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Marijuana liberalization and public finance: A capital market perspective on the passage of medical use laws

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Marijuana liberalization and public finance: A capital market perspective on the passage of medical use laws[☆]

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We find that the staggered passage of state-level laws that legalize marijuana for medical use increases states' borrowing costs by 7–9 basis points. Consistent with economic theory on substance use suggesting that marijuana legalization increases local consumption of the drug (by expanding its availability and reducing its perceived risks), we predict and find that increased consumption represents an important mechanism that explains the higher state bond spreads. We also show that following such laws' passage, states incur higher marijuana-consumption-related expenditures, including for police, corrections, and public welfare.

1. Introduction

Liberalizing marijuana is a current and controversial public health policy that has consequences for how people live as well for communities' health and welfare. Marijuana is the most widely used controlled substance in the U.S., with sixteen percent of Americans reporting its use in 2018, and forty-five percent reporting that they use it at some point in their lives (Substance Abuse and Mental Health Services Administration 2018). Although marijuana use remains illegal under federal laws, states started passing laws to legalize marijuana for medical use in 1996, and as of 2020, thirty-five states and the District of Columbia have adopted such laws. Legal approval for medical use is reshaping public opinions about marijuana's health and legal risks and altering residents' acceptance of casual marijuana use (Kilmer and MacCoun 2017). From 2002 to 2018, the number of marijuana users increased by nearly 70% (see Fig. 1).

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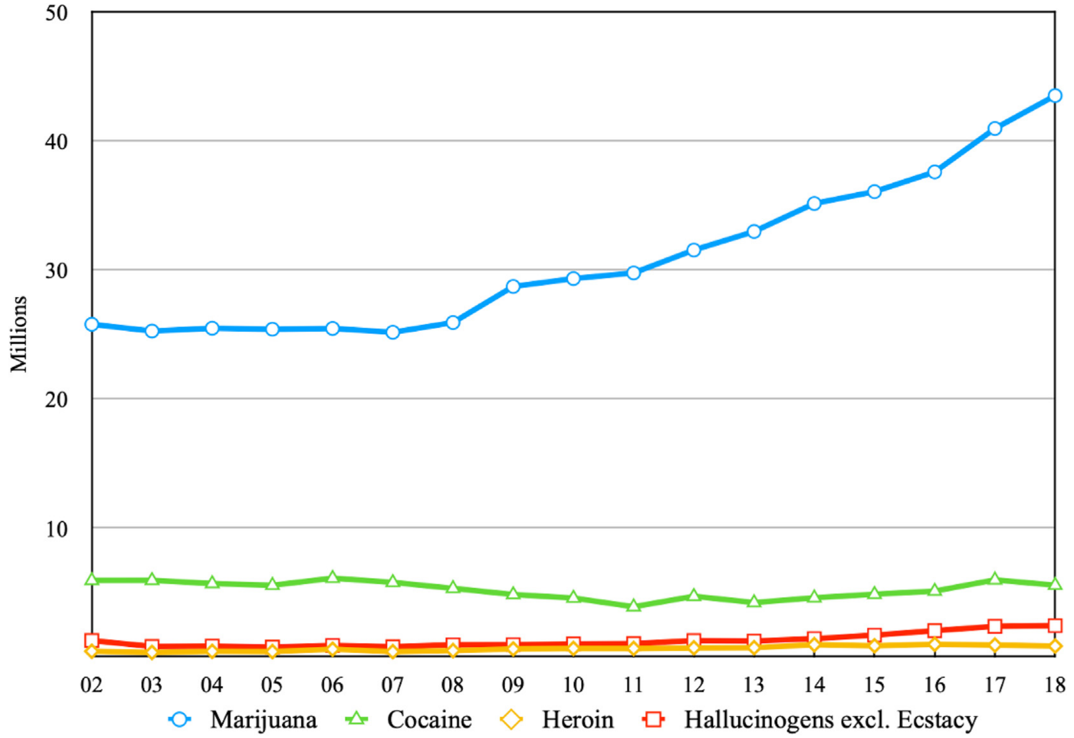


Fig. 1. Number of Users by Substance Type Between 2002 and 2018. This figure shows the number of yearly users (those who report at least one use in the year before the survey) by controlled substance type from 2002 to 2018, according to the National Survey on Drug Use and Health conducted by the Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality.

While research exists on the health and social consequences of the increased marijuana use induced by marijuana liberalization (e.g., Carliner et al. 2017; Baggio et al., 2020), evidence on the public finance impact of marijuana liberalization is scarce. In this study, we examine how the passage of medical marijuana laws (MMLs) affects state governments' borrowing costs. Our analysis of municipal borrowing costs adopts a capital market perspective in which investors condition their pricing decisions on effects related to bond issuers' expected economic prospects and financial conditions. Municipal bond pricing should thus reflect factors related to local governments' short- and long-term fiscal health.

According to economic theory on substance use (Becker and Murphy 1988; Grossman 2005), a drug liberalization reform, even for medical purposes, promotes illicit drug use, which is the use of illegal drugs and the non-medical use of prescription psychoactive medications. Legalization reduces the perceived health and legal risks associated with the drug, and increases its availability. Consistent with these predictions, Cerdá et al. (2012), Wen et al. (2015), and Hasin et al. (2017) report greater post-MML adult marijuana consumption for both medical and illicit purposes. Our supplemental tests also confirm that marijuana use increases following MML passage.

The higher marijuana consumption induced by MMLs can alter a local government's probability of default by affecting its fiscal strength. On the one hand, state governments that pass MMLs likely incur higher expenditures to enforce the laws and to mitigate the potential negative social and economic consequences of increased marijuana use. These states could also suffer from lower revenues in the long run due to marijuana users' worsened health and reduced productivity (Volkow et al., 2014). These adverse impacts strain states' debt servicing capacity, increasing their probability of default, which is the primary determinant of municipal bond spreads (Schwert 2017; Novy-Marx and Rauh 2012). On the other hand, legalization of medical marijuana can lead to a new industry, create more jobs, and attract new residents. Thus, MMLs may expand states' tax base and lower their default risk. MMLs' capital market consequences, as reflected in the municipal bond market, hence remains an empirical question.

Our analyses exploit the staggered approval of MMLs across state legislatures between 1996 and 2018 as a source of exogenous variation for identifying the effect of marijuana liberalization. We start by examining how MMLs affect the offering spreads of state bonds in the primary municipal bond market. We find that these bond spreads increase by 7–9 basis points after MML passage relative to those states that do not pass such laws. In dollar terms, using the 7 basis-point increase, MMLs increase a state's interest cost by $7.35 million for the average annual total issuance amount. Using a sample of available trading data between 2005 and 2018, we also determine that after MML passage, states' trading spreads increase by 8 basis points. Further, MMLs lead to a 0.2-notch downgrade of states' credit ratings and a 4 basis point increase in the underwriter's gross spreads, consistent with the idea that underwriters charge higher fees because they assume riskier bond inventories.

Our inferences are robust to the use of raw offering yields and tax-adjusted offering spreads, and they are not driven by changes in bond issuance. Our findings indicate that bondholders and underwriters impose higher borrowing costs on states with MMLs.

We employ two additional identification strategies to address concerns about unmeasurable time-variant state-level factors (e.g., Atanasov and Black 2016; Karpoff and Wittry 2018). We first explore the abrupt changes in state policies by comparing adjacent counties across state borders, which, in the absence of a policy change, likely have similar economic, social, and cultural characteristics. Border counties located in MML states face higher borrowing costs relative to neighboring counties in non-MML states. Next, we rely on Arizona's 2010 ballot initiative (approved with 50.1%) and Arkansas's 2012 ballot initiative (defeated with 48.6%) to better approximate a random change in marijuana liberalization. Because the vote outcomes for both initiatives are within narrow margins of the decision rule (i.e., 50%), the citizens in these states should have a voting preference on the issue that is similar across both states. We show that relative to Arkansas, Arizona's borrowing costs increase after the passage of its MML, which provides further support for a causal relation between MMLs and local governments' borrowing costs.

We next empirically investigate the underlying mechanism that links MMLs to increased borrowing costs. We start by conducting three analyses to show that the main finding of states' higher borrowing costs is explained by the increased marijuana consumption induced by MMLs. First, using a subsample of state bonds with available survey data on marijuana use rates, we perform two-stage regressions to quantify the impact of increased marijuana use on bond spreads. In the first stage, we use MMLs and other controls to predict the percentage of state population that are yearly marijuana users. In the second stage, we use the predicted value of marijuana use rates as an independent variable that explains bond spreads. We find that an MML-induced, one-percentage-point increase in the state population that uses marijuana is associated with a 7 basis point increase in states' bond offering spreads.

