of this paper when it comes to how different drug crimes were affected by the legalization of recreational marijuana. Figures 6, 7, and 8 highlight the two types of drug crimes that this study looks at, drug sale/manufacturing, and drug possession.

Figure 6 shows the number of arrests for drug sales for marijuana, synthetic narcotics, and non-narcotics in Oklahoma. These numbers were tracked before and after the legalization of recreational marijuana. The important part to specifically look at is the narcotics and non-narcotics are two variables that were used in this study. The sale and manufacturing arrests of synthetic narcotics decreased, and non-narcotics fell slightly after the legalization of recreational marijuana.

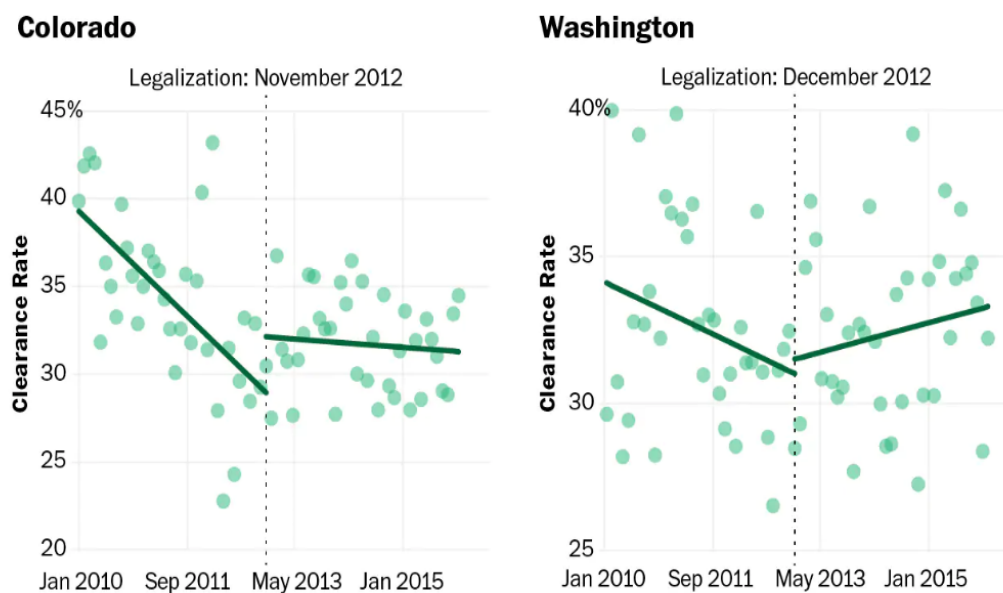
Figure 7 highlights the number of defendants sentenced for drug possession crimes in Kansas. The graph specifically highlights before and after the legalization recreational and before and after the sale of recreational marijuana. The main drug to highlight from Figure 7 is cocaine as

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it was a drug highlighted in this study. The number of drug arrests for cocaine fluctuated but remained consistent across the progression of pre-legalization to post sale of recreational marijuana. Interestingly, marijuana had a similar progression however methamphetamine saw a major spike over the time period.

Figure 8 also looks at drug arrests in Oklahoma before and after the legalization of recreational marijuana and before and after the sale of recreational marijuana. This graph also looks at marijuana, but it specifically looks at narcotics and non-narcotics. Possession arrests for these drugs remained relatively unchanged, while marijuana saw a slight decrease in possession arrests.

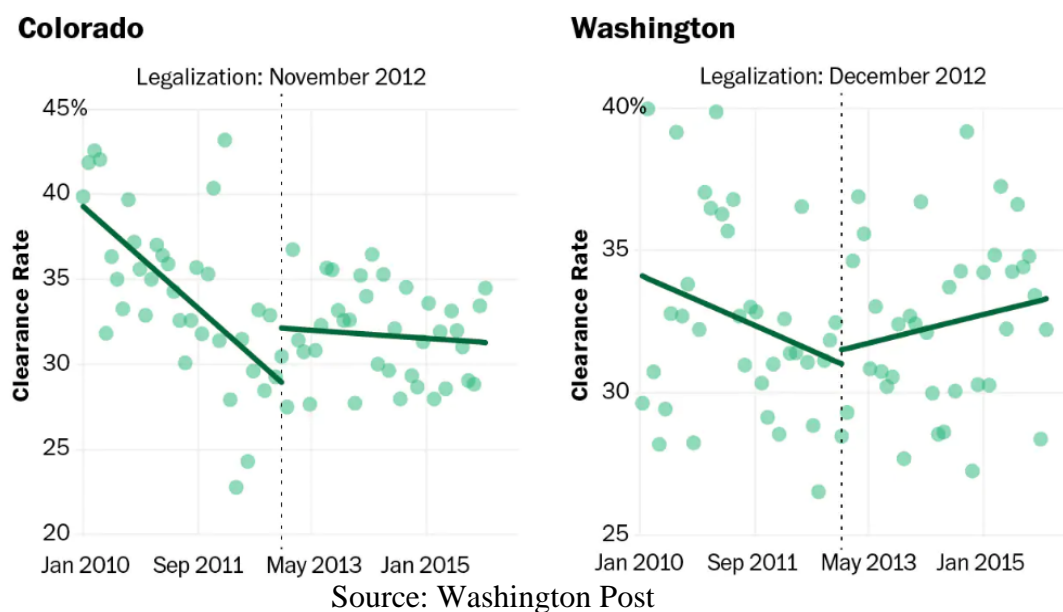
Figure 9: Violent Crime Clearance Rates in Colorado and Washington State, 2010 to 2015



