

The Link Between Marijuana Legalization and Opioid Overdoses

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Abstract

Our goal was to determine if there was a link between opioid deaths and availability of marijuana. To do this, we studied opioid deaths by state from 1999-2020 and did a difference-in-differences study where the treatment was legalization of marijuana. From 2012 to 2020, 14 states legalized marijuana for recreational use, so we used these states to determine how deaths from opioids changes when a state legalizes marijuana. We find that 5-years after legalizing marijuana, states with legal marijuana see a decrease in opioid deaths relative to those where it is still illegal.

Introduction

We are interested in estimating the causal effect of access to marijuana on opioid deaths. The parameter we care about is the average treatment on the treated of marijuana legalization on opioid deaths. We believe that marijuana could be a substitute for opioids in use for pain addiction, so we expect that the legalization of marijuana recreationally and easier access to this alternative will cause a reduction in opioid deaths.

The results of this study can enable policy changes that can help lower opioid deaths across the United States, one of the biggest problems that the country is tackling. Other laws, such as limiting prescriptions of opioids can lead to people seeking illegal substitutes, such as heroin. Legalizing marijuana could be an effective policy to combat the growing opioid epidemic.

Background

Since 2012, 14 states have made recreational use of marijuana legal. Over that same time period, we've seen the death rate of opioids explode, as shown in table 3. With the rise of the opioid crisis, due to many reasons, including prescription of opioids for pain management, people want to find an alternative for opioids. There is some literature that shows that marijuana can be a substitute for pain management, so we examine if there is a link between the two and if marijuana is used as a substitute.

We use legalization of marijuana as a random assignment of ability to use marijuana over opiates. There's no difference between states, except that more liberal states may be more likely to legalize marijuana. We assume that treatment is a random assignment of freedom to use marijuana for opioid users.

Data

Data comes from the CDC WONDER system which has data for underlying death cause from 1999 until 2020. Because of this data limitation, we ignore states that legalized marijuana after 2020 and the District of Columbia. Opioid overdose deaths are identified using underlying cause-of-death codes X40–X44, X60–X64, X85, and Y10–Y14. All data comes from the CDC and provides the death rate per 100,000 citizens from opioids for each year for each state. The data also includes the population of each state and total deaths from opioids.

The below tables show which states have the highest average rate of opioid deaths over the data period and also how the average death rate from opioids changes from year to year. We see that states like West Virginia and New Mexico have a high rate of opioid death, while the less densely populated states of North Dakota and South Dakota have less. We can also see that the average death rate each year steadily rises and quintupled over the study period.

Table 1: Year Marijuana Was Legalized Recreationally

| State | Treatment Year |
|---------------|----------------|
| Alaska | 2014 |
| Arizona | 2020 |
| California | 2016 |
| Colorado | 2012 |
| Illinois | 2019 |
| Maine | 2016 |
| Massachusetts | 2016 |
| Michigan | 2018 |
| Montana | 2020 |
| Nevada | 2016 |
| New Jersey | 2020 |
| Oregon | 2014 |
| Vermont | 2018 |
| Washington | 2012 |

Methodology

We use our state and year-level data to perform a difference in difference study and examine a causal effect between legalizing marijuana and opioid death rate. The only control we add in this study is for state population each year.

Our Paper uses the Callaway and Sant’anna Difference in Differences Estimator which uses the following formula to estimate average treatment of the treated:

$$ATT(g, t) = E[(\frac{G_g}{E[G_g]} - \frac{\frac{\hat{p}(X)C}{1-\hat{p}(X)}}{E[\frac{\hat{p}(X)C}{1-\hat{p}(X)}]})(Y_t - Y_{g-1})]$$

Results

We find a significant effect after 5 years of legalizing the recreational use of marijuana. The figure below shows our findings. Most states seem to have a comparable difference in opioid deaths leading up to treatment and even for 3 to 4 years afterwards. However, after the 5th year, we see a significant decrease in opioid deaths for our treated states compared to our untreated states and this holds for the rest of the treatment period.

