Recreational marijuana pervasiveness and student influx and outflux to college

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Abstract: How does the pervasiveness of recreational marijuana legalization (RML) affects education outcomes, enrollments and completion? we utilize institution level surveys, enrollment and completion from IPEDS, along with Difference-in-Difference[1] identification to answer this question. The findings show that RML increased enrollment especially after practical implementation of the policy, but it has a negative effect on completion among non-STEM majors also after retail stores are open. Hence, we document an evidence that RML stimulates an influx toward colleges but depresses outflux to college education among non-STEM majors. The latter findings are related to undergraduate education, associate and bachelor levels.

Keywords: RML, STEM, IPEDS, Difference-in-Difference, influx, outflux, associate and bachelor

[1] i'm also trying to use synthetic controls but I run into some issues related to having more than one level data, county and school units

1 Introduction

The pervasiveness of recreational marijuana legalization (RML) has become a controversial subject among politicians, researchers, and citizens. Whereas medical marijuana (MM) has long been permissible in many states, legal in more than 30 states as of 2020 according to Carnevale Associates (2022), recreational marijuana (RM) has been legalized by merely 12 states as of 2020 (Carnevale Associates, 2022). The literature studied the effect of MM on different aspects extensively. WhereasWen et al. (2015); Cerdá et al. (2012); Martins et al. (2016) results showed that MM legalization leads to a higher use and addiction of marijuana, Morris et al. (2014); Gavrilova et al. (2019) found that MM legalization have no effect on crime or even reduce certain crime rates such as that of homicides and rape. Using Twitter data, Carnevale Associates (2022) showed that consumption or use of marijuana concentrates are higher in states that legalized marijuana for recreational or medical use.

In 2018-2019 academic year, over 20 percent of high school seniors reported vaping marijuana according to National Institute on Drug Abuse (2019); the latter expressed alarming concerns about THC,a psychoactive ingredient of marijuana, vaping as not much is known about the effect of this THC vaping as opposed to smoking. Furthermore, the ubiquity of marijuana through recreational legalization have shifted cultural beliefs regarding marijuana usage among college students (Koval et al., 2019). According to Pearson et al. (2018), college culture that considers marijuana usage as an integral part of college experience (internalized norm) plays a major rule in how impulisvity and sensation seeking personality traits lead to more marijuana consumption among college students. In addition, there is a similar but high trend of marijuana usage among college and non-college youth with 44 percent of college students reported using marijuana and similar percentage (43 percent) of non-college youth (Schulenberg et al., 2021). In light of the growing marijuana usage among college students along with the cultural shift inducing more marijuana consumption among college students, we intend to examine how RML affects undergraduate enrollments [2] by using a

[2]We will also attempt to study other outcomes such as completion and graduation rates as IPEDS provide those outcomes, but we shall focus for now on enrollment outcome since the literature to the best of our knowledge didn't cover enrollment.

panel data from IPEDS and various other sources. We also study heterogeneous effects on gender, enrollment by age, and enrollment types. Although it's difficult to pinpoint the exact mechanisms driving our results as marijuana consumption can be induced by many factors such as student's personality, prior drugs consumption , college drugs related culture, and regulation enforcement by local or college authorities, we will at least attempt to demonstrate that the observed effects are due in fact to marijuana consumption.

The literature examined the effect of marijuana legalization on educational outcomes, but non to our knowledge considered enrollment and most focus on limited geographical location without taking into account the legalization shocks cross states. Using data from a cohort of 3246 students from 11 colleges in only two states, North Carolina and Virginia, Suerken et al. (2016) examined the effect of marijuana use trajectories on academic outcomes (senior year enrollment, plans to graduate on time, and GPA). The findings show that compared to non-users, marijuana users of different consumption patterns have low likelihood of continued enrollment in senior years, low likelihood to plan to graduate from college on time, and lower GPAs on average. Nonetheless, this study doesn't not take into consideration whether or not North Carolina and Virginia states legalized recreational marijuana. In this paper we focus on determining the effect of marijuana pervasiveness on academic outcomes, influx of students from high school to college in particular. In the same vein, marijuana use is negatively associated with GPA and graduation time through low class attendance (Arria et al., 2015). Further, compared to non-users, marijuana users are more likely to drop out or finish the program late (Suerken et al., 2016).

Nonetheless, the effect of the proliferation of marijuana legalization, mediated by an increase in consumption, on educational outcomes is scant. Only few studies examined this effect. Marie and Zölitz (2017) used a unique dataset of students grades in Maastricht city in the Netherlands and exploited the introduction of a policy that banned foreign nationalities from buying marijuana [3] Their results align with the health studies that showed that marijuana consumption affects cognitive abilities essentially and consequently impact the quantitative performance. They also used

[3]The city wanted to tackle the negative externalities associated with cannabis tourism through banning all nationalities but locals, Germans, and Belgians from purchasing marijuana at local shops.

class evaluation data to prove that the improvements in the grade among banned students were merely due to improved understanding in the classrooms. The placebo test for robustness check solidifies the findings, switching the policy time and placing false nationalities for the ban. Cerdá et al. (2017) investigates the use and the perceived harm of recreational marijuana (RM) among 8th and 10th graders. Using diff-in-diff specification to study how RM legalization in Washington and Colorado states, the first to legalize marijuana, affected high school student consumption of marijuana along with the associated harm perception, they found that marijuana use (perceived marijuana harm) among 8th and 10th graders in Washington increased (decreased); they found though no significant difference in use pre and post RML in Colorado. We contribute to this literature by first using institution, community colleges, colleges, and universities, level data (IPEDS) coupled with county level covariates which enable controlling for time and county level fixed effects as well as institution characteristics. While it's arguable whether the shock is exogenous as social movements could have triggered states to legalize RM, we exploit the panel format of the data through using diff-in-diff and synthetic control [4] specifications. We also use falsification or placebo tests for further robustness check[5].