Source: Washington Post

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Figure 10: Property Crime Clearance Rates in Colorado and Washington State, 2010 to 2015



With the legalization and decriminalization of marijuana in states, officials have the ability to redistribute their time on other offenses. This idea can have an impact on clearance rates. Clearance rates are “...crimes reported to police which result in arrest and turning over a suspect to prosecutors (Baughman 2020). Clearance rates also defined as, “...the percentage of crimes solved by arrest by a police department or a specific division of a police department” (Baughman 2020). Figure 9 shows the violent crime clearance rates from 2010 to 2015 in Colorado and Washington State before and after both states passed legislation in November 2012 and December 2021, respectively. Clearance rates were falling before legislation and post legislation began to steady. Interestingly, “...no similar shift happened in the country as a whole” (Ingraham 2018). This indicates that the legalization of recreational marijuana in 2012 by Colorado and Washington state may have had some impact on clearance rates for violent crimes. The data is not conclusive that the legalization of marijuana’s impact on violent crime clearance rates, but it does provide some indication of the legalizations potential impact on crime.

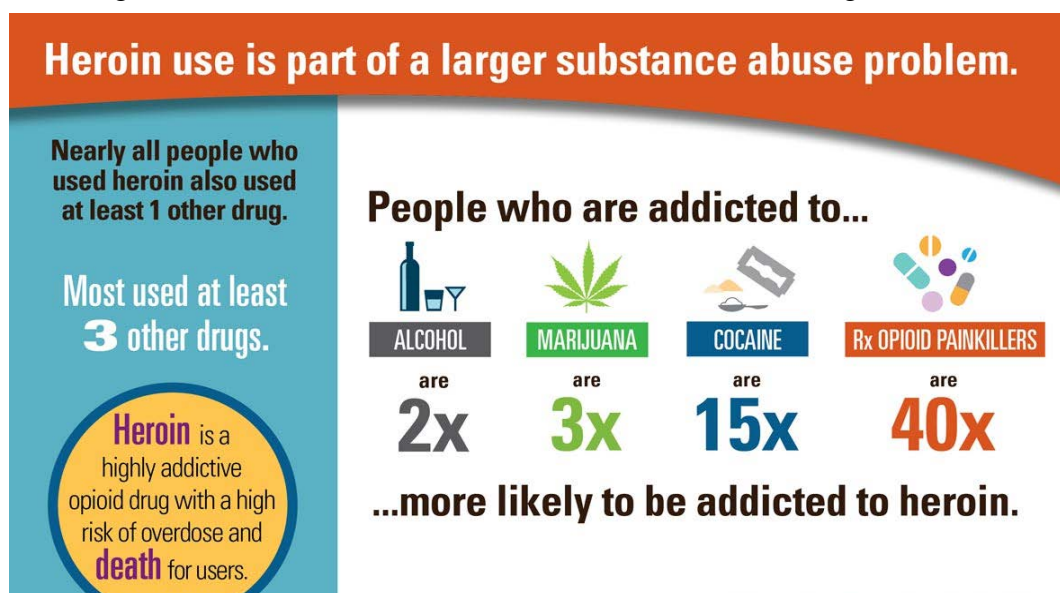
Figure 10 shows the clearance rate for property crimes in Colorado and Washington from 2010 to 2015. Colorado saw an increase in clearance after the legislation in November of

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2012 while Washington saw no change in the trend of clearance rates from before and after legalizing recreational marijuana. The Washington example for property crime clearance shows that the legalization of recreational marijuana itself does not tell the whole story, especially within the first few years after. As more years pass after legalization, the clearer the picture will be on how these policies impact crime of different forms.

The relationship between marijuana and crime is important for the society at large but on an individual level, marijuana's relationship with health plays a much different role in public perception, its impact on the opioid health crisis and the youth specifically. The most prominent argument for the usage of medical marijuana is it is a healthier alternative to opioids and prescription drugs. Figure 11 is a graphic that indicates which other drug addictions are likely to lead to one being addicted to heroin. One who is addicted to marijuana is 3 times as likely to be addicted to heroin while someone who is addicted to painkillers is 40 times as likely to be addicted to heroin.

Figure 11: Likelihood to Use Heroin Based on Another Drug Addiction



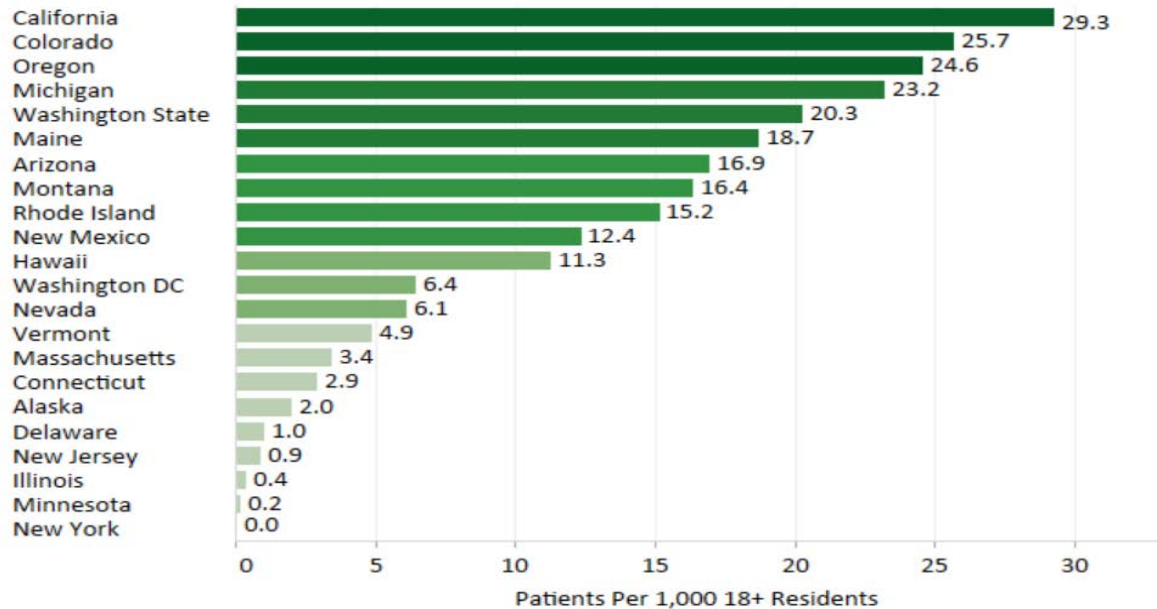
Source: National Survey on Drug Use and Health (NSDUH) 2011 – 2013

