

Recreational Cannabis Laws are Associated with Reduced Prescription Drug Use in Medicaid

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Abstract

The potential substitution of cannabis for prescription medication has attracted a substantial amount of attention within the context of medical cannabis laws. However, much less is known about the association between recreational cannabis laws and prescription drug use. We use quarterly data for all Medicaid Fee-For-Service prescriptions from 2007-2018 to investigate the effect of state-level recreational laws and dispensaries on prescription drug utilization. We estimate this effect using a series of difference-in-differences regression models. For the laws themselves, we find significant reductions in the volume of prescriptions within the drug classes that align with the medical indications for pain, nausea, and seizures. Similarly, we find significant reductions in the number of pain, nausea, seizures, and spasticity prescriptions that are associated with recreational dispensary openings. Our results align with prior literature and offer an estimate of one impact of recreational cannabis access. This study provides important evidence regarding reduced pharmaceutical utilization as well as potentially positive financial spillovers for insurance programs in the United States.

Key words: Cannabis, Drug Policy, Prescription Drug Use, Behavioral Economics, Health Economics

Introduction

The landscape of cannabis policy has changed drastically in the United States since the mid 1990's. While still federally illegal, individual states have begun to adopt laws that contradict the national policy of cannabis prohibition. Since 1996, 33 states and the District of Columbia have passed medical cannabis laws that allow for legal consumption of cannabis for qualifying patients; 11 states and the District of Columbia have passed recreational cannabis laws that allow for the legal consumption of personal-use cannabis for all adults over the age of 21; finally, 17 states have passed high-CBD/low-THC laws that legalize the use of cannabidiol (CBD) extract for qualifying patients (ProCon.org, 2018; ProCon, 2018b, 2018a).

Initially, there was significant concern among the public and policymakers that such laws would lead to an increase in overall drug use (Fox News, 2012; Pew Research Center, 2015; Wood, 2015). This would be particularly concerning given the recent trends in opioid use and opioid-related mortality that have occurred in the United States. However, recent evidence has indicated that medical cannabis laws may in fact reduce the number of prescriptions in Medicare and Medicaid as well as the number of opioid-related deaths (Bachhuber, Saloner, Cunningham, & Barry, 2014; Bradford & Bradford, 2016, 2017; Bradford, Bradford, Abraham, & Adams, 2018; Powell, Pacula, & Jacobson, 2018).

As evidence has indicated that medical laws are associated with a reduction in pharmaceutical drug use, it is reasonable to assume that recreational cannabis would lead to a similar decrease. In fact, we might even expect the reduction to be larger for recreational laws, as a recent working paper by Hollingsworth, Wing, & Bradford (2020) provides evidence that recreational laws lead to a significantly larger increase in cannabis use than medical laws do. Thus, despite the fact that recreational cannabis laws are not designed to facilitate the medical

use of cannabis, easier overall access likely leads to increased substitutability between cannabis and pharmaceuticals.

It is also important to note that many states have restrictive medical cannabis laws that only allow patients with a limited number of conditions to be eligible to access medical cannabis legally. Every state that has passed a recreational cannabis law has passed a medical cannabis law first, sequentially loosening the restrictions preventing people from accessing cannabis. Therefore, when a recreational law is enacted, it might allow people who did not have one of the qualifying conditions, but do have a condition for which they believe cannabis would benefit, to utilize cannabis medically and potentially reduce their use of prescription medications. Thus, if people are in fact using recreational cannabis to treat their medical conditions, we should expect that the utilization of drugs used to treat the conditions for which cannabis has been shown to be an effective treatment to decrease following a policy adoption.

In this study we explore potential relationship between recreational cannabis laws and Medicaid drug spending using Medicaid State Drug Utilization Data (SDUD). We use a series of difference-in-difference models to compare the changes in prescription drug utilization over time between states that adopted recreational cannabis laws and states that did not. We did so for the following conditions: anxiety, depression, glaucoma, nausea, pain, psychosis, seizure disorders, sleep disorders, and spasticity. We find statistically significant reductions in the use of drugs used to treat anxiety, depression, pain, nausea, seizures, sleep, and spasticity when states implement recreational cannabis laws and open recreational dispensaries.