Our finding show that states that legalized marijuana are attracting more college students; states that legalized RM have about 5 percent more first time enrollment than states that did not legalize RM. With the growing internalization norms of marijuana use in colleges, we hypothesis that high school students especially those majoring in non-STEM programs choose to complete their undergraduate education in states that legalized marijuana for recreational use. Further, first time enrollment is greatly affected after the policy is in effect for more than two years, the time upon which the policy is implemented by opening dispensaries. Further, the implemented legalization has no effect overall on the number of degrees conferred, but we find a negative effect on non-STEM bachelor degree counts, suggesting that STEM majors are not affected by the policy intervention.

[4] I'm still learning this method, so it may be implemented if time allows

[5] i'm thinking about assigning the policy shock to random states and regenerate my results, but I haven't done this yet

The paper proceeds as follow. In the next section, we discuss related literature. The third section presents data and summary statistics followed by the model equation and description. Finally, we present the results, discussion and conclusion.

2 Literature review

Since the acceptance to enroll in medical marijuana program is heterogeneous in that states differ in the degree at which they enforce pharmaceutical standards, Williams et al. (2016) found that among the 23 states that legalized MM, 14 states can be characterized as non-medical as their programs are nearly unregulated.

As more and more states are legalizing marijuana for recreational use, the latter is receiving more attention in the past few years. Exploiting the legalization times and border sharing between two states, Oregon and Washington, Dragone et al. (2019) used combined discontinuity design and difference-in-differences specifications to show that RML caused reduction in crimes, especially rape which is associated with alcohol consumption.

CRIME RELATED

HEALTH RELATED

based on national representative survey of 16,280 adults,Ishida et al. (2019) found that among the sub-sample that declared consuming both opioids and marijuana 41 percent of these opioid users switch to marijuana. In the same vein, Mathur and Ruhm (2022) showed an existence of positive association between marijuana dispensaries and opioid deaths. Figure 3 shows a positive association between drug deaths per 100K individuals and google search for dispensary location popularity.

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3 Background and Data

Figure 2 (b) illustrates an increase of google search for word or marijuana store locations ”dispensary” as more state legalized marijuana for recreational use. The same figure (a) shows higher google trend for dispensary in states that legalized RM. In light of pervasiveness of marijuana legalization, we aim to investigate the effect of RML on post secondary education outcomes, namely the influx of students to post-secondary education.

3.1 Policy definition

We used different sources to establish the time upon which each sate legalized RM. We also take into account the year in which the law is implemented, opening first dispensary stores. Based on Carnevale Associates (2022), MPP (2022), Kim et al. (2020) ,and online searches, Figure 4 depicts the time line of marijuana legalization by each state. We distinguish between the year in which the legalization became legal (law) and the year in which the law went into effect by distributing retail licences (first store or dispensary evidence). States that legalized marijuana by law but didn’t implement the law are excluded from the data so that our study focuses on states that legalized marijuana not just legally but also practically, opening dispensaries. Among all the states that legalized marijuana within our data period (2009-2019), six states satisfy the practical legalization condition: Colorado, Washington, Oregon, California, Massachusetts, and Nevada.

3.2 Fall enrollment

The National Center for Education Statistics (NCES) conducts each year twelve interrealated educational surveys, known as Integrated Postsecondary Education Data System (IPEDS). The latter is the main source of our data. We extracted and joined relevant surveys (enrollment and directory or institution characteristics) year by year from 2009 to 2019. The latter is chosen because IPEDS added the county geographical information to the survey starting from 2009; we also avoided using post pandemic periods so as to focus merely on the RM shock.

The enrollment survey U.S. Department of Education (U.S. Department of Education) includes both higher education and vocational institutions; we omitted the latter by restricting the sample to two year programs or above, excluding all institutions that are listed as career or vocational based on the institution name, including institutions that have at least 50 overall enrollments as most if not all the colleges and universities meet this threshold. We posit that colleges of less than 50 students in all the departments is too small and its enrollments can be affected by the management decisions. The threshold is needed also for practical reasons as we study the effects of RM on different groups, sex and race. We also included the institution characteristics survey to control for differences such as college size and geographical zones.

3.3 degree Completion

Completions survey contains the number of awards by institution, type of program, type of major (first or second), and award level. For our analysis we focus on the first major awards for associate and bachelor programs. We bind the cross-sections of the survey from 2009 to 2019. We restrict the sample to post-secondary intuitions by excluding career and vocational institutions. Further we classify type of program to STEM (Science, technology, engineering, and mathematics) and NON-STEM programs to examine any potential heterogeneous effects. We use STEM definition of SMART program by the Department of Defense that deems its defined STEM programs as critical to the national security (SMART, 2022).

3.4 Google trends

Google trends [6] refers to a normalized number, refer to as hits, that's between zero and hundred, depicting the popularity of a search for a word among other searches at a each state and time, year. Google trend measures are based on unbiased samples of all the google searches. We use the google trends measures related to the word "Dispensary" as a proxy for the demand for marijuana because

[6] The following post by Simon Rogers, a Data journalist and Data Editor at Google as of 2016, provides further details about google trend data: What is Google Trends data — and what does it mean?

people usually look up the location of marijuana stores by searching the word ”Dispensary”. We also use other google search terms for robustness check: the average hits for ”marijuana”, ”weed”, and ”pot”. Nonetheless, we posit that ”Dispensary” search is the most relevant word as it usually refers to where people buy marijuana.

3.5 Other variables

We incorporate two county level covariates, the population and real per-capita income ,from Bureau of Economic Analysis (BEA)[7] We also used the Bureau of Labor Statistics (BLS) county level data to control for unemployment rate. Hillman and Orians (2013) found positive association between undergraduate enrollments and unemployment rate.