Being 3 times as likely to be addicted to heroin is still a grim number but it is better than 40 times as likely. Another indication that marijuana is a positive alternative to prescription drugs is that medical marijuana is much less potent form of marijuana compared to

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recreational marijuana, which indicates a less addictive quality. Usage of medical marijuana is at relatively high levels as shown in Figure 12. Figure 13 shows the medical conditions of medical marijuana patients. With the likeliness of deadly drug addictions associated with marijuana than prescription painkillers being much lower and the overall less addictive and potent qualities of medical marijuana, it seems to be a clear alternative to opioids.

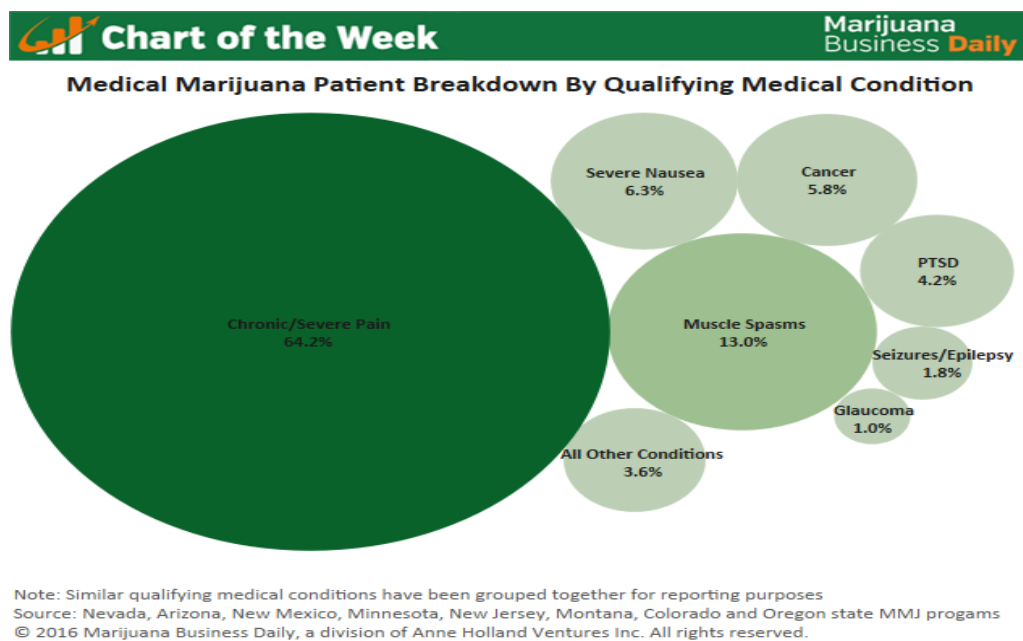
Figure 12: Medical Marijuana Patients Per Capita



Source: Medical Marijuana Program and the U.S. Census Bureau 2016

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Figure 13: Medical Marijuana Patient Breakdown by Qualifying Medical Condition

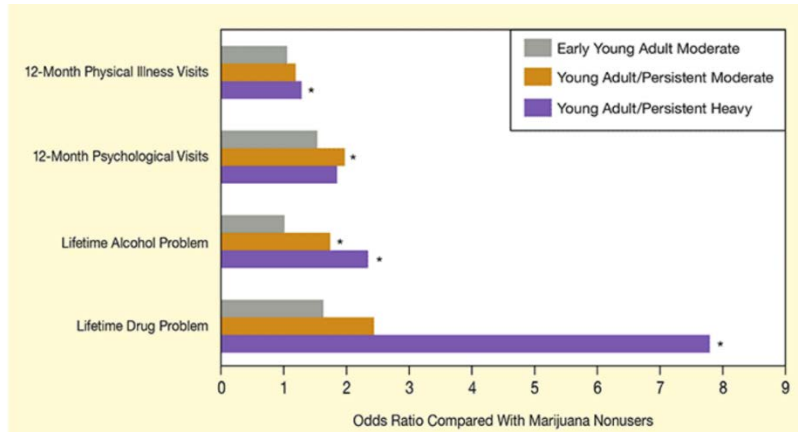


Source: Medical Marijuana Programs of NV, AZ, NM, MN, NJ, MT, CO, OR

On the contrary, with the legalization of medical marijuana displaying benefits, the legalization of recreational marijuana can also have an impact on health as users do not need a medical condition and prescription for purchase and use. Figure 14 shows different health issues on the y-axis and the likeliness of a marijuana user having certain health issues compared to a non-marijuana user on the x-axis based on age and level of usage. Figure 14 concludes that, “...people with long-term marijuana use during young adulthood have more health problems at age 50 than those with short-term use” (Sarlin 2018). This is an interesting discovery by Sarlin (2018); however, the data fails to differentiate between medical marijuana use and recreational marijuana use. That distinction will be key in determining the health benefits and risks associated with marijuana as it is known that medical marijuana is less potent than recreational marijuana. Differentiating between the two and the health risks of each will help the public policy decisions on its legality based on the health risks and benefits to society.