Second, cross-sectional tests reveal that bondholders impose higher borrowing costs on states where MMLs likely induce greater increases in marijuana consumption. MMLs' effect on borrowing costs is stronger for states with a higher level of corruption (which likely exhibit weaker monitoring and enforcement of non-medical use), for those with social-demographics that are associated with higher marijuana use (which leads to higher demand), and for states with a climate that is more conducive to cultivating marijuana (which results in more supply).

Third, we use intertemporal tests to exploit three institutional factors associated with MMLs. Using the staggered openings of the first medical marijuana dispensaries as a second shock to marijuana consumption, we find that MML states incur even higher borrowing costs after the first dispensary opens in the state. An attractive feature of this test is that these openings represent a specific consequence of the passage of MMLs. This finding supports the marijuana use mechanism and alleviates the concern that other confounding events, occurring at the same time as MML passage but unrelated to marijuana liberalization, could explain our results. Next, in the wake of the Cole memorandum, which reduces the legal risk with regard to federal intervention in local states' marijuana legalization, the MML effect becomes stronger. If legal risk offers a partial explanation for higher spreads, then the MML effect should have become weaker. Because it does not, the analysis supports the idea that the observed bond spread increase is not primarily due to heightened uncertainty about future prosecution (e.g., Pástor and Veronesi 2013). Last, when marijuana gains more acceptance from the general public, we find that MMLs lead to further increases in offering spreads. This result is inconsistent with the idea that investors prefer to avoid so-called "sin" stocks (e.g., Hong and Kacperczyk 2009), which implies that greater acceptance leads to decreases in spreads. Hence, this particular investor preference is unlikely to explain our results.

We next examine the relation between MMLs and states' heightened fiscal burdens. As a benchmark, MML passage is not associated with states' spending on highways, natural resources, and parks and recreation, all of which are unrelated to marijuana use. In contrast, MMLs' passage is associated with higher expenditures on police, corrections, and, particularly, public welfare, which correspond to areas that prior research views as related to marijuana use (e.g., Volkow et al., 2014). Other extant research (Bray et al., 2000; Brook et al., 2013; Schmidt et al., 1998) offers corroborating evidence that increased marijuana consumption adversely impacts individuals' school attainment and career prospects, increasing their dependency on public welfare.

Our bond characteristic tests provide additional support for a link between fiscal spending and bond investors' pricing decisions. The increase in states' borrowing costs following MML passage is greater for general obligation (GO) bonds, which are backed by the state's ultimate taxing ability and hence should reflect expectations about heightened state expenditures, than the borrowing costs for revenue (RV) bonds, which are repaid restrictively by project-specific revenues. Similarly, the effect of MMLs is greater for bonds with lower credit ratings, which should also be more sensitive to expanded state government expenditures. Given that the passage of MMLs is associated with increases in both marijuana consumption and state expenditures over the long term, bonds with longer maturities should be more affected by MMLs, which is what we find.

In our final analyses, we provide preliminary evidence on the effect of some states' recent decisions to legalize marijuana for recreational use. A number of academic and media articles suggest that MMLs smooth the transition to non-medical (i.e., recreational) legalization by facilitating the development of the marijuana industry and further changing residents' perception of marijuana (e.g., Kilmer and MacCoun 2017; Lane 2009). On the one hand, allowing marijuana for recreational use can lead to several economic benefits, such as reduced law enforcement costs, increased tax revenues, and the creation of jobs via the increased size of the marijuana industry (McGinty et al., 2016, 2017; Jacobi and Sovinsky 2016). On the other hand, the reasons for the higher borrowing costs that we document with MMLs are likely to be exacerbated when legalizing marijuana for recreational use because expected marijuana consumption becomes even greater. With the caveat that only a limited number of states have post periods that allow us to study the change in spreads, we provide modest evidence that legalizing marijuana for recreational purposes further increases states' borrowing costs. Anecdotal evidence of disappointing tax revenues from recreational marijuana sales supports this conclusion (e.g., Daniels and Aiello 2018; Frosch 2015).

This study contributes to the most recent debate on the further legalization of marijuana at both the state and federal levels by identifying and quantifying a cost that state and local governments bear when legalizing marijuana for medical use. Our results imply that municipal bond investors perceive MMLs as creating a net economic cost rather than a net benefit. A unique feature of our study is that it represents a more holistic view of the positive and negative economic effects of marijuana liberalization. Currently, the financial impact of marijuana liberalization is mainly limited to discussions of tax revenues.

Our study also presents evidence that a current public health policy—marijuana liberalization—leads to a higher public financing cost. As such, we add to the burgeoning research on public health issues (e.g., Cornaggia et al., 2022; Chen et al., 2022).[1] Importantly, the health and well-being of people in the workplace and communities is a core environmental, social, and governance (ESG) indicator (World Economic Forum 2020). While the academic literature emphasizes ESG from a firm's perspective, ESG factors at the government or community level are also beginning to draw attention (Government Finance Officers Association 2020). Our results contribute to the understanding of the linkage between local governments' ESG decisions and the municipal market. For example, Larcker and Watts (2020) document that municipal bondholders are not more likely to pay higher prices for eco-friendly ‘green’ bonds than they are for other bonds with similar credit risk. They point out, however, that bondholders may rationally take ESG factors into account when the factors affect local governments' future cash flows and credit quality. Our evidence is consistent with this rational economic view. More broadly, we contribute to the emerging municipal academic research in accounting and finance.[2]

2. The setting

2.1. Federal prohibition of marijuana

The cultivation, consumption, and distribution of marijuana by residents is prohibited under federal laws. During the Great Depression of the 1930s, growing and smoking marijuana became popular among west coast settlers.[3] Pressure from western state governments to address the issue led Congress to pass the Marihuana Tax Act of 1937, which led to an implicit prohibition of marijuana through the federal government's taxing power. Despite federal regulatory efforts, however, marijuana remained popular and became widespread in the 1960s.

To deter the growing popularity of marijuana among residents, the Comprehensive Drug Abuse Prevention and Control Act of 1970 listed it as a controlled substance, along with other abusive drugs such as heroin and cocaine. Marijuana was listed in Schedule I to indicate that it had the highest abusive potential and the lowest medical value.[4] Title II of the 1970s Act, known as the Controlled Substances Act (CSA), laid down the legal foundation of the federal government's legislation for controlled substances. The CSA explicitly banned the manufacture, importation, possession, use, and distribution of marijuana. Violations can result in criminal and civil charges (e.g., drug trafficking offenses). In 1973, the Drug Enforcement Administration (DEA) was established to manage, in concert with the Food and Drug Administration, the administration, supervision, and enforcement of federal laws related to controlled substances. The schedule in which a substance is listed also determines how it is controlled by the DEA. As a Schedule I drug, marijuana is prohibited by federal laws for use by residents regardless of the intended purpose (Mikos 2011).

Although marijuana remains illegal at the federal level, the U.S. House of Representatives passed a bill in December of 2020, which would remove marijuana from the Controlled Substances Act, leaving the legalization decisions to states (Andrews 2020).

2.2. State medical marijuana laws

The past two decades have witnessed a tremendous shift in state marijuana policies. In the late 1980s, legalizing marijuana for medical use gathered support in select states, partly in tandem with the rising public empathy for patients living in pain

[1] According to the American Public Health Association, public health is the health of people and the communities where they live, learn, work, and play (https://www.apha.org/what-is-public-health, access date: March 6, 2021). One objective of public health is to promote health and efficiency through organized community effort for the development of social machinery to ensure that everyone obtains a standard of living adequate for the maintenance of health; public policies are an important means of achieving this goal (Tulchinsky and Varavikova 2000).

[2] For example, studies in accounting include Kido et al. (2012), Naughton et al. (2015), Cuny (2016), Cuny (2018), Cuny et al. (2021), Costello et al. (2017), Beck (2018), and Beatty et al. (2019); in finance they include Gao et al. (2020), Gao et al. (2019), Butler et al. (2009), Butler and Yi (2022), Painter (2020), and Dougal et al. (2019).

[3] See Musto (1991) for a history of marijuana laws.

[4] The act divided the controlled substances into five schedules. Substances in Schedule I (Schedule V) have the highest (lowest) abusive potential and the lowest (highest) medical value (https://www.dea.gov/drug-information/drug-scheduling, access date: March 6, 2021).