4 Model

We use difference in difference specification with fixed effects (time, state and county) and covariates related to county level demographics and institution level characteristics.

$$Y_{ikjt} = \alpha + \beta_1 \text{RM}_{jt} + \beta_2 \text{MM}_{jt} + \delta X_{kjt} + \delta Z_{ikjt} + \phi_k + \theta_t + \epsilon_{ikjt} \tag{1}$$

$$Y_{ikjt} = \alpha + \beta_{11} \text{RM12}_{jt} + \beta_{12} \text{RM3+}_{jt} + \beta_2 \text{MM}_{jt} + \delta X_{kjt} + \delta Z_{ikjt} + \phi_k + \theta_t + \epsilon_{ikjt} \tag{2}$$

where Y_{ijkt} refers to the the outcomes of interest, first time fall enrollment and degree completion counts for institution i in county k and state j at time t. RM_{jt} is a dummy variable for the adoption of recreational marijuana law; it is assigned one if state j legalized marijuana at or after time t. Similarly, MM_{jt} is a binary variable for the adoption of medical marijuana law. MM and RM are staggered dummies in that RM represents a continuation of MM. We also use variation of equation (1) by splitting RM dummy into short and long term dummies; the former (RM12) is assigned one if the policy (RM) is adopted within the previous two years; the long term binary

[7]We extracted BEA series through an R package, ”bea.R”.

(RM3+) is assigned one if the policy takes place after two years.

X and Z refer to all baseline county and college covariates which we control for. We also control for county level fixed effects,ϕ_k, and time fixed effect,θ_t

4.1 Common trend assumption

The validity of our specification hinges primarily on parallel trend assumption; although figures visualizing pre-treatment outcome by group depicts that this assumption is nearly valid (see figure 2), we implement Abadie (2005) and Prince and Simon (2017) test and found that the coefficient of the interaction of time and treatment dummy is insignificant (see table 6). Note that in the latter table the sample is restricted to the pre-shock period, so the insignificance of the interaction terms provides more support to the claim that common trend assumption holds.

5 Results

Overall states that legalized marijuana seem to attract more college enrollments especially in the long term. Table 4 (panel A) shows that compared to states that didn't legalize marijuana for recreational use, states that did have about 5.4 percent more first time enrollment; said another way, first time enrollment (total enrollment) changes or increases by 5.4 (9.7) percent as states switch from being Not-RM to RM.

When we break down the effect into short, the past two years of legalization, and long term, after the 2nd year of legalization, we notice that the first time enrollment is only positively affected in the long term so that RM states seem to attract more enrollment only after the policy went into effect for more than two years (see table 5). Also, the magnitude of enrollment changes is higher in the long term. One potential explanation is that states that legalize RM take about one to two years to implement the policy and eventually giving licences for dispensaries. For instance, as shown in figure 4 Colorado legalized marijuana for recreational use in 2012 but the first marijuana store was open in 2014.

Even though RM policy has no effect on overall number of degrees conferred, it has negative effect on number of bachelor degrees or awards upon implementation of the policy, after two years of policy intervention (see table 7). The number of bachelor completion decreases by about 16.3 percent as states switch to RM legalization after 2 years. The latter result is driven by non-STEM program completion as shown in table 8. One possible explanation for this finding is the existence of sample selection in STEM program completion. STEM majors are known to require intense technical and quantitative skills, so only highly qualified students choose to pursue this type of programs. While we have no evidence to show the STEM majored students consume less marijuana or none compared to their counterpart, non STEM majored students, one can also argue that STEM programs provide better success incentives. For instance, the Department of defense SMART's program provide full tuition, summer internships, mentoring services, and other benefits[8] for qualified STEM majored students

6 Discussion and conclusion

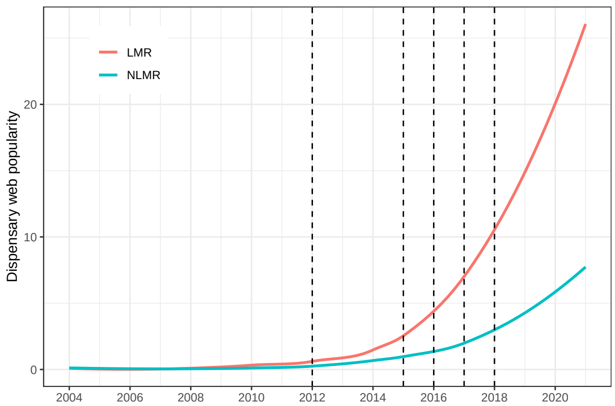
- need to show higher marijuana consumption if RM states
- mechanisms for higher enrollment: shift in college culture and perception of marijuana harm (cite papers here)
- further mechanisms for lower bachelor completion (NOT SURE!) among non-stem students; it's intuitive that non-stem are more likely to over-consumer marijuana but I need to find some evidence for that.
- implication for policy makers and college boards

[8]source: SMART program benefits

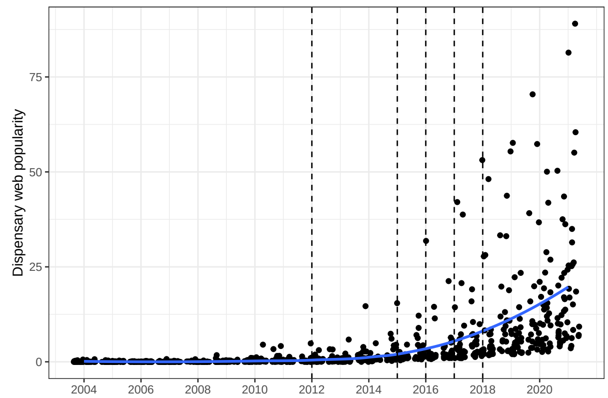
Figures and tables

6.1 Figures

Figure 1: Marijuana consumption indicator by legalization status



(a)