Discussion

As we expected, opioid deaths goes down after a state legalizes marijuana. However, this does not happen immediately, but takes 5 years for opioids deaths to have a significant decrease. We believe that this is because marijuana becomes a substitute for opioids.

Even though we find a causal link between opioid deaths and marijuana legalization, we believe that there are ways we could improve this study and some things to consider further. First, there could be selection bias in the states that legalize marijuana. Some of the first adopters of legalized marijuana policies are more liberal and could have other factors that allow them to have less opioid deaths outside of legalizing marijuana.

We see that less densely populated states have less opioid deaths, so we could add a control for population density or region.

We also don’t check to see if the loss in opioid deaths leads to higher deaths in other areas.

Conclusion

Marijuana legalization leads to less opioid deaths. Legalizing marijuana can save lives.

Table 2: Mean Opioid Deaths per State from 1999 to 2020

| State | Mean Death Rate |
|----------------|-----------------|
| Alabama | 11.02 |
| Alaska | 14.47 |
| Arizona | 16.90 |
| Arkansas | 10.79 |
| California | 10.82 |
| Colorado | 14.61 |
| Connecticut | 16.33 |
| Delaware | 18.63 |
| Florida | 15.91 |
| Georgia | 10.16 |
| Hawaii | 10.65 |
| Idaho | 10.58 |
| Illinois | 12.69 |
| Indiana | 14.74 |
| Iowa | 7.10 |
| Kansas | 9.50 |
| Kentucky | 21.05 |
| Louisiana | 16.04 |
| Maine | 15.50 |
| Maryland | 19.35 |
| Massachusetts | 17.56 |
| Michigan | 14.72 |
| Minnesota | 8.24 |
| Mississippi | 9.95 |
| Missouri | 15.14 |
| Montana | 11.17 |
| Nebraska | 5.74 |
| Nevada | 19.32 |
| New Hampshire | 17.17 |
| New Jersey | 14.31 |
| New Mexico | 22.24 |
| New York | 10.73 |
| North Carolina | 13.67 |
| North Dakota | 5.20 |
| Ohio | 19.29 |
| Oklahoma | 15.72 |
| Oregon | 11.79 |
| Pennsylvania | 19.64 |
| Rhode Island | 19.01 |
| South Carolina | 13.46 |
| South Dakota | 5.78 |
| Tennessee | 17.90 |
| Texas | 9.03 |
| Utah | 17.09 |
| Vermont | 13.27 |
| Virginia | 10.82 |
| Washington | 13.91 |
| West Virginia | 28.38 |
| Wisconsin | 12.38 |
| Wyoming | 11.64 |

Table 3: Average Death Rate by Year

| Year | Mean Death Rate |
|------|-----------------|
| 1999 | 5.74 |
| 2000 | 6.20 |
| 2001 | 7.11 |
| 2002 | 8.30 |
| 2003 | 9.22 |
| 2004 | 9.63 |
| 2005 | 10.30 |
| 2006 | 11.75 |
| 2007 | 12.32 |
| 2008 | 12.67 |
| 2009 | 12.52 |
| 2010 | 12.93 |
| 2011 | 14.07 |
| 2012 | 13.94 |
| 2013 | 14.72 |
| 2014 | 15.84 |
| 2015 | 17.45 |
| 2016 | 20.41 |
| 2017 | 21.99 |
| 2018 | 21.19 |
| 2019 | 22.11 |
| 2020 | 28.09 |