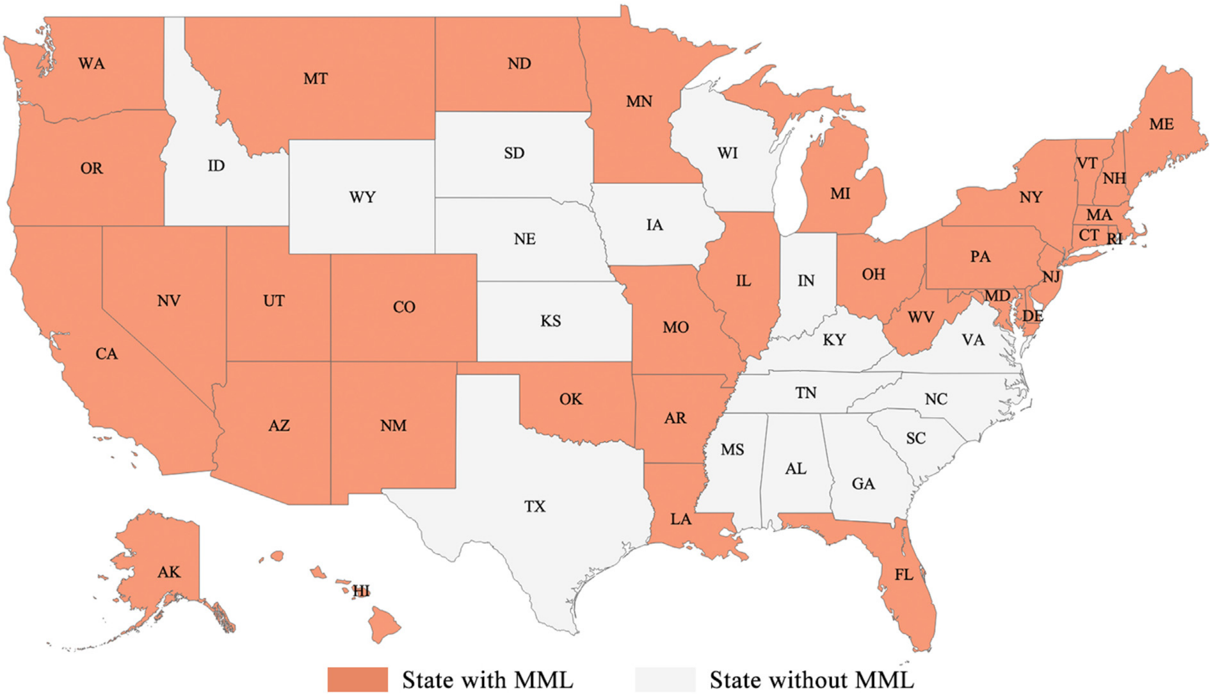


Fig. 2. States with MMLs. This map labels states with medical marijuana laws (MMLs) by the end of the sample period (i.e., 2018).

from cancer and AIDS (Kilmer and MacCoun 2017).[5] The west coast showed especially strong enthusiasm for allowing patients to use marijuana as a means of relief from medical ailments. In 1996, California passed Proposition 215—the first state law to legalize marijuana for medical use, "where that medical use is deemed appropriate and has been recommended by a physician who has determined that the person's health would benefit from the use of marijuana in the treatment of cancer, anorexia, AIDS, chronic pain, spasticity, glaucoma, arthritis, migraine, or any other illness for which marijuana provides relief."[6]

At different times over the next two decades, other states passed similar laws. By 2000, seven states had legalized medical marijuana. Seven additional states and the District of Columbia passed comparable laws over the next decade. Eighteen states passed MMLs between 2011 and 2018. Appendix A lists the MML passage date for each state. States that have legalized the medical use of marijuana generally allow residents to possess, consume, and grow the drug after obtaining a qualifying diagnosis from a board-licensed physician.[7] Fig. 2 visually presents the marijuana policy for each state in 2018.

2.3. The consequences of state medical marijuana laws

Economic theory on substance use, as advocated by Becker and Murphy (1988) and Grossman (2005), suggests that individuals maximize their utility of consuming intoxicating substances subject to their own cost constraints. According to this theory, illicit users face additional costs—health and legal risks, and search costs for finding the substance—in addition to the monetary price (Grossman 2005; Pacula et al., 2010; Galenianos et al., 2012). Although MMLs appear to only allow marijuana for 'medical' use, the passage of an MML reduces the additional costs borne by illicit users, and hence, initiates broader consumption of illicit marijuana. First, following states' legal approval, marijuana can now be viewed as a medicine rather than an intoxicating substance. MMLs thereby reduce the perceived health risk associated with using marijuana and favorably alter public attitudes about it. Fig. 3 shows that the national acceptance rate for marijuana use has been trending upward since the 1990s.[8] Second, MMLs reduce the perceived legal risk because law enforcement's ability to distinguish between illicit and medical marijuana users tends to be low (Lofton 2019). Third, MMLs initiate the development of a legal marijuana industry, and expand the production and supply of the drug in the marketplace. Marijuana products can be diverted to non-medical use

[5] For instance, patients with AIDS suffer from loss of appetite (which by itself is a life-threatening condition), nausea, and pain. Although the effect of marijuana was not medically tested, the patients reported that marijuana mitigated these symptoms (Treaster 1993).

[6] https://leginfo.legislature.ca.gov (access date: March 6, 2021).

[7] Doctors in these states can only recommend (but cannot prescribe) marijuana to patients with an appropriate diagnosis because marijuana is prohibited under federal laws.

[8] Data are from the General Social Survey by the National Opinion Research Center at the University of Chicago.

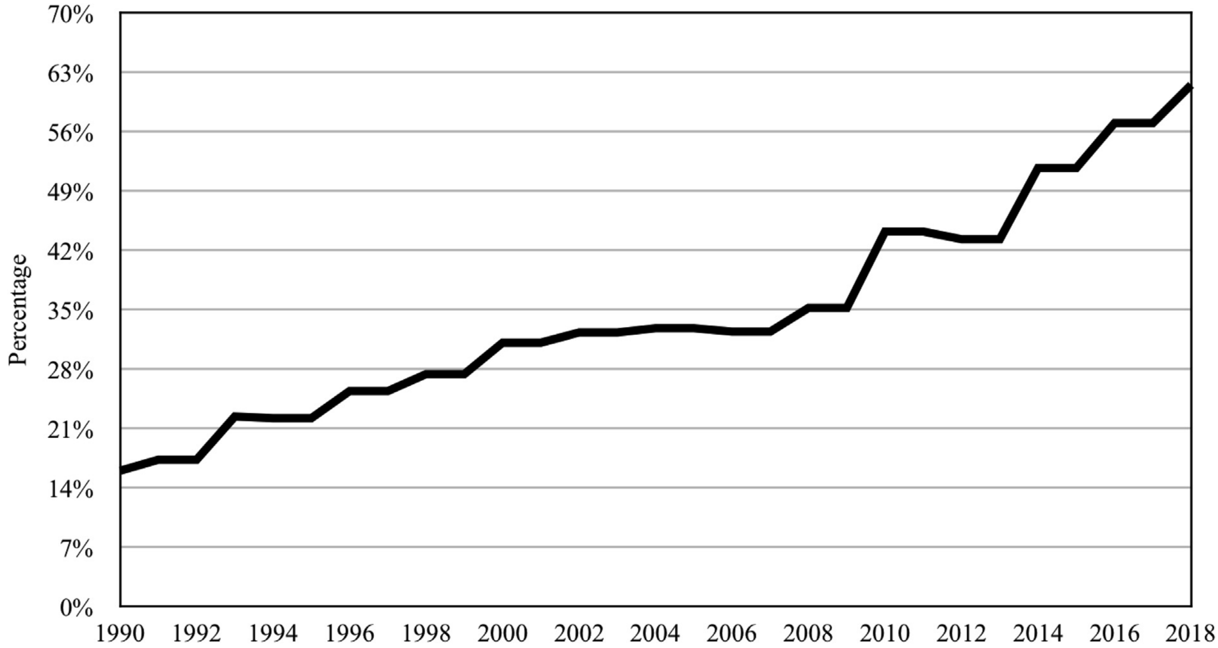


Fig. 3. Marijuana Acceptance Rates over Time. This figure shows the national acceptance rate for marijuana from 1990 to 2018, according to the General Social Survey conducted by the National Opinion Research Center at the University of Chicago.

through either drug trafficking or straw purchases.[9] As such, medical marijuana legalization can increase the drug's availability to local residents and reduce illicit users' potential search costs. In sum, MMLs reduce the perceived health and legal risks as well as the search costs associated with marijuana, leading to higher illicit consumption.

In Appendix B, we directly investigate MMLs' empirical relation with states' marijuana use rates and residents' perceptions about its health and legal risks and its availability. We collect data from the National Survey on Drug Use and Health (NSDUH), which conducts household face-to-face interviews with approximately 70,000 respondents over the age of 12 across different states about their tobacco, alcohol, and drug use every year. Individual-level data are aggregated at the state-year level, using weights based on population estimates from the Census Bureau. Because marijuana use data were first available in 2002, we present the results only for states that passed MMLs after that year to allow for the establishment of pre-trends.