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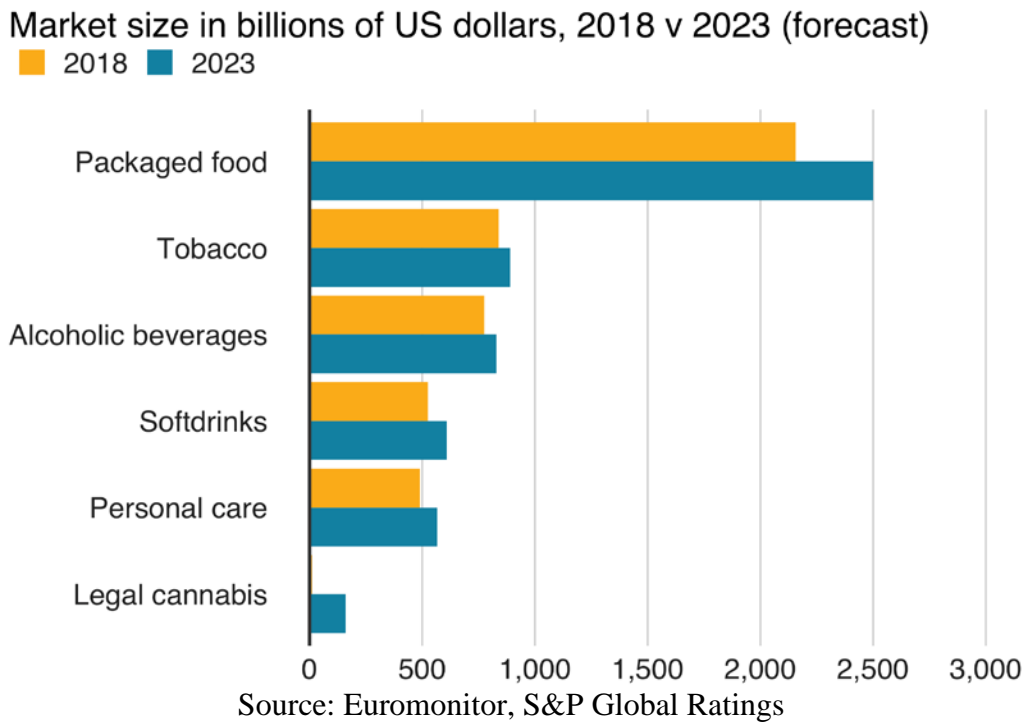
Figure 14: Health Risks Associated With Different Levels of Marijuana Use



Source: Sarlin 2018

Marijuana is becoming more of a product that people purchase and consume on a regular basis. Figure 15 shows the market size of different consumer products in 2018 and projected in 2023. 2023 will still be the relative early stages of the legalization process of recreational and medical marijuana on a nationwide scale but the project indicates the potential impact of this growing industry.

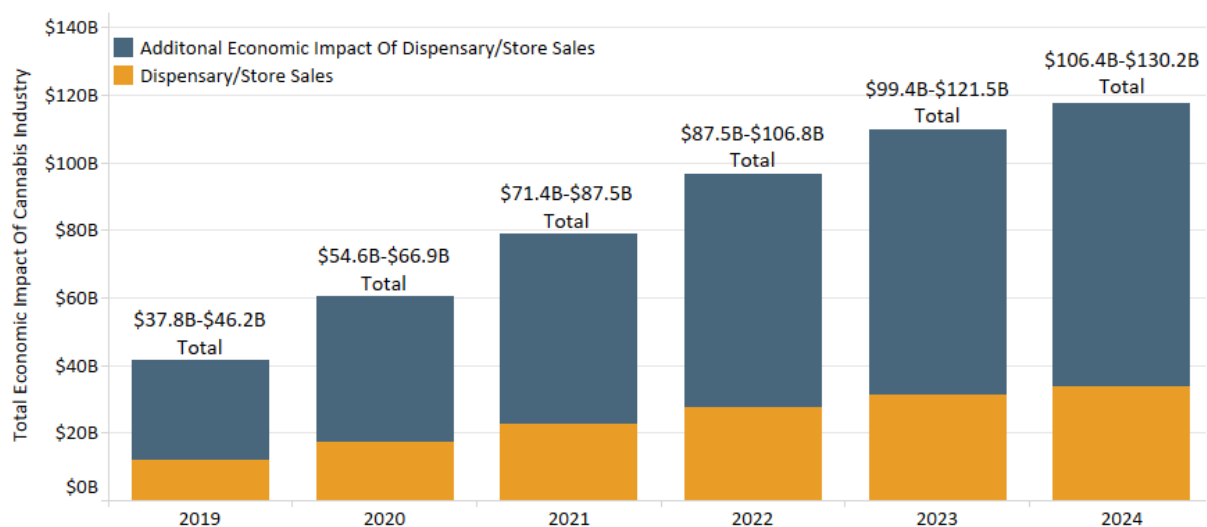
Figure 15: How Global Cannabis Market Compare With Others



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It seems that consumers are beginning prioritizing marijuana in their budget. There is little question of the positive effect that marijuana has the economy. The dispensaries across the country create jobs and tax revenue for the states and federal government. Figure 16 shows the projected U.S. cannabis industry's total economic impact from 2019-2024. With all this growth in the industry comes tax revenue from the state and local governments to the federal government.