Background

Policy History

Cannabis has been regulated by the federal government since Congress passed the Cannabis Taxation Act of 1937. However, it wasn't until the 1970's that cannabis was officially made illegal when the Controlled Substances Act of 1970 was passed. This law criminalized the consumption, manufacture, and distribution of a variety of substances, including cannabis. Substances were placed into categories with varying levels of restriction, referred to as schedules. Drugs in Schedule I, such as cannabis, are the most heavily restricted. These are the substances that have been deemed by Congress to have a high potential for abuse, no currently accepted medical use, and a lack of accepted safety for use (DEA, 2019). Despite this federal prohibition, states have begun to pass their own laws loosening the restrictions for cannabis use.

Since 1996, 33 states and the District of Columbia have passed their own form of medical cannabis law (ProCon.org, 2018). There is significant variation in the details of each medical cannabis law. For example, each state has a different list of qualifying conditions that a patient must present with before they can receive a recommendation from a physician and thus apply for a medical cannabis card. There are also different means of access that are permitted by individual states. Some states allow home cultivation, where patients or designated caregivers are allowed to grow their own cannabis plant to be used as medication, while other states allow dispensary systems, which act as pseudo pharmacies where patients can purchase medical cannabis from a licensed distributor. Still other states allow both. Other variations in state medical cannabis laws include: the number of designated caregivers that are permitted; whether patient registration is mandatory; the quantity of cannabis or cannabis plants that a patient is legally allowed to possess at one time; the means of consumption (i.e. whether cannabis can be smoked in its whole botanical form); whether a state provides reciprocity for visitors from other medical cannabis states; and the level at which medical cannabis is taxed (ProCon.org, 2018).

In November of 2012, Colorado and Washington became the first two states to pass recreational cannabis laws. These laws legalized the personal, non-medical use of cannabis for all adults over the age of 21. Currently 11 states and D.C. have passed recreational cannabis laws. Similar to medical laws, the details of recreational laws differ substantially from state to state. There is variation in the quantity that can be legally possessed at one time; the allowed means of consumption (i.e. whether smoking is permitted); the means of access; restrictions on where recreational cannabis can be consumed; and the level of taxation (ProCon, 2018b).

Cannabis Laws and Prescription Medication Utilization

As medical cannabis laws have been in place since the mid-1990's, there is a much larger body of literature surrounding the effects of these laws on prescription medication use compared to that surrounding recreational cannabis laws. The evidence collected thus far indicates that, in a variety of settings, medical cannabis laws are associated with a reduction in the utilization of the prescription drugs that are used to treat the conditions for which there is some evidence that cannabis may be an effective treatment, including opioids (Bradford & Bradford, 2016, 2017; Bradford et al., 2018; Ozluk, 2017; Wen & Hockenberry, 2018). Additional evidence indicates that medical cannabis laws and dispensaries may lead to a reduction in opioid related mortality of between 18 to 35 percent (Bachhuber et al., 2014; Powell et al., 2018), although more recent evidence suggests that this effect may have reversed over time (Shover, Davis, Gordon, & Humphreys, 2019)

As previously mentioned, as recreational cannabis laws are such a recent phenomenon, the body of literature surrounding the potential impacts on prescription medication utilization is much less developed. Wen & Hockenberry (2018), present evidence that that recreational

cannabis laws reduce opioid prescribing specifically in the Medicaid population, the same setting as the current study. Importantly, the reduction was found to be larger in recreational states than it was in states that only adopted medical laws. Finally, similar to medical laws, recreational cannabis laws have also been found to be associated with a reduction in opioid-related mortality, with dispensary-based laws inducing the largest effect (Chan, Burkhardt, & Flyr, 2019).

Empirical Strategy

Data

To investigate the impacts of these policies on prescribing, granular payor-level data would be ideal. Since these data are not readily available, we opt to use Medicaid State Drug Utilization Data (SDUD), which provides quarterly totals of drug utilization indexed at the national drug code (NDC) level. These data, which serve as the primary data for our analysis, were retrieved from the National Bureau of Economic Research (NBER) archive and capture years 2007 to 2018.