Consistent with the economic theory of substance use mentioned above, our tests reveal that in states that pass an MML, residents perceive the health and legal risks associated with marijuana use to be lower and the availability of marijuana to be greater. MML states also have significantly higher marijuana use rates after passage relative to non-MML states. Importantly, our tests further show that this increase in marijuana use is at least partially explained by the lower health and legal risks as well as the greater availability induced by MMLs. Our findings are consistent with several prior studies (Cerdá et al., 2012; Wen et al., 2015; Pacula et al., 2015; Hasin et al., 2017) that document greater illicit marijuana consumption by both adults and youths following MML passage.[10]

The higher marijuana consumption induced by MMLs may negatively affect residents' lives and health. According to a review article by Volkow et al. (2014), marijuana use is associated with substantial adverse effects, such as addiction to it or other substances, motor vehicle accidents, abnormal brain development, and diminished lifetime achievement. They further suggest that these adverse effects are expected to be pronounced in states with marijuana laws because of marijuana's increasing availability and social acceptability. Moreover, in many states, medical marijuana policies have been expanded to include provisions for the retail sale of marijuana for medical purposes. In cities such as Los Angeles, medical marijuana dispensaries are popularly thought to outnumber Starbucks coffee shops (Barco 2009). Appendix C summarizes the health and social benefits as well as the costs of MMLs as they are discussed in news articles and the existing literature.

[9] A straw purchase refers to an agent obtaining a good or a service on behalf of an ultimate end user, who may or may not be able to legally purchase the good or service.

[10] Drawing on the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), Cerdá et al. (2012) report that in 2004 the average annual prevalence of marijuana use among adults is 7.13% in MML states, while it is only 3.57% in non-MML states. Wen et al. (2015) find that MMLs lead to a 14-percent increase in current marijuana use, a 15-percent increase in regular (daily) marijuana use, and a 10-percent increase in marijuana abuse by adults in the ten states that passed MMLs between 2004 and 2012. Hasin et al. (2017) report that MMLs increase illicit marijuana use from 5.55% to 9.15% and marijuana use disorders from 1.48% to 3.10% from 1991/92 to 2012/13.

3. Data and sample

Our main sample consists of state bond offerings from 1990 to 2018. We focus on state bonds because MMLs are passed and enacted at the state level. Our analysis starts in 1990 to allow pre-MML trends to be established before California passed the first law in 1996. We collect data on states' marijuana laws from ProCon.org. This organization is a non-profit non-partisan public charity that details the pros, cons, and related research on more than 80 controversial issues, including propositions or bills associated with states' marijuana laws. Previous research uses data from this organization to study the impact of marijuana laws (e.g., Chu and Townsend 2019). Appendix D presents an example to illustrate the timeline of MMLs. We use Arizona to illustrate that the passage date of Arizona's medical marijuana law is the first event that resolves the significant uncertainty associated with passing the law. It is also the start of a chain of events that liberalize marijuana's use, such as the opening of the first state-licensed dispensaries. As such, we use the dates when state medical marijuana initiatives are approved through the state legislative process as the passage dates of medical marijuana laws in our tests.[11] We validate the approval dates' accuracy by reconciling them with those reported on state legislature websites and in existing studies (Wen et al., 2015; Williams et al., 2019).

We collect data on state bonds' offerings from Bloomberg. In an initial offering, an underwriter organizes bonds (i.e., facilities) into packages (i.e., issues). The average issue in our sample includes 16.6 facilities. We follow prior municipal research (e.g., Gao et al., 2020) to obtain state bonds' facility-level data. We download the monthly treasury yield curve rates from the Federal Reserve of St. Louis, and we interpolate the treasury rates for bonds with the same maturity terms to calculate treasury-adjusted bond spreads. Moreover, we collect states' total population, median population age, population by ethnicity and locality (i.e., urban-rural classification), income per capita, and unemployment rates from the U.S. Census Bureau, the Bureau of Labor Statistics, the Bureau of Economic Analysis, and the Federal Reserve of Philadelphia. After requiring non-missing values for the test and control variables, our final sample consists of 113,723 state-bond facility-level observations. Table 1 shows that California, Florida, Ohio, Oregon, Texas, Washington, and Wisconsin are the top seven issuers.

Table 2, Panel A gives the summary statistics for bond contractual features. The mean state bond raw offering yield is 3.99%. State bonds typically have lower yields than the corresponding treasuries due to municipal bonds' tax exemption benefit for investors, so the mean treasury-adjusted offering spread is negative (−0.40%). Standard & Poor's rates 85% of the bonds. We convert the bond ratings into numerical values by assigning a value of 21 to the highest credit rating (AAA), 20 to the next-highest rating (AA+), and so forth. The mean rating for the rated bonds is between AA and AA+ (19.36). These

Table 1
Sample composition.

State	Obs.	Percentage	MML	State	Obs.	Percentage	MML
AK	640	0.6%	80%	MT	1,365	1.2%	31%
AL	491	0.4%	0%	NC	1,310	1.2%	0%
AR	1,355	1.2%	2%	ND	137	0.1%	0%
AZ	420	0.4%	15%	NE	603	0.5%	0%
CA	8,196	7.2%	83%	NH	847	0.7%	15%
CO	585	0.5%	87%	NJ	952	0.8%	12%
CT	3,566	3.1%	22%	NM	210	0.2%	32%
DC	2,535	2.2%	36%	NV	3,017	2.7%	58%
DE	1,058	0.9%	26%	NY	2,445	2.1%	8%
FL	5,736	5.0%	5%	OH	5,985	5.3%	10%
GA	2,228	2.0%	0%	OK	188	0.2%	0%
HI	2,177	1.9%	72%	OR	7,321	6.4%	69%
IA	231	0.2%	0%	PA	2,444	2.1%	6%
ID	29	0.0%	0%	RI	1,507	1.3%	49%
IL	5,170	4.5%	9%	SC	2,269	2.0%	0%
IN	2,840	2.5%	0%	SD	100	0.1%	0%
KS	39	0.0%	0%	TN	790	0.7%	0%
KY	125	0.1%	0%	TX	6,949	6.1%	0%
LA	851	0.7%	9%	UT	342	0.3%	0%
MA	4,920	4.3%	20%	VA	1,091	1.0%	0%
MD	2578	2.3%	11%	VT	1,132	1.0%	54%
ME	821	0.7%	56%	WA	7,699	6.8%	75%
MI	3,875	3.4%	10%	WI	6,632	5.8%	0%
MN	2,063	1.8%	18%	WV	435	0.4%	16%
MO	753	0.7%	0%	WY	13	0.0%	0%
MS	4,658	4.1%	0%	Total	113,723	100%	

This table presents the composition of the main sample by state. For each state, we provide the number of state bond facility-level observations, the percentage of the sample that each state's observations represent, and the percentage of each state's observations issued after the passage of medical marijuana laws (MMLs).

[11] Our inferences are robust to the use of MMLs' effective dates.

Table 2
Summary statistics.

Variable	N	Mean	Std.	p1	p25	p50	p75	p99
Panel A: Bond Contractual Terms								
Raw Offering Yield (%)	113,723	3.99	1.54	0.43	3.00	4.15	5.05	7.25
Offering Spread (%)	113,723	−0.40	0.87	−2.10	−1.00	−0.46	0.14	2.08
Tax-Adjusted Spread (%)	113,723	1.76	1.15	−1.32	1.03	1.79	2.52	4.73
Gross Spread (%)	37,045	0.50	0.31	0.06	0.32	0.45	0.58	1.94
Credit Rating	97,113	19.36	1.74	13	19	20	21	21
Size (millions)	113,723	8.68	15.58	0.02	0.62	2.86	10.00	101.62
Maturity (years)	113,723	9.97	6.45	0.59	4.93	9.00	14.03	29.92
GO Bond	113,723	0.62	0.49	0	0	1	1	1
Insurance	113,723	0.18	0.38	0	0	0	0	1
Refunding	113,723	0.22	0.42	0	0	0	0	1
Ad Valorem	113,723	0.31	0.46	0	0	0	1	1
Fed Exempt	113,723	0.87	0.34	0	1	1	1	1
State Exempt	113,723	0.69	0.46	0	0	1	1	1
AMT	113,723	0.05	0.22	0	0	0	0	1
BQ	113,723	0.03	0.16	0	0	0	0	1
Sinkable	113,723	0.06	0.23	0	0	0	0	1
Callable	113,723	0.42	0.49	0	0	0	1	1
Puttable	113,723	0.00	0.01	0	0	0	0	1
Competitive	113,723	0.43	0.50	0	0	0	1	1
Panel B: State Characteristics								
Marijuana Use Rate (%)	731	11.87	3.38	6.90	9.60	11.10	13.50	23.51
Unemployment (%)	1,479	5.55	1.82	2.60	4.30	5.30	6.60	11.10
Income	1,479	10.38	0.34	9.67	10.11	10.41	10.64	11.12
Population	1,479	15.06	1.03	13.14	14.22	15.18	15.71	17.39

This table summarizes state bonds' contractual features at the facility level and state characteristics.

statistics for the bond contractual features are generally comparable to those reported in Butler et al. (2009) and Painter (2020). Panel B of Table 2 presents the statistics for state characteristics. The averages of states' marijuana use rates and unemployment rates are 11.87% and 5.55%, respectively. The annual income per capita and population in log adjusted numbers are 10.38 (which translates to $32,209) and 15.06 (which translates to 3.5 million), respectively.