Figure 16: U.S. Cannabis Industry Total Economic Impacts: 2019-2024

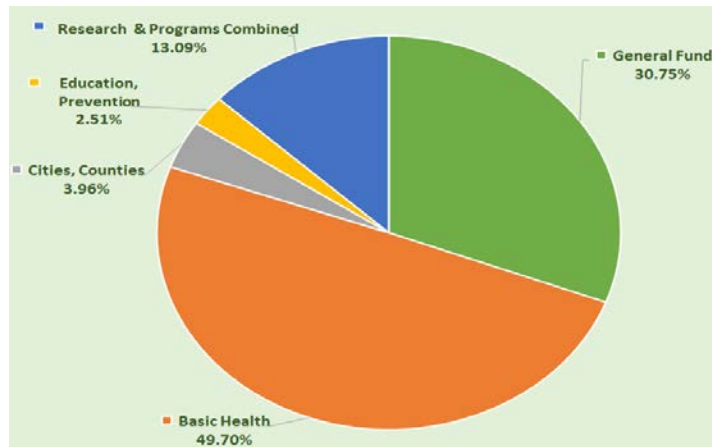


Source: Marijuana Business Daily 2020

The key issue is how that revenue is used to have a positive impact on the state and local communities. Figure 17 shows the distribution of cannabis tax revenue in the fiscal year 2019 in Washington State. Almost half the revenue was distributed to basic health while about 30% was distributed to general funds. Since health is an important factor in terms of public perception it appears that the money is being used in a seemingly productive fashion while general funds is a vague usage of the revenue. As long as the governments are being transparent in their usage of the tax revenue, the public perception of the selling of marijuana will not take any drastic shifts in the near future.

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Figure 17: Cannabis Revenue Distribution by Percentage in Washington State in FY 2019



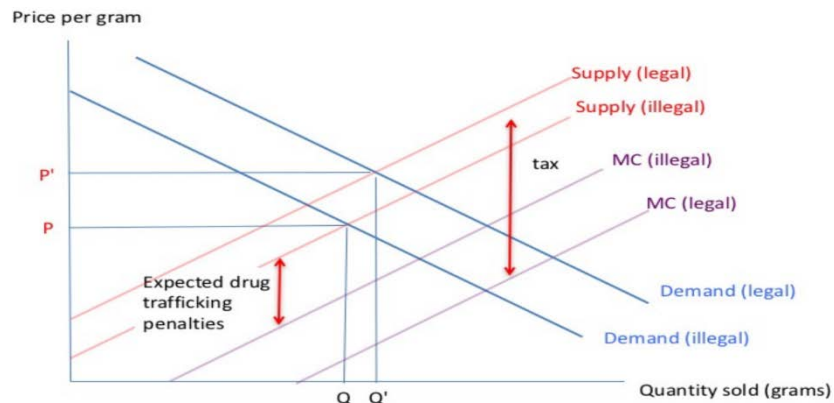
Source: Washington State Treasury

With selling and purchasing of recreational and medical marijuana being done by local regulated dispensaries, the microeconomic supply and demand concept is an important aspect to be analyzed. Figure 18 shows a supply and demand graph with the shifts in the different curves based on the illegal and legal markets for marijuana. This supply and demand graph is for Canada, but the basics of this newly emerging market remain consistent.

The graph shows that the demand curve for illegal marijuana is lower than the demand for legal marijuana. As a result, there is a higher supply curve for illegal market than the legal market. Because of that difference there is a higher marginal cost of the legal market than the illegal market. The legalization of marijuana reduced production cost and that improved production increases the demand.

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Figure 18: Supply and Demand Curve for the Legal and Illegal Marijuana Market in Canada



Source: Gordon et al. 2016

This paper has three main research objectives that differ from other literature on the topic of marijuana and crime. First, this paper will identify trends and important correlations among different crimes, drug-related and non-drug-related, across a time horizon to highlight the impacts that all three types of marijuana policies have had on these crime variables. Second, while most literature compares one or two states or all 50 states, this paper will assess a single region of the country – New England in the Northeast U.S. -- which includes the states of Vermont, Maine, Massachusetts, New Hampshire, Connecticut, and Rhode Island. Each one of the New England states has at least one of the marijuana policies discussed above in place, so the study will show if having one policy in place has more or less of an impact than having multiple policies in effect. The study will also highlight any gradual, incremental effects on crime rates that one policy has had and what happens when another one is implemented. Lastly, by studying this issue for a region of contiguous states in New England, the paper will show the impacts that marijuana policies of one or more states have had on bordering states and their crime rates.

LITERATURE REVIEW

The most significant piece of literature that was found during an extensive literature review was Dragone et al. (2018). The study done in this paper adapted the model used in that study. Dragone et al. (2018) looked at violent and property crimes in Washington State and Oregon

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before and after the legalization of recreational marijuana in those states. The study's methodology used a dummy variable in its model. A 0 was used before recreational marijuana was legalized and a 1 was used after recreational marijuana was legalized. The study conducted in this paper uses that same method of dummy variable use but expands it to apply to more marijuana related policies. Dragone et al. (2018) found that the legalization of recreational marijuana resulted in a decrease in violent and property crimes as well as a decrease usage of non-marijuana drugs. Dragone et al. (2018) findings are similar to the results of this paper.

Farley et al. (2019) was another important piece of literature in the formation of this study. Farley et al. (2019) looked at 11 states that have recreational marijuana legalized for use and marijuana decriminalized or share a border with states with those two policies in place. The study tracked different drug crime rates before and after the implementation of these policies. Farley et al. (2019) found that a decrease or no change in drug sale and possession crimes after marijuana was legalized recreational. These results were similar but not completely consistent with the results from this paper's study.