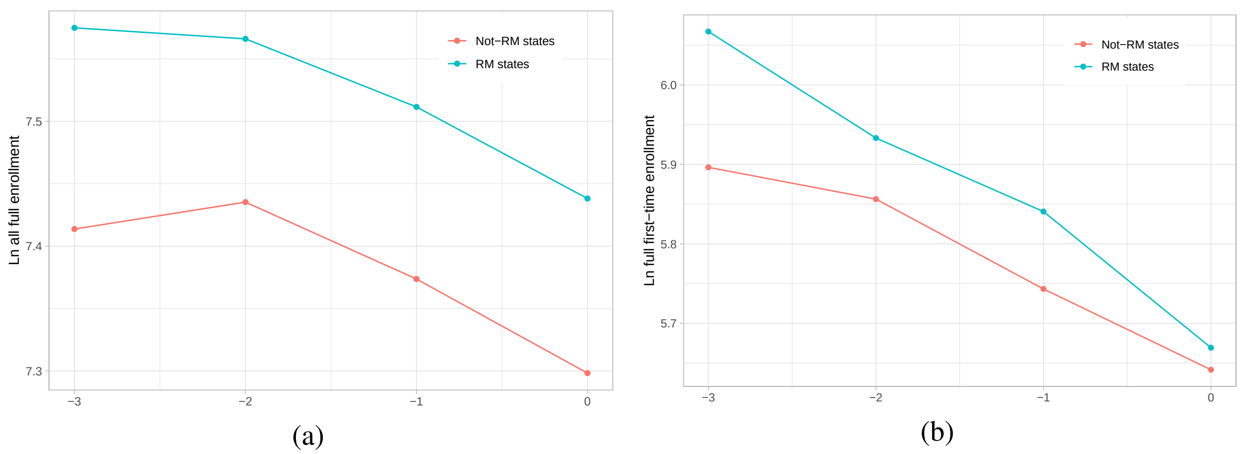


(b)

Note: The vertical lines refer to the time period in which a state legalized marijuana for recreational use (LMR) ; for instance, Washington and Colorado LMR in 2012. Google web popularity [9](refer to as hits in google trend) is a number between 0 and 100 that measures the popularity of google search terms or words, showing how popular a word is among all other searches in particular region and time. In figure (a), we took the average of google web popularity for both states that LMR and those that didn't legalized marijuana for recreational use (NLMR). Also, note that NLMR include states that legalized marijuana for medical use which explains why NLMR have an increasing but smaller web popularity for dispensary compared to LMR states.

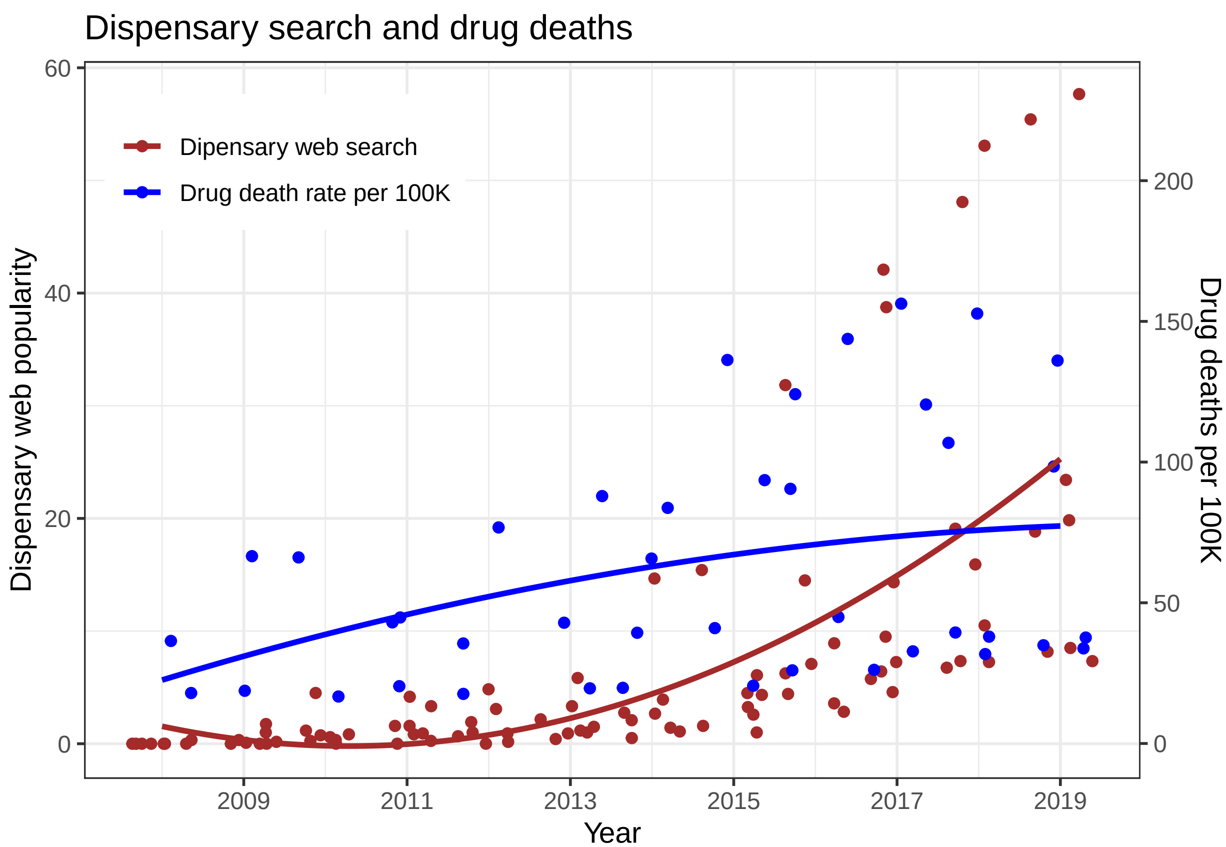
[9]We extracted google trend data via 'gtrendsR', an R library. Data source: Google Trends (https://www.google.com/trends)

Figure 2: Common trend



Note: In the x-axis, zero refers to 2012, the first year in which RM is first legalized by Colorado and Washington states. The plots show that common trend nearly holds before the policy shock for both first time and all undergraduate enrollments.