4. Empirical results

4.1. Baseline results

For our main identification strategy, we use the staggered passage of MMLs, which affect different states at different points in time. Relative to a single-shock design, staggered shocks reduce the likelihood that a confounding factor might explain the treatment effect because such a factor would have to be correlated with each of the staggered shocks. Our research design is similar to Gao et al. (2020), who study the impact of newspaper closures on public finance, in that we exploit staggered shocks and employ long-window tests of local governments' borrowing costs. In our setting, the legislation of MMLs is not a single event, rather, it involves several steps (e.g., the vote, the formation of a regulatory system, and the establishment of a monitoring channel). Also, marijuana use's potential impact may emerge over a longer period. This design allows us to evaluate both the near- and long-term impact following MML passage.[12]

We estimate the effect of MMLs on offering spreads, using an ordinary least squares (OLS) regression with the following model:

$$y_{ijt} = \alpha + \beta MML_{jt} + \gamma' X_{it} + \delta' Z_{jt} + \eta_j + \mu_t + \varepsilon_{ijt} \quad (1)$$

where y_{ijt} is the offering spread of bond i issued by state j during year-month t, measured as the offering yield adjusted by the treasury rate for corresponding maturity terms. MML_{jt} is an indicator variable that equals one for bonds issued after corresponding state j's medical marijuana law passes, zero otherwise. We control for the bond contractual features and state economic factors that, according to prior literature, could affect bond spreads (e.g., Butler et al., 2009; Gao et al., 2020; Painter 2020). X_{it} is a vector of bond-level characteristics. Z_{jt} is a vector of state-year-level economic factors. We include state fixed effects (η_j) to account for state-specific and time-invariant characteristics, and time (year-month) fixed effects (μ_t) to absorb

[12] In addition to MMLs, states also passed decriminalization laws that reduced the penalties for illegal marijuana use. We focus on MMLs rather than decriminalization laws for three reasons. First, while such laws reduced the penalties for marijuana use, they were less consequential than MMLs (which helped introduce a new marijuana industry). Second, the passage of state decriminalization laws is clustered in two waves (i.e.,1973−1978 and 2010s), and is, consequently, less staggered over time. Third, data on municipal bonds' offering and trading in the 1970s are very limited.

Table 3
State bond offering spreads and MMLs.

	(1)	(2)	(3)	(4)
	Off. Spread	Off. Spread	Off. Spread	Off. Spread
MML	0.11***	0.10***	0.09***	0.07***
	(5.02)	(5.31)	(4.75)	(4.01)
Size		−0.01***	−0.02***	−0.01**
		(−4.96)	(−5.27)	(−2.53)
Time to Maturity		0.13***	0.13***	0.14***
		(10.31)	(10.41)	(10.84)
GO Bond		−0.19***	−0.19***	−0.10***
		(−13.37)	(−13.51)	(−7.01)
Insurance		−0.15***	−0.15***	−0.05***
		(−12.99)	(−13.54)	(−4.24)
Refunding		−0.05***	−0.05***	−0.06***
		(−4.34)	(−4.65)	(−5.06)
Ad Valorem		−0.02	−0.01	−0.01
		(−1.28)	(−1.06)	(−0.86)
Fed Exempt		−1.11***	−1.10***	−1.12***
		(−25.99)	(−26.04)	(−26.69)
State Exempt		−0.11***	−0.12***	−0.07***
		(−5.49)	(−6.02)	(−4.06)
AMT		−0.92***	−0.91***	−0.92***
		(−17.75)	(−17.39)	(−18.17)
BQ		−0.93***	−0.93***	−1.04***
		(−16.68)	(−16.91)	(−19.21)
Sinkable		0.21***	0.21***	0.16***
		(13.71)	(13.55)	(11.71)
Callable		0.20***	0.20***	0.19***
		(21.37)	(21.63)	(20.40)
Puttable		−0.62**	−0.62**	−0.59**
		(−2.39)	(−2.41)	(−2.38)
Competitive Bid		−0.09***	−0.09***	−0.09***
		(−8.51)	(−8.25)	(−8.09)
Unemployment			0.03***	0.03***
			(4.72)	(4.17)
Income			−0.74***	−0.52***
			(−3.79)	(−3.00)
Population			−0.10	−0.16**
			(−1.06)	(−2.11)
Rating FE	No	No	No	Yes
State FE	Yes	Yes	Yes	Yes
YM FE	Yes	Yes	Yes	Yes
Obs.	113,723	113,723	113,723	113,723
Adj. R^2	0.70	0.82	0.83	0.84

This table presents the main results for the effect of MMLs on state bond offering spreads. Column 1 includes state and time (year-month) fixed effects. Column 2 adds bond characteristics as control variables. Column 3 further controls for state economic conditions. Column 4 includes credit-rating fixed effects. We cluster standard errors by issue and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

time-varying economy-wide trends. Because bonds contained in the same issue tend to have the same intended purpose, such as funding a highway or an airport (Painter 2020; Ang and Green 2011), the residuals are likely to be correlated at the issue level due to project-specific features or risks. The residuals may also be correlated over time due to macroeconomic factors or changes in market conditions (e.g., bond demand and supply). Hence, we double cluster standard errors by bond issue and year-month of issuance. The coefficient on MML_{jt} gauges the effect of changes in the level of marijuana liberalization on a state issuer's borrowing cost relative to those for the issuers of unaffected states.

Table 3 presents the estimates of the impact from MMLs on state bonds' offering spreads. We report specifications with different sets of control variables, as some of these variables could be endogenous to the passage of MMLs and hence bias our estimate. As a benchmark, Column (1) shows the results when only the *MML* indicator and state and year-month fixed effects are included in the regression. The coefficient on *MML* is positive (0.11) at the 1% level, indicating that MMLs lead to an 11 basis point increase in states' offering spreads.

In Column (2), we control for bond contractual features. We find that offering spreads decrease in size and increase in time to maturity. The offering spread is lower for GO bonds, insured and tax-exempt bonds, and bonds issued through competitive bids, and it is higher for bonds with sinking or callable provisions. These coefficients are largely consistent with those reported in Butler et al. (2009), Gao et al. (2020), and Painter (2020). Notably, while accounting for these bond contractual features greatly improves our model's fit (the R^2 increases from 70% to 82%), the coefficient on *MML* remains at a similar level (Coefficient = 0.10; *t*-statistic = 5.31).

In Columns (3) and (4), we obtain more conservative estimates of the borrowing cost increase by including some variables that may have been affected by MMLs. Column (3) adds additional control variables for local economic conditions, including the state's unemployment rate, income per capita, and population. Column (4) augments Column (3)'s regression specification with rating fixed effects. Consistent with local economic conditions changing as a result of MMLs and credit rating agencies incorporating some of MMLs' effects, we find lower estimates of the MML effect in both columns (Coefficients = 0.09 and 0.07, respectively).[13]

The results in Table 3 indicate that MMLs lead to an increase in state bond offering spreads in the range of 7−11 basis points. In terms of the dollar-value impact, MMLs increase states' borrowing costs by $1.59 million per average state bond issue, or by $7.35 million per average state annual issuance.[14] The economic significance is comparable to that of the newspaper-closure effect (i.e., 5 to 11 basis points) documented by Gao et al. (2020).

4.2. Robustness tests

Our main results are robust to alternative and additional measures of states' borrowing cost. First, we further follow Gao et al. (2020) and evaluate a state's borrowing cost using secondary-market trading spreads as a robustness check. For the bonds in our main sample, we collect data on secondary market trading transactions from the Municipal Securities Rulemaking Board (MSRB). This self-regulatory organization collects and releases secondary market trading data, including a trade's price, yield, par value, and type (customer purchase from a dealer, customer sale to a dealer, or inter-dealer trade). However, because the MSRB only provides trading data for research purposes starting in 2005, our trading yield analysis is limited to the years from 2005 to 2018. This period is only a subset of our full sample, which spans from 1990 to 2018. To allow for the establishment of the pre-trends in the treated states, we exclude states that passed MMLs before 2005. Despite these data's shortcomings, analyzing MMLs' effect using secondary trading data complements our main analyses of bond offering yields because we can further explore the within-facility variation using facility fixed-effects, which reduce the possibility that the documented bond-offering effect is due to differences in bond-level features.