A very similar study to this study is Wu (2020). It looked at various crime rates in Oregon from 2007 to 2017 to see the effect of the state legalizing marijuana in 2014. It also used data from the same data source as this paper, the FBI Uniform Crime Reporting Program. The paper notes the mixed results of similar papers and its results go against one of the models run in this paper. Wu (2020) found the legalization of recreational marijuana led to an increase in violent and property crimes.

Along with the legalization of recreational marijuana, medical marijuana laws and the decriminalization of marijuana are two important pieces of policy to look at in connection with crime rates. A paper that looks at these two policies is Huber III et al. (2016). Huber III et al. (2016) looked at 27 states w/ medical marijuana laws and decriminalization laws. The states with medical marijuana laws saw a decrease in property crimes after the policy was

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enacted. States that decriminalized marijuana saw no effect or a slight increase crime rates, which is consistent with the results from this study.

When looking at crime and marijuana, the drug cartels of Mexico and how legislation has impacted the trafficking of drugs is important when looking at the impact of marijuana policy on crime. Gavrilova (2017) looked into that impact, specifically on medical marijuana and decriminalization of marijuana to see how these laws were affecting the drug cartels and the crime associated with them. The study looked at states bordering Mexico. It found that the decriminalization of marijuana and medical marijuana legalization both led to a decrease in violent crime which is consistent with the existing literature but inconsistent to the results from this study.

Another significant study regarding states medical marijuana laws related to crime is Morris et al. (2019). This study looked at states with medical marijuana laws. The study found that medical marijuana laws led to a decrease or no significant change in violent and property. These findings are consistent with the study in this paper.

The existing literature does not really touch on how marijuana policy impacts the crime rates associated with other drugs, with the exception of Farley et al. (2019). Therefore, looking at how the policies have affected consumption of other drugs, like marijuana and opioids, can be a proxy for harder drug usage like cocaine, narcotics, and non-narcotics and the sale and possession crimes that can be associated with those hard drugs. Bachhuber et al. (2019) and Bradford (2016) are two studies that highlighted this idea. Bachhuber et al. (2019) concluded that states with medical marijuana laws led to a decrease in opioid overdoses. Bradford (2016) concluded that medical marijuana laws led to a decrease in the number of prescribed drugs. These studies were important to analyze because there was little to no existing literature on medical marijuana and other drug crimes because people that are generally impacted the most by medical marijuana laws are people who use the drug as an alternative to opioids and pain killers, so those people are not associated with crimes of non-marijuana drug sale and possession.

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These studies were all used to get an idea of trends on marijuana laws and crime connections from the existing literature. The results were used to build a hypothesis, expectation, and the potential signs of the variables from the different models that will appear later in the paper. There was an abundance of literature out there on the three types of marijuana policy and their impact on violent and property crimes. Alternatively, there was little research on these policies and their relationship to the crimes related to other drugs. The only policy in existing literature is the legalization of recreational marijuana like in Farley et al. (2019). Bachhuber et al. (2019) and Bradford (2016) are important studies to look at to get some idea of the impact of these laws on the usage of other drugs. Although it is not crime, these results used as proxies can be helpful to see certain trends.

DATA AND EMPIRICAL METHODOLOGY

DATA

The data used for this study is a panel data set from 2000-2019 for the six New England states, Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont. The data was crime data gathered from the FBI Uniform Crime Reporting Program. There were three categories of crime rate variables that were gathered for each state that were broken down into their per capita values. The first two were non-marijuana drug sale/manufacturing crime rates and non-marijuana drug possession crime rates.

The non-marijuana drugs consisted of opium/cocaine, non-narcotics, and synthetic narcotics. The third crime rate variables gathered was non-drug crimes, similar to the violent and property crime variables used in much of the existing literature. These non-drug crimes consisted of aggravated assault, arson, burglary, disorderly conduct, driving under the influence, drunkenness, theft, murder, rape, robbery, simple assault, vandalism, and weapons charges.

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Along the crime variables, there were economic variables used as control variables for the regression model. The variables used in the model were population density, poverty rate, and median household income. These variables were gathered from the state’s websites, the U.S. Census Bureau, and the Bureau of Labor Statistics.

Lastly, adapted from Dragone et al. (2018), three dummy variables were used in the model. Each dummy variables represented the three marijuana related policies that each state has or could possibly enact. These are the legalization of recreational marijuana, the legalization of medical marijuana, and the decriminalization of marijuana. The dummy variable equaled 0 if the policy is not in place and the dummy variable equaled 1 if the policy is in place in the given year. Table 1 displays the summary statistics for all the input variables for the models created in this study.

Table 1: Summary Statistics

Summary Statistics					
Variable	Observations	Mean	Std. Dev.	Minimum	Maximum
Non-Marijuana Drug Sale Crime Rates	120	45.61305	17.41004	8.591885	88.24387
Non-Marijuana Drug Possession Crime Rates	120	101.7899	43.81845	25.37301	227.1988
Non-Drug Crime Rates	120	1570.643	376.4653	841.6219	2851.673
PopDen	120	473.3952	3999.86	41.385	1025.431
MHI	120	57075.68	10549.15	37589	85700
Poverty Rate	120	10.42833	2.059297	5.6	14.8
Recreational Dummy	120	.1166667	.3223687	0	1
Medical Dummy	120	.575	.4964157	0	1
Decriminalized Dummy	120	.5	.5020964	0	1