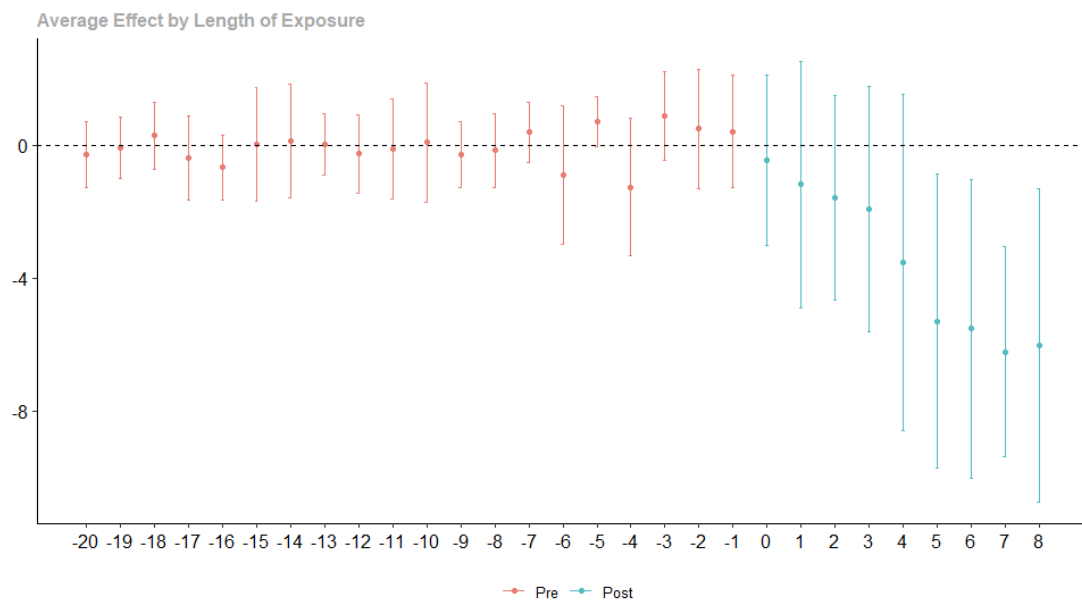


Figure 1: ATT of treatment year on opioid death rate per 100k

Table 4: Table of ATT Based on Time from Treatment Year

| Year from Treatment | ATT | Standard Error | Lower Bound | Upper Bound |
|---------------------|-------|----------------|-------------|-------------|
| -20 | -0.27 | 0.37 | -1.00 | 0.46 |
| -19 | -0.07 | 0.34 | -0.75 | 0.62 |
| -18 | 0.29 | 0.37 | -0.44 | 1.03 |
| -17 | -0.37 | 0.47 | -1.30 | 0.55 |
| -16 | -0.66 | 0.36 | -1.39 | 0.06 |
| -15 | 0.02 | 0.63 | -1.23 | 1.27 |
| -14 | 0.13 | 0.64 | -1.13 | 1.40 |
| -13 | 0.03 | 0.34 | -0.64 | 0.70 |
| -12 | -0.25 | 0.44 | -1.12 | 0.61 |
| -11 | -0.12 | 0.56 | -1.22 | 0.99 |
| -10 | 0.09 | 0.66 | -1.22 | 1.41 |
| -9 | -0.28 | 0.37 | -1.00 | 0.45 |
| -8 | -0.15 | 0.41 | -0.96 | 0.65 |
| -7 | 0.40 | 0.33 | -0.26 | 1.06 |
| -6 | -0.89 | 0.77 | -2.42 | 0.63 |
| -5 | 0.71 | 0.28 | 0.16 | 1.27 |
| -4 | -1.26 | 0.77 | -2.78 | 0.26 |
| -3 | 0.89 | 0.50 | -0.09 | 1.87 |
| -2 | 0.51 | 0.66 | -0.81 | 1.82 |
| -1 | 0.41 | 0.63 | -0.82 | 1.65 |
| 0 | -0.43 | 0.95 | -2.31 | 1.45 |
| 1 | -1.18 | 1.37 | -3.90 | 1.54 |
| 2 | -1.58 | 1.14 | -3.83 | 0.67 |
| 3 | -1.93 | 1.36 | -4.63 | 0.77 |
| 4 | -3.53 | 1.87 | -7.23 | 0.17 |
| 5 | -5.29 | 1.64 | -8.54 | -2.04 |
| 6 | -5.51 | 1.66 | -8.80 | -2.22 |
| 7 | -6.21 | 1.17 | -8.53 | -3.89 |
| 8 | -6.02 | 1.75 | -9.48 | -2.56 |