Table 4, Panel A presents the statistics that describe this limited sample. Compared with the main sample reported in Table 2, the average bonds in this trading sample are larger in size, have shorter maturities, are more likely to receive a credit rating from Standard & Poor, and when they do receive a rating, it is slightly higher. Panel B of Table 4 presents the regression results. Similar to the main analyses, we use the baseline model in Column (1), we control for bond contractual features in Column (2), we add controls for the local economic conditions in Column (3), and further include rating fixed effects in Column (4). The inferences remain unchanged from those of Table 3. Importantly, in Column (5), we replace state fixed effects with facility fixed effects. We find that MML passage continues to result in an increase in trading spreads using within-facility yield variation, which is not subject to changes in unmeasurable bond features because the underlying facility remains the same.

Second, our main results are robust to the use of alternative ways of calculating the bond offering spread. Table 5, Columns (1) and (2) present the estimates using raw offering yields and tax-adjusted offering spreads, respectively. We collect state income tax rates from the National Bureau of Economic Research and we follow Schwert (2017) in adjusting the offering spreads of federal- and state-exempt bonds. The magnitudes of the coefficients in both columns are at levels similar to those reported in Table 3. An untabulated test shows that MMLs do not significantly affect the total amount of states' new bond issuance, confirming that the increase in state bond spreads is not driven by new bond issuance from local governments. Further untabulated analysis shows that the main results are robust to excluding any one of the U.S. census regions (i.e., West, Midwest, Northeast, and South), which alleviates the concern that the main effect may be driven by a small number of states.

Third, we explore the micro-structure of the primary bond issuance market and adopt underwriter fees as an additional measure of states' borrowing costs. In a municipal bond offering deal, the underwriter assumes the risk and responsibility of selling the bonds (O'Hara 2012). The underwriter is compensated by the issuer with a fee (referred to as the gross spread), which is the difference between the purchase price from the issuer and the issue price (at which the bond is set to be offered to investors). The underwriter can make additional profit by selling the bond to investors at a price that is higher than the issue price, as long as the sale price does not exceed a predetermined level set by the issuer in the offering deal. Thus, the gross spread is an underwriting fee paid by the issuer. If MMLs increase the state's fiscal burdens and thus the default risk, we expect the underwriter to demand a higher fee from the issuer to compensate for holding riskier bonds in inventory. Column (3) of Table 5 shows that MML states experience a 4 basis point increase in the gross spread relative to non-MML states. That is, out of every $100 raised, four cents flow to underwriters. In dollar terms, this increase adds $420,000 to the annual cost of issuing bonds for MML states. This fee paid to the underwriter is in addition to the interest cost paid to investors (i.e., the offering spread).[15]

[13] The inferences are unchanged if we cluster by state and year-month of issuance.

[14] We interpret MMLs' economic impact using the most conservative estimate from Column (4) of Table 3 in which we control for changes in both economic conditions and credit ratings. In our sample, the average state issue size is $227 million, and the mean maturity term is ten years. We obtain the $1.59 million estimate by multiplying $227 million by 7 basis points and then by 10 years. The average annual issuance amount is $1.05 billion (with 4.6 issues per year). We obtain the $7.35 million estimate by multiplying $1.05 billion by 7 basis points and then by 10 years.

[15] Note that the offering yield excludes the expenses incurred in the bond issuance process, such as the fees paid to underwriters and lawyers.

Table 4
State bond trading spreads and MMLs.

Panel A: Summary Statistics

Variable	N	Mean	Std.	p1	p25	p50	p75	p99
Trading Spread (%)	796,322	−0.06	0.91	−2.17	−0.67	−0.07	0.40	2.99
Credit Rating	758,461	19.76	1.53	14	19	20	21	21
Size (millions)	796,322	21.23	27.74	0.60	5.77	12.75	25.00	185.45
Maturity (years)	796,322	8.14	6.21	0.25	3.25	6.75	11.58	27.41
GO Bond	796,322	0.67	0.47	0	0	1	1	1
Insurance	796,322	0.19	0.39	0	0	0	0	1
Refunding	796,322	0.29	0.45	0	0	0	1	1
Ad Valorem	796,322	0.36	0.48	0	0	0	1	1
Fed Exempt	796,322	0.95	0.21	0	1	1	1	1
State Exempt	796,322	0.80	0.40	0	1	1	1	1
AMT	796,322	0.01	0.10	0	0	0	0	1
BQ	796,322	0.00	0.04	0	0	0	0	0
Sinkable	796,322	0.10	0.30	0	0	0	0	1
Callable	796,322	0.50	0.50	0	0	0	1	1
Puttable	796,322	0.00	0.00	0	0	0	0	0
Competitive	796,322	0.38	0.49	0	0	0	1	1

Panel B: Effect of MMLs on Trading Spreads

	(1)	(2)	(3)	(4)	(5)
	Trad. Spread	Trad. Spread	Trad. Spread	Trad. Spread	Trad. Spread
MML	0.22***	0.20***	0.13***	0.12***	0.08***
	(8.34)	(8.81)	(5.87)	(5.95)	(8.56)
Size		−0.06***	−0.07***	−0.05***	
		(−9.67)	(−9.99)	(−9.61)	
Time to Maturity		−0.01	−0.01	−0.01	−0.41***
		(−0.66)	(−0.72)	(−1.05)	(−28.33)
GO Bond		−0.17***	−0.17***	−0.15***	
		(−6.67)	(−6.64)	(−6.48)	
Insurance		−0.10***	−0.10***	0.03	
		(−4.42)	(−4.60)	(1.36)	
Refunding		−0.47***	−0.48***	−0.46***	
		(−17.88)	(−17.95)	(−18.34)	
Ad Valorem		−0.02	−0.02	−0.01	
		(−0.96)	(−1.02)	(−0.72)	
Fed Exempt		−0.90***	−0.89***	−0.86***	
		(−14.60)	(−14.89)	(−21.57)	
State Exempt		−0.03	−0.03	0.12**	
		(−0.61)	(−0.69)	(2.25)	
AMT		−0.18**	−0.19**	−0.26***	
		(−2.16)	(−2.25)	(−3.59)	
BQ		−0.69***	−0.69***	−0.84***	
		(−4.66)	(−4.71)	(−6.27)	
Sinkable		0.34***	0.35***	0.25***	
		(10.40)	(10.51)	(8.49)	
Callable		−0.05***	−0.05***	−0.07***	
		(−2.94)	(−3.01)	(−4.26)	
Puttable		−0.38***	−0.39***	−0.67***	
		(−10.94)	(−11.18)	(−16.85)	
Competitive Bid		−0.01	−0.02	0.02	
		(−0.65)	(−1.02)	(1.28)	
Unemployment			0.04***	0.04***	0.04***
			(4.01)	(4.16)	(9.23)
Income			−0.76***	−0.84***	−0.75***
			(−3.02)	(−3.32)	(−5.31)
Population			−3.10***	−2.52***	−2.77***
			(−8.89)	(−7.87)	(−13.49)
Rating FE	No	No	No	Yes	No
State FE	Yes	Yes	Yes	Yes	No
YM FE	Yes	Yes	Yes	Yes	Yes
Facility FE	No	No	No	No	Yes
Obs.	796,322	796,322	796,322	796,322	796,136
Adj. R^2	0.38	0.52	0.52	0.55	0.75

This table presents the results for the effect of MMLs on state bond trading spreads. Panel A summarizes state bonds' contractual features at the facility-month level. Panel B details the regression results. Column 1 includes state and time (year-month) fixed effects. Column 2 adds bond characteristics as control variables. Column 3 further controls for state economic conditions. Column 4 includes credit-rating fixed effects. Column 5 includes bond facility and time (year-month) fixed effects. We cluster standard errors by issue and time (year-month) from Columns 1 to 4. In Column 5, we cluster standard errors by facility and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

Table 5
Alternative and additional measures.

	(1)	(2)	(3)	(4)
	Alternative Measures		Additional Measures	
	Raw Off. Yield	Tax-Adjusted Off. Spread	Gross Spread	Credit Rating
MML	0.06***	0.09***	0.04**	−0.20**
	(3.20)	(3.04)	(2.14)	(2.18)
Controls	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	No
State FE	Yes	Yes	Yes	Yes
YM FE	Yes	Yes	Yes	Yes
Obs.	113,723	113,723	37,043	97,113
Adj. R^2	0.92	0.78	0.52	0.45

This table presents the results for the robustness checks of the alternative and additional measures of states' borrowing costs. Columns 1 and 2 respectively present results using raw offering yields and tax-adjusted offering spreads as the dependent variable. Column 3 uses gross spreads as the outcome variable. Column 4 uses credit ratings as the outcome variable. We cluster standard errors by issue and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

Fourth, because default risk is the primary determinant of municipal bond spreads (Schwert 2017; Novy-Marx and Rauh 2012), we further investigate whether MMLs affect states' credit ratings. Column (4) of Table 5 shows that bond credit ratings deteriorate following MML passage, suggesting that MMLs adversely affect states' credit quality as evaluated by credit rating agencies.