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MODELS

The crime rates were split into three categories and three regressions will be run for each dependent variable. Each one including one of each of the three dummy variables, for a total of 9 regression models. The following models were created:

Model 1: Non-Marijuana Drug Sale Crime Rates

$$1a. \text{DrugSale} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Rec}B_4 + \varepsilon$$

$$1b. \text{DrugSale} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Med}B_4 + \varepsilon$$

$$1c. \text{DrugSale} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Decrim}B_4 + \varepsilon$$

Model 2: Non-Marijuana Drug Possession Crime Rates

$$2a. \text{DrugPossess} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Rec}B_4 + \varepsilon$$

$$2b. \text{DrugPossess} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Med}B_4 + \varepsilon$$

$$2c. \text{DrugPossess} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Decrim}B_4 + \varepsilon$$

Model 3: Non-Drug Crime Rates

$$3a. \text{NonDrug} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Rec}B_4 + \varepsilon$$

$$3b. \text{NonDrug} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Med}B_4 + \varepsilon$$

$$3c. \text{NonDrug} = B_0 + B_1\text{PopDen} + B_2\text{MHI} + B_3\text{PovRate} + \text{Decrim}B_4 + \varepsilon$$

Each of the three model consist of three separate dependent variables. In Model 1, the dependent variable DrugSale represents the variable of non-marijuana drug crime rates. In Model 2, the dependent variable DrugPossess is the variable non-marijuana drug possession crime rates. Model 3's dependent variable, NonDrug, represent the variable of non-drug crimes rates.

For the independent variables, PopDen is the population density, MHI is the median household income, and PovRate is the poverty rate. See Appendix A for variable description and specific source of each variable.

The individual dummy variables Rec, Med, Decrim represent the states marijuana policy. Whether it was legalized recreationally, medically, or decriminalized, respectively. In the

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individual equations, R=0 when the recreational marijuana was not legalized and R=1 when recreational marijuana was legalized. M=0 when medical marijuana was not legalized and M=1 when medically marijuana was legalized. D=0 when marijuana was not decriminalized and D=1 when marijuana was decriminalized. B_0 is the intercept variable and ε is the error term. See Appendix B for what each independent and dependent variable captures and the expect sign of each variable that would result from the models. The following Tables 2, 3, and 4 display the regression results of Models 1, 2, and 3, respectively.

RESULTS

Table 2: Regression Results for Model 1

Non-Marijuana Drug Sale Crime Rates			
Variable	1a	1b	1c
Constant	33.889*** (13.980)	19.503 (15.500)	60.721*** (15.625)
PopDen	.0109*** (.0042)	.0079* (.00500)	.0164*** (.00432)
MHI	-.0002 (.0002)	-.00002 (.00017)	-.00045*** (.00018)
Recreational Dummy	9.686** (5.098)		
Medical Dummy		-2.819 (4.354)	
Decriminalized Dummy			15.195*** (3.9355)
Poverty Rate	1.603** (.7925)	2.405** (1.067)	-.4572 (.9644)
R ²	0.1467	0.1231	.2209
F-Stat	4.94	4.04	8.15
Observations	120	120	120

Note: ***, **, and * denotes significance at the 1%, 5%, and 10% respectively. Standard errors in parentheses

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Some important takeaways from this model are that in Model 1a, PopDen was significant and positive, meaning that the more densely populated the area is, the more drug sale crimes are committed as people have closer access to other people to sell to. MHI is significant and negative for Model 1c, meaning that the higher the median income, the decrease in drug sales so people do not need to resort to selling drugs as their income increase. PovRate is positive and significant for 1a and 1b, which says that as more people are in poverty, these people move to selling drugs as a source of income. The recreational dummy is positive and significant which points to an increase in non-marijuana drug sale crimes after marijuana is legalized recreationally. This is somewhat inconsistent with Farley et al. (2019). The last important takeaway is the decriminalized dummy being significant and positive in Model 1c. There was no specific study that was researched that indicated this result but this result indicates that people were shifting to the sale of harder drugs once marijuana was decriminalized.

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Table 3: Regression Results for Model 2

Non-Marijuana Drug Possession Crime Rates			
Variable	2a	2b	2c
Constant	1.642 (36.011)	44.177 (39.705)	46.573 (42.500)
PopDen	-.0029 (.01077)	.0069 (.0128)	.00413 (.01176)
MHI	.001527*** (.00044)	.00103** (.000452)	.00097** (.00049)
Recreational Dummy	-22.538* (13.1319)		
Medical Dummy		11.5163 (11.1789)	
Decriminalized Dummy			9.882 (10.704)
Poverty Rate	1.6266 (2.0416)	-1.0611 (2.7299)	-.7120 (2.6232)
R ²	.1062	0.0917	0.0901
F-Stat	3.42	2.90	2.85
Observations	120	120	120

Note: ***, **, and * denotes significance at the 1%, 5%, and 10% respectively. Standard errors in parentheses

Model 2, with the dependent variables as non-marijuana drug possession, was the least significant model among the three. MHI being positive and significant in 2a, 2b, 2c can be attribute to people with higher income purchasing harder drugs and being caught with possession. The recreational dummy variable was significant and negative in 2a. This indicates that people were not shifting to possession of other drugs but just utilizing the legalization of recreational marijuana. The important takeaway from this model is that drug possession crimes, of the three types of crime studied in this paper, is the least associated with

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organized crime, as specifically indicated by MHI being positive and significant. People who have money are being caught with possession crimes but are generally not involved in the selling of drugs or any organized crime.