Figure 3



Note: The figure illustrates an existing positive association between web search for dispensary[10](marijuana consumption proxy) and drug related deaths per 100K [11]. Whereas the point show the actual measures, the lines represent the quadratic linear fit or trend.

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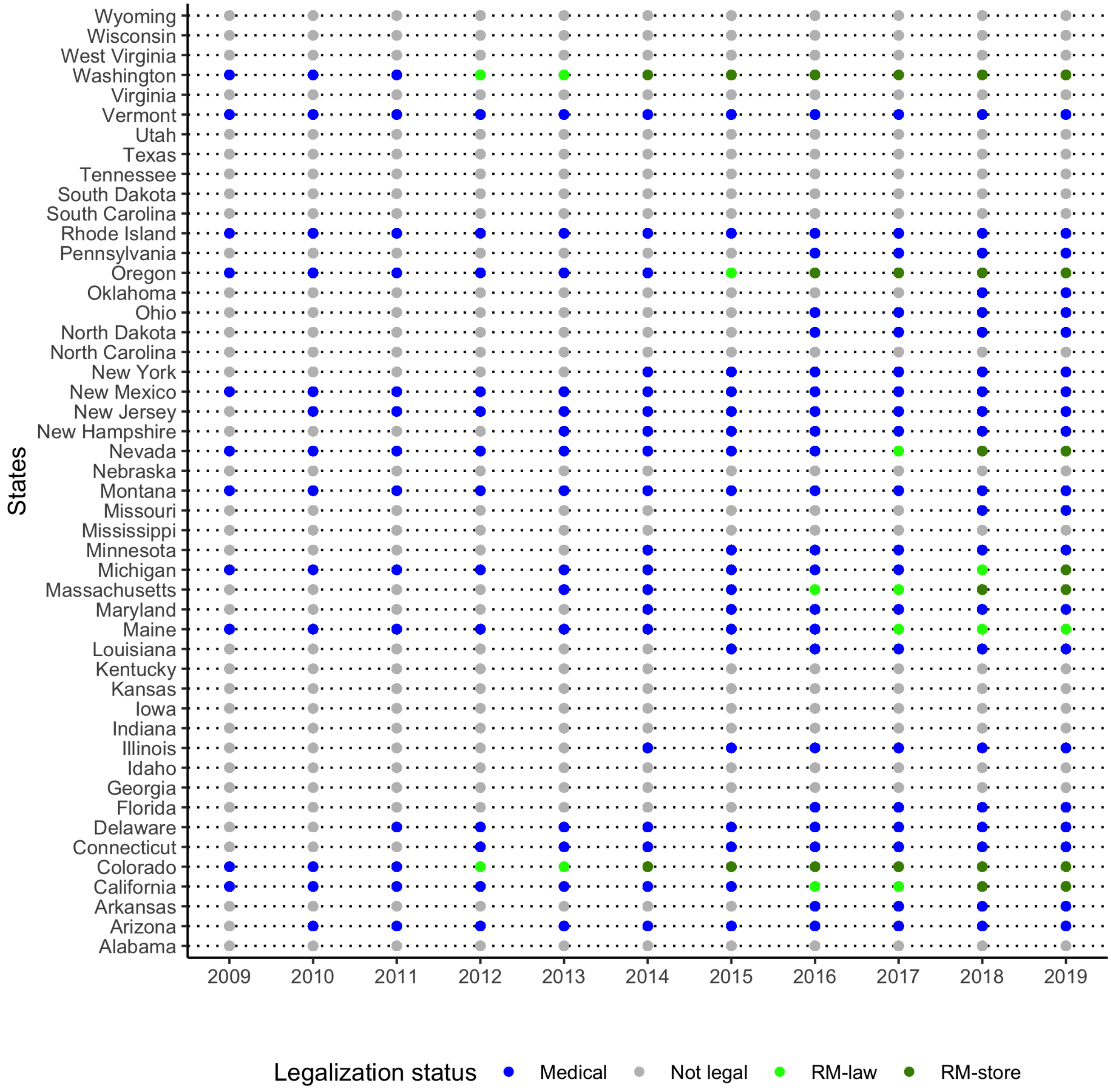
[11]We extracted google trend data via 'gtrendsR', an R library. Data source: Google Trends (https://www.google.com/trends)

[12]We extracted the drug mortality for age groups 15 to 34 from CDC CDC WONDER database (WONDER, 2022)

Figure 4: Marijuana legalization timeline



Note: The gaps depict transition from one status of legalization to another. DC, Arizona and all US territories are excluded due to either not sharing borders or unavailability of county and enrollment data.