These data detail drug utilization in the form of prescriptions written, units reimbursed, and fee-for-service (FFS) dollars reimbursed by Medicaid. The Medicaid Drug Rebate Program (1990) requires quarterly reporting of drug utilization from participating states. All states except for Arizona opted into the program initially, although Arizona did join in 2010. Though these data are limited to aggregate counts of disbursed drugs, they are insightful in providing quarterly measures of drug utilization in our states of interest. Furthermore, the SDUD data do not permit stratification of our analysis by race, gender, or other demographic factors. We restricted our sample to align with a prior analysis by Bradford & Bradford (2017), identifying only drugs with indications for substitutive clinical cannabis applications or that treat common state qualifying

conditions. Thus, our analysis studies nine clinical areas: anxiety, depression, glaucoma, nausea, pain, psychosis, seizure disorders, sleep disorders, and spasticity. Note that these categories of drugs include both on- and off-label prescriptions.

Data on our key explanatory variables of interest, recreational cannabis laws and dispensaries, as well as information on medical cannabis laws were sourced from Hollingsworth et al. (2020) . A complete set of sources is available upon request. Covariate data was retrieved from multiple agencies and publicly available sources. Unemployment data was sourced from the Bureau of Labor Statistics (BLS) Local Area Unemployment files for the relevant years. This allows us to adjust for state-level economic changes that may impact Medicaid enrollment. Median income at the state level was sourced from the Census Bureau portal for Current Population Survey (CPS) data. We control for changes in our study population by dividing the reimbursed units of our selected drug groups by state-level fee-for-service Medicaid enrollment counts retrieved from the Centers for Medicaid and Medicare Services (CMS). Coding and dating for active must-access prescription drug monitoring programs (PDMPs) was adapted from Buchmueller & Carey (2018) and were used as a covariate in our analysis. Coding and dating for Medicaid expansions is used as specified by Carey, Wherry, & Miller (2018) to account for 2016 and 2017 expansions. Active physician counts at the state-year level were extracted from Area Health Resource Files (AHRF) produced by Health Resources and Services Administration (HRSA).

Measures

We aggregated the number of units reimbursed at the state-year level for each study drug class from the State Drug Utilization Data. We then divided this aggregate count by state-level

Medicaid enrollment counts to generate a per-capita unit reimbursement value. Our outcome variable of interest was the log of per-capita units reimbursed by Medicaid in each state per quarter and year. This outcome of interest was created for each of the nine clinical drug classes that we account for in our analysis. Our primary explanatory variable was the presence of a state recreational cannabis law for each observation. This treatment indicator was coded as having a value of 1 when an observation was in a state, year, and quarter with a recreational law and 0 otherwise. Indicators were also coded for the presence of medical cannabis laws and the existence of medical or recreational cannabis dispensaries. As covariates, we used the following state-level characteristics: whether the state had a must-access PDMP in place; the number of active physicians per capita; the proportion of households living below the federal poverty line; the median household income; the average unemployment rate; the overall population; whether the state had expanded Medicaid under the Affordable Care Act; whether the state had a medical cannabis law in place; whether the state had medical dispensaries active. State and region-by-year fixed effects were also included.

Statistical Analysis

We fit a series of difference-in-difference models to estimate the effect of recreational cannabis laws on the number of units reimbursed for our chosen drug groups. These models compare the group means of our treated and non-treated (control) states before and after cannabis legalizations. These comparisons are presented as the estimated effect of legalizations on utilization in treated states compared to control states. Our model for the logged prescriptions per capita per quarter, y_{st} , in state s and quarter t is the following:

$$(1) \ln(y_{st}) = \beta_0 + \beta_1 Medical_{st} + \beta_2 Recreational_{st} + \beta_3 Med.Dispensary_{st} + \beta_4 Rec.Dispensary_{st} + \beta X_{st} + \mu_s + \theta_{r(s)t} + \varepsilon_{st}$$

In our approach: *Medical_{st}* is an indicator variable for whether state *s* had an effective medical law in place in year *t*; *Recreational_{st}* is an indicator variable for whether state *s* has a recreational law in effect in year *t*; *Med.Dispensary_{st}* is an indicator for whether state *s* had at least one medical dispensary open in year *t*; *Rec.Dispensary_{st}* is an indicator for whether state *s* had at least one recreational dispensary open in year *t*; *X_{st}* is a vector of covariates indexed at state-time; and finally, μ_s and $\theta_{r(s)t}$ are state and region-by-year fixed effects. This two-way fixed effects setting allows us to adjust for unobserved state-level and region-by-year level trends that may bias the effect of our explanatory variable on our outcome of interest. Our primary difference-in-differences coefficients of interest are the indicators for whether a state has an effective recreational cannabis law and the indicator for whether a state has as an active dispensary system. We opt to utilize region-by-year fixed effects in an attempt to adjust for regional variations in recreational cannabis policy rollout. All standard errors are clustered at the state level.