4.3. Parallel trends

We examine the parallel trends assumption by evaluating the effects of MMLs by year on offering spreads and by month on trading spreads in the periods before and after the approval dates. Fig. 4 plots the coefficients by year using the offering spread

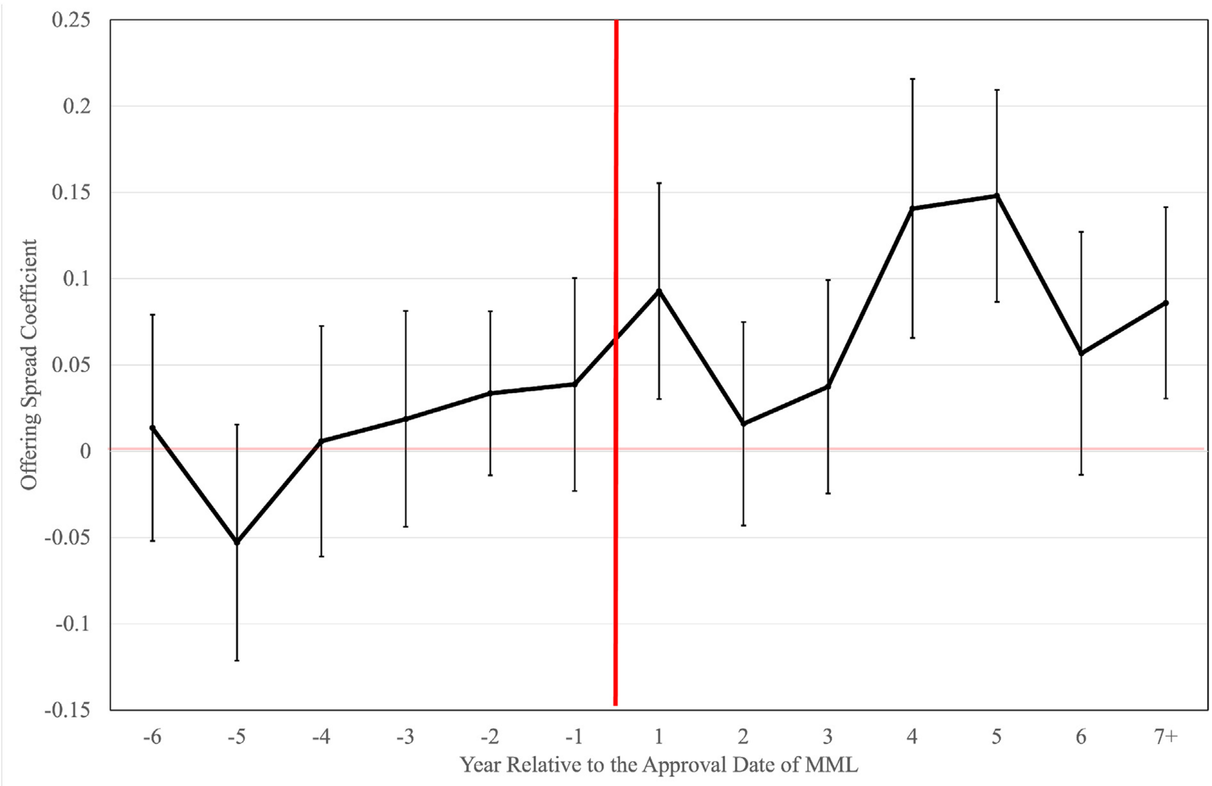


Fig. 4. Parallel Trends Assumption: Offering Spreads. This graph examines the parallel trends assumption using the primary sample. We plot the incremental effect of MMLs on state bonds' offering spreads by year in event time. The x-axis denotes the year relative to the date of MML passage. The y-axis plots the coefficients for each event-year estimated using the regression specification in Column 4 of Table 3. The dots (connected horizontally) represent the estimated coefficients, and the vertical lines represent 95% confidence intervals.

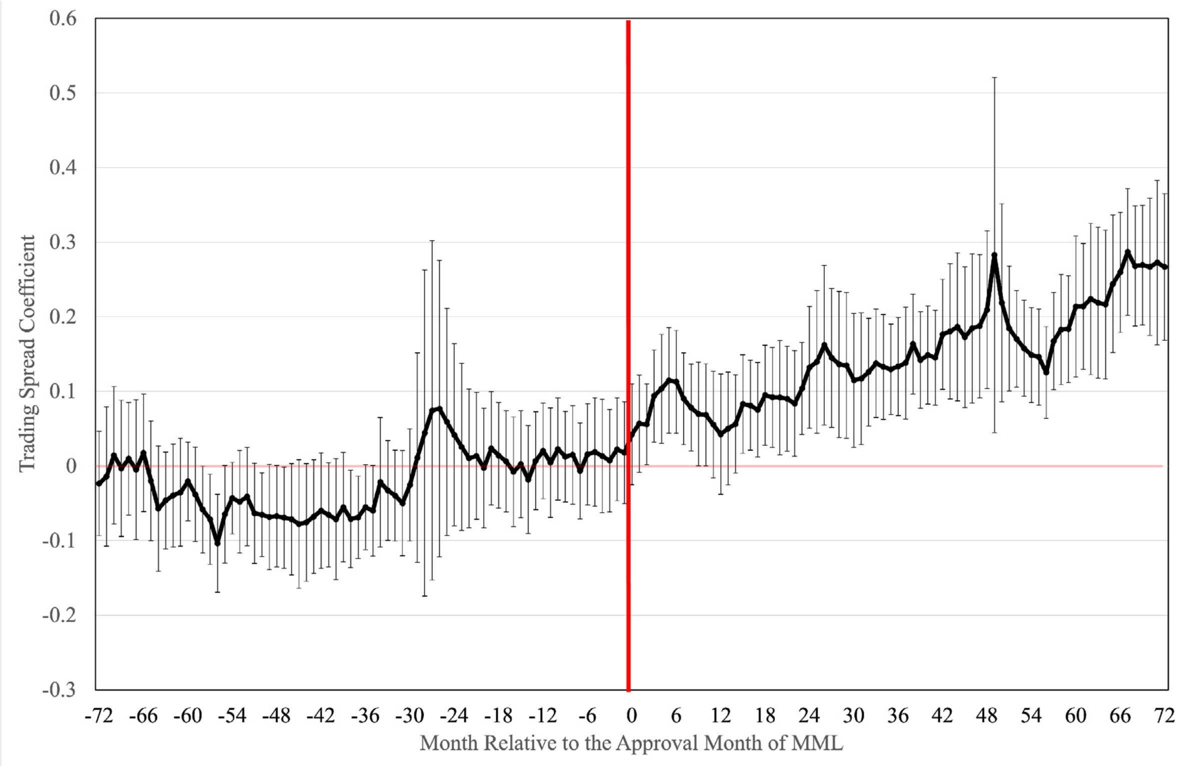


Fig. 5. Parallel Trends Assumption: Trading Spreads. This graph examines the parallel trends assumption using the secondary sample. We plot the incremental effect of MMLs on the state-bond trading spreads by month in event time. The x-axis denotes the month relative to the date of MML passage. The y-axis plots the coefficients for each event-month estimated using the regression specification in Column 5 of Panel B, Table 4. The dots (connected horizontally) represent the estimated coefficients, and the vertical lines represent 95% confidence intervals.

model specification in Column (4) of Table 3, while Fig. 5 presents the effects on trading spreads by month using the Column (5) model in Table 4, Panel B to estimate the monthly coefficients. Across both figures, we observe no significant changes in states' borrowing costs between those that pass and those that do not pass MMLs in the pre period. Based on the average coefficient estimates prior to and following the MML approval date, we believe that our assumption of parallel trends is reasonable.

In addition, states passing MMLs incur higher borrowing costs on average in the post period across both figures, which are consistent with our expectations that the effects of MMLs are more long term in nature. As mentioned previously, the MML legislation represents a series of actions, such as voting, the formation of a regulatory system, and the establishment of a monitoring channel. We do notice a 'dip' in spreads in some post periods, in which the spreads, while positive, are not significantly different from zero at the 5% levels. These insignificant periods are not consistent with our expectation. While we are not able to identify any systematic reason for these temporarily weaker effects, anecdotally we know that MMLs specific rules and requirements are enacted following passage. It is possible that the implementation may have differed from what investors initially anticipated due to, for example, short-term temporary legislative push back after the laws were approved (Appendix D provides an example for the state of Arizona in which after MML passage, a lawsuit was filed questioning the MML's legality and then an additional MML-related bill was passed.). We also highlight that the power of a yearly or monthly coefficient is reduced compared to a single coefficient that captures the effects across the full post period as presented in our main tests. Given that some early post periods are insignificant, in an untabulated test we confirm that our main results (using either offering or trading spreads) hold if we limit the sample to the three years before and after MML passage for the treated states as well as all observations for the control states, which never passed MMLs.[16]

[16] We also investigate whether the inclusion of controls for economic conditions and rating fixed effects affect the statistical significance of the annual offering and monthly trading spreads. As our tabulated main tests show, and as we expect ex ante, these controls absorb some of the MMLs' effect on borrowing costs. In untabulated analyses, we re-estimate Fig. 4 using a specification that excludes economic condition variables and rating fixed effects. We find that the number of insignificant post periods is reduced and that although the coefficient on year 2 remains insignificant, those on years 3 and 6 become statistically significant at the 5% level. Similarly, we re-estimate Fig. 5 using a specification that excludes the economic condition variables (this specification automatically subsumes rating fixed effects). We find that in the post periods, all coefficients are statistically significant at the 5% level.