6.2 Tables

Table 1: Summary statistics by group-enrollment sample

	Not RM states					RM states				
	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Panel A: first time fall enrollments										
Total enrollment	24292	6.187	1.142	3.932	10.629	5413	6.398	1.262	3.932	9.100
Female enrollment	24292	5.576	1.184	0.000	10.307	5413	5.798	1.246	0.693	8.660
Male enrollment	24292	5.255	1.421	0.000	9.338	5413	5.457	1.574	0.000	8.490
African American enrollment	22994	3.958	1.507	0.000	8.548	5183	3.397	1.388	0.000	7.142
Hispanic American enrollment	22994	3.510	1.683	0.000	9.204	5183	4.835	1.614	0.000	8.214
White enrollment	22994	5.314	1.608	0.000	9.468	5183	5.275	1.502	0.000	8.489
Per-capita income	23863	10.645	0.261	9.878	12.036	5413	10.790	0.266	10.068	11.734
Population	23863	12.303	1.507	7.820	15.475	5413	13.716	1.492	8.756	16.128
Unemployment rate	23863	6.419	2.557	1.100	25.600	5413	7.345	3.428	1.900	29.400
Large college dummy		0.793					0.818			
Medical degree dummy		0.044					0.035			
Not private dummy		0.865					0.834			
City location dummy		0.638					0.837			
Unique N Institutions or colleges	2732					635				
Unique N Counties	1095					121				
Unique N States	40					6				
Unique N Years	11					11				
Panel B: total fall enrollments										
Total enrollment	28924	7.368	1.427	3.932	12.658	6711	7.569	1.601	3.932	10.709
Female enrollment	28924	6.812	1.514	0.000	12.294	6711	7.020	1.586	1.386	10.358
Male enrollment	28924	6.307	1.714	0.000	11.472	6711	6.515	1.949	0.000	9.866
African American enrollment	27479	5.116	1.799	0.000	10.745	6444	4.617	1.716	0.000	9.668
Hispanic American enrollment	27479	4.507	1.958	0.000	10.685	6444	5.850	1.956	0.000	9.973
White enrollment	27479	6.525	1.831	0.000	11.579	6444	6.529	1.804	0.000	9.956
Per-capita income	28438	10.657	0.259	9.878	12.036	6711	10.797	0.259	10.068	11.734
Population	28438	12.412	1.511	7.812	15.475	6711	13.810	1.445	8.756	16.128
Unemployment rate	28438	6.324	2.518	1.100	25.600	6711	7.238	3.386	1.900	29.400
Large college dummy		0.684					0.696			
Medical degree dummy		0.043					0.034			
Not private dummy		0.802					0.760			
City location dummy		0.670					0.862			
Unique N Institutions or colleges	3124					746				
Unique N Counties	1112					121				
Unique N States	40					6				
Unique N Years	11					11				
Panel C: Completion sample– number of degrees conferred										
ln total N awards	29159	5.626	1.623	0.000	11.181	6699	5.739	1.743	0.000	9.553
ln per-capita income	28659	10.596	0.258	9.813	11.972	6699	10.737	0.261	10.003	11.670
ln population	28659	12.433	1.513	7.812	15.475	6699	13.807	1.437	8.756	16.128
Unemployment rate	28659	6.311	2.518	1.100	25.600	6699	7.185	3.378	1.900	29.400
Large college dummy		0.678					0.697			
Medical degree dummy		0.043					0.034			
Not private dummy		0.797					0.775			
City location dummy		0.674					0.862			
Unique N Institutions or colleges	3125					737				
Unique N Counties	1095	121								
Unique N States	40					6				
Unique N Years	11					11				

Note: All enrollment variables, per-capita income and population are logged. Completion refers to the number of degrees or awards conferred by the institution. The mean of the dummy variables shows the share or percentage of colleges with such characteristics; for instance, 79.3 and 81.8 percent of colleges are considered large (over 1000 on-going enrollments) in states that respectively didn't and did legalize RM. The other categorical variables, classification of institutions programs and highest level offer, are shown in tables 2 and 3.

Table 2: Classification of institution programs

	Not RM states		RM states	
	2 year program	4 year program	2 year program	4 year program
Panel A: enrollment sample				
N colleges or institutions (first time)	1791	1065	374	313
N colleges or institutions (All)	2105	1177	460	344
Panel B: completion sample				
N colleges or institutions	2138	1146	475	319

Table 2 above presents the number of unique colleges available in each program class by RM group. The 2 year program refers to associate degree programs, whereas 4 year program denote the bachelor level. Note that this categories are enrollment dependent. Completion refers to the number of degrees or awards conferred by the institution.

Table 3: Highest level of offering-enrollment sample

	Not RM states							RM states						
	3	4	5	6	7	8	9	3	4	5	6	7	8	9
Panel A: enrollment sample														
N colleges or institutions (first time)	976	270	661	27	703	211	673	255	153	142	9	141	39	131
N colleges or institutions (All)	1079	302	821	33	848	252	764	274	171	167	13	180	50	166
Panel B: completion sample														
N colleges or institutions	1091	247	839	32	864	255	773	272	146	172	13	183	50	176

Table 3 above presents the number of unique colleges available in each type of institution based on the highest level offered. This variable is part of the IPEDS Directory survey which is left joined year by year to IPEDS enrollment survey. Completion refers to the number of degrees or awards conferred by the institution.

3 - Associate's degree

4 - Postsecondary award, certificate or diploma of at least two but less than four academic years