Results

Table 1 shows variable means and standard deviations. For the regression results, in three of the nine clinical areas studied, we found a significant ($p < 0.05$) negative associations between the presence of a recreational cannabis law and quarterly logged units of each medication field. These results are presented visually in Figure 1. Exact numerical values can be found in Appendix Table 2.3. We found that having a recreational cannabis law in place led to the following decreases in utilization of the following drug classes: a 23 percent reduction for drugs

used to treat nausea ($p < .05$); a 16 percent reduction for drugs used to treat pain ($p < .05$); and a 20 percent reduction for drugs used to treat seizures ($p < .01$). Four condition categories (depression, anxiety, seizures, and sleep disorders) only saw a marginally significant reductions at the 10% level.

Recall that our second primary explanatory variable of interest is an indicator variable for whether a state had at least one active recreational dispensary. We find statistically significant results for four of the nine categories of clinical conditions. Specifically, we find: a 31 percent reduction in drugs used to treat nausea ($p < .05$); a 26 percent reduction in drugs used to treat pain ($p < .05$); a twenty-seven percent reduction in drugs used to treat seizures ($p < .05$); and finally, a twenty-nine percent reduction in drugs used to treat spasticity ($p < .05$). The results for sleep disorder medications were only marginally significant. A coefficient plot of these results can be found in Figure 2, while the full set of results can be found in Appendix Table 2.4.

We ran two primary robustness checks. A key underlying assumption of difference-in-difference modeling is parallel pre-treatment trends for the treatment and control groups, meaning that the effects seen in the regression estimates can be identified as the effect of our explanatory variable. To test this assumption, we estimate a set of event study analyses which allow us to visually assess if our key variable of interest is associated with significant non-zero pre-treatment differences. Our event study graphs can be found in the Appendix; we found no violations of the parallel pre-trend assumption. Additionally, following the approach of Bradford & Bradford (2017), to rule out unobserved state-based characteristics, we performed falsification tests with drugs from four classes in which there is no evidence of any effect from cannabis. These drug classes were blood-thinning agents, phosphorous-stimulating agents for patients with end-stage renal disease, antivirals used to treat influenza, and antibiotics. We found no consistent

evidence of a statistically significant association between having a recreational cannabis law and the utilization of drugs in these four classes.

Limitations

Our study faced several limitations, some of which were addressed in our empirical approach and selection of drug classes. First and foremost, our study is reliant on data from the Medicaid population. Our use of the Medicaid State Drug Utilization Data files as the primary source for our analysis means that we were restricted to the fee-for-service population of Medicaid enrollees. While Medicaid Managed Care data is included in the SDUD, prior to 2011 the managed care prescription data were unreliable, so we chose not to include it. Thus, our estimated effect of recreational cannabis laws for Medicaid following recreational cannabis legalization serve as a lower bound, as we do not include data from the Medicaid managed care population.

An additional limitation of this study is the continuing legalization of cannabis in many states. In the most recent year excluded from our study (2019) due to a lack of data availability, three additional states decriminalized cannabis and one state (Illinois) legalized recreational cannabis. In 2018 (the most recent year of data used in the study), Oklahoma legalized medical cannabis, Michigan and Vermont legalized recreational cannabis, and additional states legalized CBD for any use. Thus, we may not capture the full effect of recreational cannabis laws in our analysis and our results should be viewed as a conservative estimate of the effect of these policies.

Finally, these data are aggregated to the drug-state-quarter level. As they are not at the individual level, we cannot infer anything about individual-level responses to recreational

cannabis legalization and access so as to avoid an ecological fallacy (Finney, Humphreys, Kivlahan, & Harris, 2011).