Table 4: Regression Results for Model 3

Non-Drug Crime Rates			
Variable	3a	3b	3c
Constant	2202.845*** (297.3369)	2576.85*** (340.1641)	2637.281*** (363.5415)
PopDen	-.02143 (.08899)	.03251 (.10985)	.03866 (.10065)
MHI	-.00563 (.00366)	-.01074*** (.00387)	-.01142*** (.00419)
Recreational Dummy	-357.3132*** (108.4572)		
Medical Dummy		18.3201 (95.7719)	
Decriminalized Dummy			39.5768 (91.567)
Poverty Rate	-24.76407 (16.8571)	-40.1749* (23.3883)	-43.381* (22.439)
R ²	0.1745	0.0968	0.0980
F-Stat	6.08	3.08	3.12
Observations	120	120	120

Note: ***, **, and * denotes significance at the 1%, 5%, and 10% respectively. Standard errors in parentheses

Table 4 shows the results from Model 3, where the dependent variable is non-drug crime rates. MHI was significant and negative for models 3b and 3c. This means that people with higher incomes are not participating in the non-drug crimes. The recreational dummy variables was negative and significant which say that people are not getting into other non-

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drug crimes when recreational marijuana is legalized. This result was consistent with Dragone et al. (2018).

LIMITATIONS

When conducting this study and research, there were some limitations that were faced along the way that are important to highlight. First, the research was limited to 120 observations which can bring some quality results, but more observations would yield much more conclusive results. Similar to how there was limited observations and data available, this topic is new and constantly changing so there is limited research out there on the topic and differing results from each study. There were issues in conducting the models with finding the right combination of control variables to use. The final economic control variables came down the sign of the results and what could be reasonably explained. Therefore, multiple regressions were run with different variables in a trial-and-error process. This issue was partial because of how highly correlated the typical economic control variables are. For example, poverty rate and unemployment are highly correlated, along with income per capita and median household income. Those were typical control variables that other studies used so finding the right one to use took time. Next, the signs of the recreational and decriminalized dummy were hard to develop expectations for as the existing literature had no relative consensus on the direction. Lastly, there is the aspect of the legalization of recreational marijuana where it is legalized for use but not for sale. Of the New England states where data was gathered in this study, Massachusetts as of 2016 reported recreational marijuana sales. This will be something to continue to monitor as more states allow for sales.

POLICY IMPLICATIONS

After conducting this study and analyzing results, it is important to look at the policy implications that the results can highlight. When looking at Model 1, it is important to continue to monitor the crime impact of these policies in more densely populated and impoverished areas. The closer people are the greater access they have to people to sell drugs to and the poorer the population, the more likely they will turn to selling drugs as source of income. As shown across all three model results, the legalization of recreational marijuana and the decriminalization of marijuana had a much more profound impact on crime rates than the legalization of medical marijuana. Intuitively, the people most impacted by the legalization of medical marijuana generally are not involved in the sale or possession of other drug or other types of non-drug crime. This is more a necessity and positive alternative to opioids. Similarly, Model 2, non-marijuana drug possession being the dependent variable, was the least significant model of the three because, as the positive signs of the median household income and poverty rate signify, getting caught with possession hard drugs does not usually make one associated with organized crime, like selling harder drugs or committing violent or property crimes would. For example, Models 1 and 3, which have non-marijuana drug sale/manufacturing and non-drug crimes as the dependent variable respectively, showed that poorer people are selling drugs to people with higher incomes. Model 2 indicates that those people with higher incomes are getting caught for possession crimes.

The results of the three models conducted in this study are only a snapshot of the NE region over a 19-year period with limited observations and variables used. However, this study can be added to the existing literature and be new evidence to a complex relationship of marijuana laws and crime.

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APPENDICES

APPENDIX A - VARIABLE DESCRIPTION AND DATA SOURCES

Variable	Description	Data Source
Non-Marijuana Drug Sale Crime Rates	Non-marijuana drug sale crime rates in the given state in the given year	FBI Uniform Crime Reporting (UCR) program
Non-Marijuana Drug Possession Crime Rates	Non-marijuana drug possession crime rates in the given state in the given year	FBI Uniform Crime Reporting (UCR) program
Non-Drug Crime Rates	Non-drug crime rates in the given state in the given year	FBI Uniform Crime Reporting (UCR) program
PopDen	Number of people per square mile of land area	U.S Census Bureau
MHI	The median income of households in the given state	Bureau of Labor Statistics
Poverty Rate	The percentage of residents in the given state living under the poverty level of income	Bureau of Labor Statistics
Recreational Dummy	0 for before marijuana was legalized recreationally and 1 for year of and post legalization recreationally	State website
Medical Dummy	0 for before marijuana was legalized medically and 1 for year of and post legalization medically	State website
Decriminalized Dummy	0 for before marijuana was decriminalized and 1 for year of and post decriminalization	State website

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APPENDIX B - VARIABLES AND EXPECTED SIGNS

Variable	Variable Description	What it Captures	Expected Sign
Recreational Dummy	0 for before marijuana was legalized recreationally and 1 for year of and post legalization recreationally	The presence or absence of the legalization of recreational marijuana policy for the given state in that given year	+/-
Medical Dummy	0 for before marijuana was legalized medically and 1 for year of and post legalization medically	The presence or absence of the legalization of medical marijuana policy for the given state in that given year	-
Decriminalized Dummy	0 for before marijuana was decriminalized and 1 for year of and post decriminalization	The presence or absence of the decriminalization of marijuana policy for the given state in that given year	+/-
PopDen	Population Density	Number of people per square mile of land area	+
MHI	Median Household Income	The median value income of households in the given state	-
PovRate	Poverty Rate	The percentage of residents in the given state living under the poverty level of income	+

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