5 - Bachelor's degree

6 - Postbaccalaureate certificate

7 - Master's degree

8 - Post-master's certificate

9 - Doctor's degree

Table 4: Fall enrollment and RM

	Dependent variable:					
	All	M	W	AA	HA	WT
Panel A: first time fall enrollments						
RM	0.053*	0.053	0.051	0.116**	-0.067	0.016
	(0.026)	(0.033)	(0.028)	(0.037)	(0.039)	(0.036)
MM	-0.013	-0.020	-0.011	0.031	-0.041	-0.021
	(0.014)	(0.017)	(0.015)	(0.020)	(0.021)	(0.019)
ln Per-capita income	0.243*	0.206	0.278*	0.440**	0.207	0.230
	(0.103)	(0.121)	(0.113)	(0.151)	(0.159)	(0.151)
Unemployment rate	-0.001	0.000	0.003	0.022***	-0.005	-0.003
	(0.004)	(0.005)	(0.004)	(0.007)	(0.007)	(0.006)
Not private dummy	0.906***	1.218***	0.737***	0.448***	1.007***	1.125***
	(0.049)	(0.066)	(0.059)	(0.066)	(0.064)	(0.070)
Offers MD	1.150***	1.450***	1.049***	0.668***	1.197***	1.489***
	(0.082)	(0.104)	(0.081)	(0.113)	(0.122)	(0.117)
N Obs.	29276	29276	29276	27765	27765	27765
N college	3365	2750	3126	1859	1688	2702
Adjusted R2	0.68	0.59	0.64	0.63	0.73	0.65
Panel B: total fall enrollments						
RM	0.093**	0.112**	0.090**	0.113**	-0.005	0.029
	(0.029)	(0.036)	(0.031)	(0.037)	(0.040)	(0.036)
MM	0.028	0.032	0.025	0.035	0.015	0.015
	(0.015)	(0.018)	(0.016)	(0.021)	(0.021)	(0.019)
ln Per-capita income	0.159	0.032	0.226	0.274	0.053	0.256
	(0.124)	(0.141)	(0.136)	(0.168)	(0.167)	(0.164)
Unemployment rate	0.001	0.000	0.004	0.033***	-0.004	0.001
	(0.005)	(0.006)	(0.005)	(0.007)	(0.007)	(0.006)
Not private dummy	0.497***	0.804***	0.287***	-0.048	0.462***	0.646***
	(0.043)	(0.056)	(0.054)	(0.060)	(0.057)	(0.059)
Offers MD	0.647***	0.785***	0.598***	0.157	0.737***	0.995***
	(0.125)	(0.159)	(0.116)	(0.149)	(0.149)	(0.140)
N Obs.	35149	35149	35149	33456	33456	33456
N college	3866	3549	3761	3089	2727	3566
Adjusted R2	0.73	0.65	0.68	0.67	0.75	0.70
Year FE	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y
Other college covariates	Y	Y	Y	Y	Y	Y
Other county covariates	Y	Y	Y	Y	Y	Y

Note: The dependent variable All refers to all students, M to Men, W to women, AA to African American, HA to Hispanic American, and WT to white. The the independent variables, RM denotes the policy dummy variable that's assigned one if a state legalizes marijuana for recreational (RM) use in or after a particular year. For instance, California legalized RM in 2018, so the dummy is all ones in 2018 and 2019, the last year in our data, and zero otherwise. MM denotes the medical legalization dummy which is defined exactly as RM, but MM takes precedent over RM–MM policy went to effect years before RM policy. Note also that RM and MM are mutually exclusive. That is, we don't double count MM once RM policy goes into effect. Not private dummy refers to colleges that public and not for profit. Offers MD refers to colleges that offer medical degree. The county covariates include also logged population. The other college covariates are as follow: institution size classes, whether public and not for profit, whether located in city,regional location (New England,Southeast, Southwest, Mid East,Great Lakes,Plains,Rocky Mountains, and Far West), the highest level offer, and classification of offered programs (associate or bachelor). The standard error is clustered at the institution or college level. $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 5: Short and long term effects

	Dependent variable:					
	All	M	W	AA	HA	WT
Panel A: first time fall enrollments						
RMST	0.032	0.030	0.032	0.094**	-0.081*	0.000
	(0.025)	(0.032)	(0.028)	(0.037)	(0.038)	(0.036)
RMLT	0.118***	0.124**	0.111**	0.186***	-0.021	0.067
	(0.034)	(0.040)	(0.037)	(0.049)	(0.050)	(0.046)
MM	-0.010	-0.017	-0.008	0.035	-0.039	-0.018
	(0.014)	(0.017)	(0.015)	(0.020)	(0.021)	(0.019)
ln Per-capita income	0.229*	0.190	0.265*	0.422**	0.195	0.217
	(0.104)	(0.122)	(0.114)	(0.151)	(0.160)	(0.151)
Unemployment rate	-0.002	-0.001	0.002	0.021**	-0.005	-0.003
	(0.004)	(0.005)	(0.004)	(0.007)	(0.007)	(0.006)
Not private dummy	0.906***	1.218***	0.737***	0.448***	1.007***	1.125***
	(0.049)	(0.066)	(0.059)	(0.066)	(0.064)	(0.070)
Offers MD	1.150***	1.450***	1.049***	0.669***	1.197***	1.489***
	(0.082)	(0.104)	(0.081)	(0.113)	(0.122)	(0.117)
N college	3365	2750	3126	1859	1688	2702
N Obs.	29276	29276	29276	27765	27765	27765
Adjusted R2	0.68	0.59	0.64	0.63	0.73	0.65
Panel B: all fall enrollments						
RMST	0.082**	0.100**	0.079*	0.102**	-0.006	0.021
	(0.029)	(0.036)	(0.031)	(0.037)	(0.040)	(0.035)
RMLT	0.132***	0.152***	0.129**	0.153**	0.000	0.058
	(0.037)	(0.046)	(0.040)	(0.048)	(0.053)	(0.046)
MM	0.030*	0.034	0.027	0.037	0.016	0.017
	(0.015)	(0.018)	(0.016)	(0.021)	(0.021)	(0.019)
ln Per-capita income	0.149	0.022	0.216	0.264	0.051	0.248
	(0.124)	(0.141)	(0.136)	(0.169)	(0.167)	(0.164)
Unemployment rate	0.001	0.000	0.004	0.033***	-0.004	0.001
	(0.005)	(0.006)	(0.005)	(0.007)	(0.007)	(0.006)
Not private dummy	0.497***	0.804***	0.287***	-0.048	0.462***	0.646***
	(0.043)	(0.056)	(0.054)	(0.060)	(0.057)	(0.059)
Offers MD	0.647***	0.785***	0.598***	0.157	0.737***	0.995***
	(0.125)	(0.159)	(0.116)	(0.149)	(0.149)	(0.140)
N Obs.	35149	35149	35149	33456	33456	33456
N college	3866	3549	3761	3089	2727	3566
Adjusted R2	0.73	0.65	0.68	0.67	0.75	0.70
Year FE	Y	Y	Y	Y	Y	Y
County FE	Y	Y	Y	Y	Y	Y
Other college covariates	Y	Y	Y	Y	Y	Y
Other county covariates	Y	Y	Y	Y	Y	Y