Discussion

The purpose of this study is to investigate the role of recreational cannabis laws and dispensaries on prescribing in the Medicaid Fee-For-Service population. While these laws are intended to facilitate recreational use, it is likely that they might still reduce prescription medication use as increased access allows for increased substitution. This is particularly important as there are a variety of medical conditions that are not protected under individual state medical laws but that might still lead patients to experiment with their own medical treatment. Even within the medical conditions that are protected under state laws, some patients might have been deterred from speaking with their physician due to stigma or desire to avoid the ordeal associated with obtaining medical cannabis.

We find a statistically significant reduction in prescriptions used to treat three broad categories of medical conditions associated with a recreational cannabis laws going into effect, and significant reduction in four broad categories associated with recreational dispensaries. Interestingly, we did not find a consistent evidence in a significant reduction associated with medical laws during our time frame, in contrast to Bradford & Bradford (2017). This could indicate that the reduction in prescriptions in the Medicaid FFS populations was more short-lived than was initially assumed. This result would fall in line with recent evidence indicating that the negative association between medical cannabis laws and opioid mortality may have been short-lived as well (Shover et al., 2019).

Our results suggest that recreational cannabis laws are having an impact on the pharmaceutical medication market, a result which fits within the body of literature thus far. While we cannot directly measure any substitution between prescription medication and cannabis, these results imply that some patients are responding to recreational laws in a similar way that they did to medical cannabis laws. This study represents an important next step in investigating the effect of cannabis liberalization on prescription medication utilization, although more research is needed to capture the full social, economic, and medical effect of such policies.

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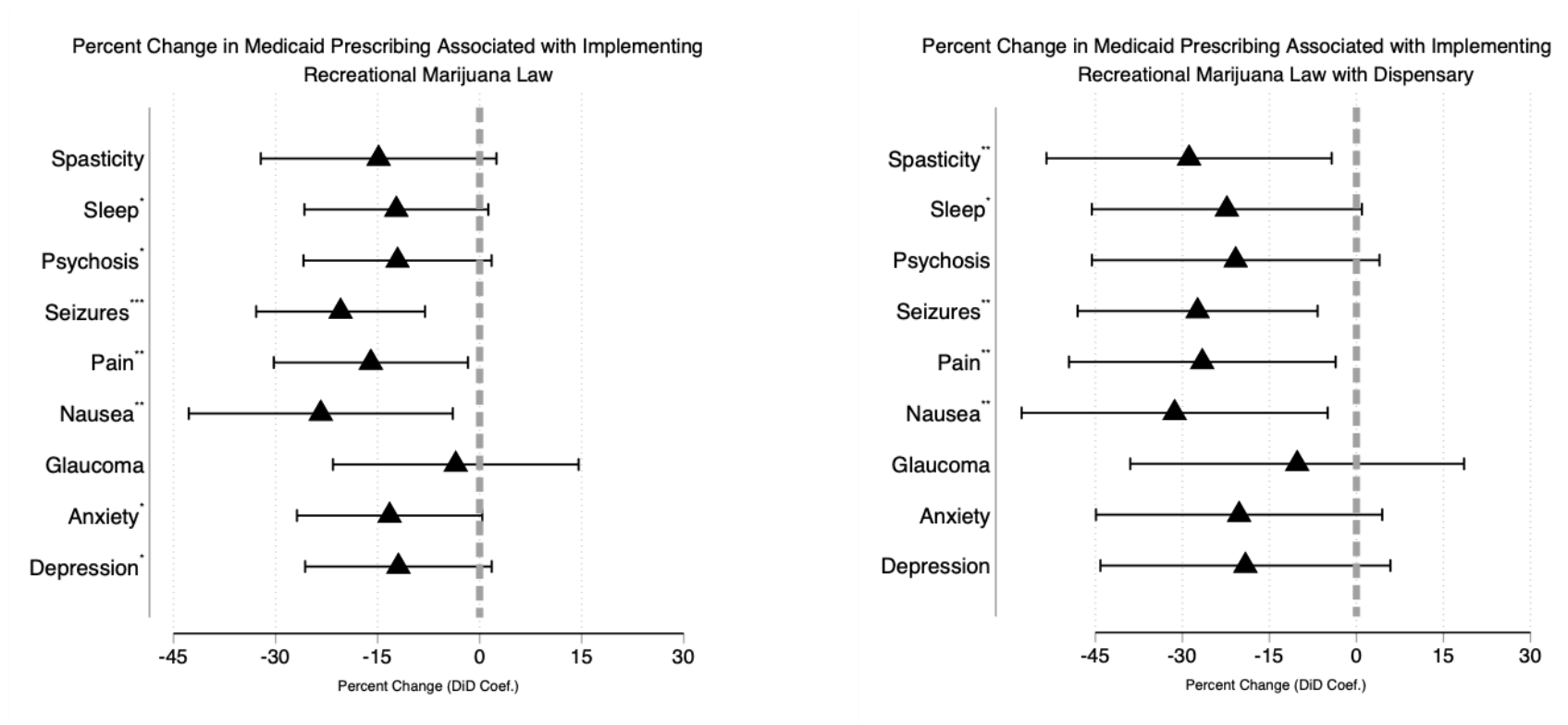
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Table 1: State/Year Level Means and Standard Deviations for Variables of Interest