Note: The dependent variable All refers to all students, M to Men, W to women, AA to African American, HA to Hispanic American, and WT to white. The the independent variables, RMST denotes the policy dummy variable in the short term that's assigned one if a state legalizes marijuana for recreational use within the previous two years. In the same vein, RMLT refers to the policy dummy in the long term, after two years of legalization time. MM denotes the medical legalization dummy which is defined exactly as RM, but MM takes precedent over RM–MM policy went to effect years before RM policy. Note also that RM and MM are mutually exclusive. That is, we don't double count MM once RM policy goes into effect.Not private dummy refers to colleges that public and not for profit. The county covariates include also logged population. The other college covariates are as follow: institution size classes, whether public and not for profit, whether located in city,regional location (New England,Southeast, Southwest, Mid East,Great Lakes,Plains,Rocky Mountains, and Far West), the highest level offer, and classification of offered programs (associate or bachelor). The standard error is clustered at the institution or college level. * $p < 0.05$, ** $p< 0.01$, *** $p < 0.001$.

Table 6: Common trend test

	Dependent variable:	
	First-time	ALL
Treated States	17.092	-10.364
	(10.993)	(11.809)
Year	-0.020***	-0.017***
	(0.003)	(0.003)
Year × Treated States	-0.009	0.004
	(0.005)	(0.006)
N Obs.	27014	32277
Adjusted R2	0.68	0.73
N college	3331	3826
County FE	Y	Y
College covariates	Y	Y
County covariates	Y	Y

Note: First, the data sample is restricted to before the policy intervention time for each affected state. Second, we regressed the logged number of enrollments, full first-time and aggregate total, on Treated States dummy which is assigned one if a state legalized RM and zero otherwise, time trend or Year, the interaction between the two latter covariates, and all other baseline covariates. The insignificance of the interaction term coefficients supports our claim that Diff-in-Diff common trend is satisfied. Standard errors clustered by institution level are reported in parenthesis. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$.

Table 7

	Dependent variable: N of degrees conferred		
	Undergraduate	Associate	Bachelor
Panel A: common trend test			
TREAT	-16.914	-46.530	10.657
	(17.756)	(28.878)	(26.562)
YEAR	0.013**	0.020**	-0.001
	(0.004)	(0.007)	(0.006)
YEAR*TREAT	0.008	0.022	-0.007
	(0.009)	(0.014)	(0.013)
N Obs.	32454	22407	21258
N college	3812	2784	2507
Adjusted R2	0.66	0.61	0.71
Panel B: main effect			
RM	0.006	0.087	-0.047
	(0.039)	(0.067)	(0.060)
MM	-0.014	-0.040	0.073**
	(0.020)	(0.034)	(0.028)
N Obs.	35358	24271	23095
N college	3857	2823	2581
Adjusted R2	0.66	0.62	0.69
Panel B: effects by terms			
RM12	0.012	0.048	0.045
	(0.039)	(0.065)	(0.060)
RM3+	-0.001	0.134	-0.151*
	(0.046)	(0.077)	(0.073)
MM	-0.014	-0.037	0.065*
	(0.020)	(0.034)	(0.028)
N Obs.	35358	24271	23095
N college	3857	2823	2581
Adjusted R2	0.66	0.62	0.69
Year FE	Y	Y	Y
County FE	Y	Y	Y
College covariates	Y	Y	Y
County covariates	Y	Y	Y

Note: The first panel A shows that parallel trend assumption is reasonably satisfied, insignificant interaction term. In the same panel A which includes only pre-policy period, TREAT is dummy variable for the states that legalized recreational marijuana. RM or recreational marijuana (MM or medical marijuana) is a binary variable for states that legalized RM (MM) at and after the legalization year. RM12 is a dummy for whether a state legalized marijuana in the previous two years; RM3+ is a binary for whether a states legalized RM after 2 years. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 8: Bachelor degrees by STEM programs

	Dependent variable: N of degrees conferred	
	STEM	Not STEM
Panel A: common trend test		
TREAT	-18.641	13.470
	(27.300)	(27.757)
YEAR	0.007	-0.002
	(0.006)	(0.007)
YEAR*TREAT	0.009	-0.008
	(0.014)	(0.014)
N Obs.	14134	21258
N college	1572	2507
Adjusted R2	0.63	0.69
Panel B: main effect		
RM	0.082	-0.067
	(0.053)	(0.064)
MM	-0.029	0.071*
	(0.027)	(0.030)
N Obs.	15124	23095
N college	1582	2581
Adjusted R2	0.62	0.67
Panel B: effects by terms		
RM12	0.077	0.028
	(0.051)	(0.064)
RM3+	0.087	-0.175*
	(0.063)	(0.078)
MM	-0.029	0.064*
	(0.027)	(0.030)
N Obs.	15124	23095
N college	1582	2581
Adjusted R2	0.62	0.67
Year FE	Y	Y
County FE	Y	Y
College covariates	Y	Y
County covariates	Y	Y

Note: The first panel A shows that parallel trend assumption is reasonably satisfied, insignificant interaction term. In the same panel A which includes only pre-policy period, TREAT is dummy variable for the states that legalized recreational marijuana. RM or recreational marijuana (MM or medical marijuana) is a binary variable for states that legalized RM (MM) at and after the legalization year. RM12 is a dummy for whether a state legalized marijuana in the previous two years; RM3+ is a binary for whether a states legalized RM after 2 years. We classify completion survey programs as STEM (Science, technology, engineering, and mathematics) or not STEM based on the definition of SMART program by the Department of Defense that deems its defined STEM programs as critical to the national security. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix

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