	Total	No RML	Active RML
Depression Units per Enrollee	20.28 (7.08)	20.66 (7.20)	18.58 (6.28)
Anxiety Units per Enrollee	18.80 (7.05)	19.07 (7.14)	17.63 (6.49)
Glaucoma Units per Enrollee	2.61 (1.27)	2.80 (1.29)	1.80 (0.68)
Nausea Units per Enrollee	6.25 (3.20)	6.46 (3.15)	5.34 (3.24)
Pain Units per Enrollee	52.63 (19.13)	53.61 (19.83)	48.29 (14.88)
Seizures Units per Enrollee	21.91 (7.77)	22.06 (8.01)	21.26 (6.59)
Psychosis Units per Enrollee	23.65 (8.02)	24.25 (8.18)	21.01 (6.67)
Sleep Units per Enrollee	17.05 (6.01)	17.59 (6.05)	14.67 (5.22)
Spasticity Units per Enrollee	1.83 (0.81)	1.82 (0.82)	1.87 (0.80)
Blood Units per Enrollee	0.15 (1.60)	0.16 (1.76)	0.10 (0.30)
Phosphorus Units per Enrollee	0.07 (0.06)	0.06 (0.04)	0.11 (0.10)
Flu Units per Enrollee	0.17 (0.42)	0.19 (0.46)	0.08 (0.11)
Antibiotics Units per Enrollee	1.24 (0.78)	1.32 (0.82)	0.91 (0.44)
Medicaid Enrollment (millions)	1.21 (1.65)	1.11 (1.17)	1.68 (2.89)
Unemployment Rate	0.06 (0.02)	0.06 (0.02)	0.07 (0.02)
Median Income per Household	54502.41 (9874.80)	53115.16 (9564.60)	60628.57 (8848.35)
Expanded Medicaid	0.26 (0.44)	0.22 (0.41)	0.45 (0.50)
Has Active PDMP	0.80 (0.40)	0.80 (0.40)	0.78 (0.41)
	N=2,164	N=1,765	N=399

Note: Units of each drug class per enrollee were aggregated from the Medicaid State Drug Utilization Data [SDUD]. Medicaid enrollment was sourced from reports produced by the Centers for Medicare and Medicaid Services. Unemployment rates were sourced from Bureau of Labor Statistics Local Area Unemployment files. Median income was sourced from the FRED archive at the Federal Reserve Bank of St. Louis. Medicaid Expansion status was sourced from coding in Carey, Wherry, & Miller (2019) and presence of an active prescription drug monitoring program (PDMP) was validated by Buchmueller & Carey (2018) and updated to capture the years of our analysis that theirs did not.

Figure 1: Coefficient Plot for 9 Testing Drug Classes



Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. DiD regression coefficients are plotted from same specification with all covariates, the first plot shows only the effect of recreational marijuana laws, the second shows the effect of recreational marijuana laws with dispensaries. This specification includes covariates for unemployment, median income, number of active physicians, Medicaid expansion status, and active PDMPs, with population weighting and robust standard errors and is listed in our empirical method. The triangular points represent the coefficient associated with the percent change in the utilization of drugs in the corresponding class. Brackets represent 95% confidence intervals, calculated from robust standard errors clustered at the state level. DiD regression coefficients use a natural log transform of the raw data where the coefficient is transformed by

100(exp(coef.)-1) and the standard errors are transformed using the delta method.*