Table 6
Alternative identification I: Border counties in different states.

Panel A: Sample Construction

	Pairs
Existing adjacent county pairs across state borders	1,308
Pairs for which both counties have at least one bond issuance in our sample period	674
After keeping pairs that satisfy the following requirements	
Sample 1. One county is in a state that passes an MML and the other county is in a state that does not do so in that year	459
Sample 2. One county is in a state that passes an MML and the other county is in a state that does not do so in any year in our sample period	274
Sample 3. Both counties have at least one bond issuance before and after the MML's passage year for the treated county	72
Sample 4. Both counties have at least one bond issuance in both the four years before the MML passage year for the treated county and the four years after it	42
Sample 5. Each treated county is matched with a single control county that is the closest in population size	32

Panel B: Effect of MMLs on Offering Spreads across Border Counties

	(1)	(2)	(3)	(4)	(5)
	Sample 1	*Sample 2*	*Sample 3*	*Sample 4*	*Sample 5*
	Off. Spread	Off. Spread	Off. Spread	Off. Spread	Off. Spread
MML	0.07***	0.10***	0.12***	0.09*	0.11*
	(2.92)	(3.90)	(3.31)	(1.77)	(1.80)
Controls	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes
Pair FE	Yes	Yes	Yes	Yes	Yes
YM FE	Yes	Yes	Yes	Yes	Yes
No. Pairs	459	274	72	42	32
Obs.	146,006	71,623	35,516	9,066	6,638
Adj. R^2	0.85	0.86	0.88	0.83	0.83

This table presents the results of the first alternative identification strategy test, using the border county samples. Panel A presents the construction of the five samples used in the tests. Panel B shows the effect of MMLs on the offering spreads using these five border county samples. Fig. 6 depicts a map of the sample used in the regression in Column 1 of Panel B. All columns include rating, border county-pair, and time (year-month) fixed effects. We cluster standard errors by issue and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

4.4. Alternative identification I: border counties in different states

Although we adopt a staggered shock design, we cannot fully rule out the possibility that our main results are driven by unmeasurable time-variant state-level factors that correlate with the staggered passage of MMLs. For example, changes in the composition of local residents and expectations of a gloomy local economy can lead to MML passage and thereby confound our main findings. To mitigate such concerns, we employ an alternative identification strategy in which we examine adjacent counties residing in different states. Without a random assignment of MMLs to regions, one way to identify MMLs' causal effect on borrowing costs is to select a counterfactual region that is similar to the treated one and then compare the differences in the pair's borrowing costs around MMLs. We examine two adjacent counties on either side of the state border, the characteristics of which are very likely to be similar in the absence of the policy change (Holmes 1998). This approach relies on the abrupt changes in state policy (i.e., policy discontinuity) around the state borders for identification—any difference in changes to the borrowing cost that we observe between the two border counties around MML passage can be more confidently attributed to the MMLs. We obtain county bond offerings from Bloomberg, and we use Eq. (1) with multiple samples to estimate the effect of MMLs on border counties.

Table 6, Panel A describes our sample construction method. First, we follow Dube et al. (2010) in constructing a sample of adjacent counties divided by state borders, in which the treated counties are paired with control counties with replacement. We start with a list of 1308 adjacent county pairs across state borders that we obtain from the U.S. Census. We require that both counties in the pair have at least one bond issuance in our sample period, resulting in 674 pairs. We further require one county in the pair to be in a state where an MML was passed (i.e., the treated county), while the other be located in a state that had not passed an MML at the time when the treated county's state did so (i.e., the control county). These procedures produce the first test sample (*Sample 1*), which consists of 495 pairs of border counties with a total of 146,006 county-bond offerings. Fig. 6 illustrates this sample on a map.

A long estimation window in *Sample 1* allows us to capture the effect of MMLs over time, but it is also more susceptible to confounding factors. To mitigate this concern, we apply four sequential data steps to derive a sample for the strict difference-in-differences test suggested by Huang (2008). Specifically, we require that the control county does not pass an MML at any time during the sample period (*Sample 2*), both counties in the pair have at least one bond issuance before and after the treated county's MML passage (*Sample* 3), and both counties have at least one bond issuance within the four years before and after the treated county's MML passage (*Sample* 4). Last, if multiple control counties are available for a single treated county, we keep the county that is closest in population size (*Sample 5*). These data procedures limit *Sample 5* to a restrictive sample of 32 pairs of one-to-one matched treatment and control counties with 6638 bond offerings. With this last sample, we are able

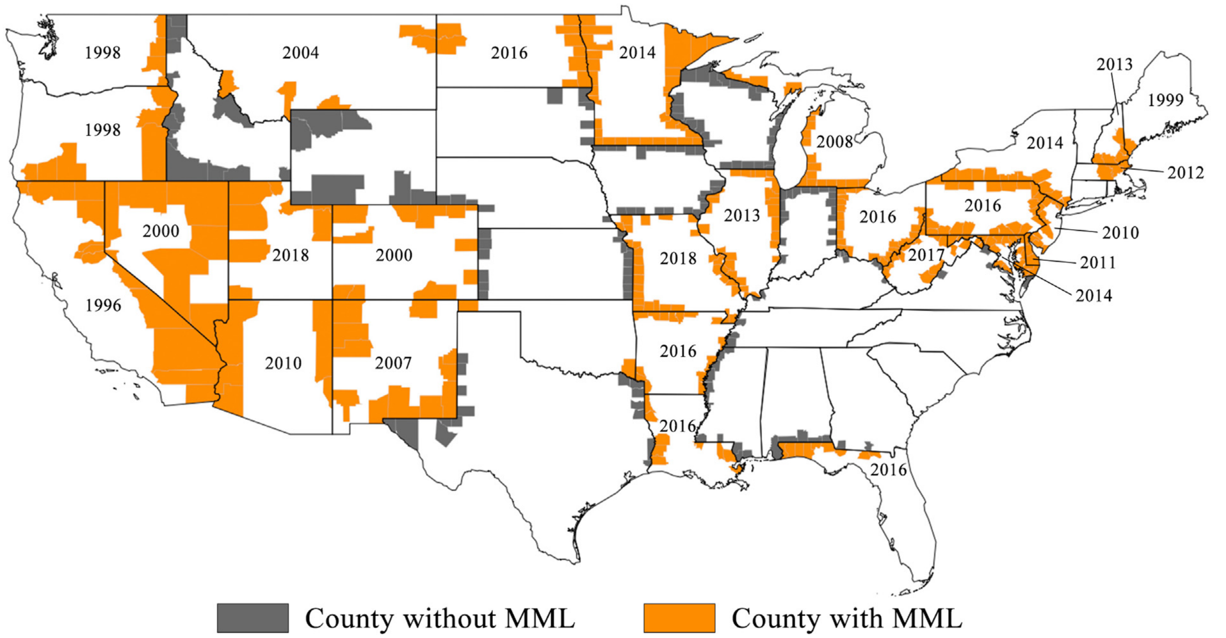


Fig. 6. Identification Strategy I: Border Counties. This figure demonstrates the sample used for the border county test in Column 1 of Table 6. We indicate the MML approval years for the treated counties. Due to MMLs' staggered passage, a county in a state that has not yet passed an MML can serve as the control county for a treated county that passes an MML. For instance, California passed its MML in 1996, and Arizona passed its MML in 2010. A county in Arizona that is along the California-Arizona border can serve as the control county for a California county that joins the MML treatment group in 1996.

to compare the changes in the treated county's borrowing costs from the four years before to the four years after MML passage, relative to a control county in a border state that does not pass an MML.

Panel B of Table 6 reports the regression estimate corresponding to each sample described above. Using *Sample 1* (as suggested by Dube et al. (2010)), Column (1) reveals that border counties located in MML states experience a 7 basis point increase in their borrowing costs relative to the control counties. Columns (2) to (4), which use the intermediate samples (i.e., *Sample 2* to *Sample 4*), show that border counties located in MML states experience greater borrowing costs in the range of 9–12 basis points. Using *Sample 5* (as suggested by Huang (2008)), Column (5) indicates that the treated counties incur a significant 11 basis point increase in borrowing costs relative to the control counties. Collectively, the border county results reduce the possibility that states' cultural, social, and economic differences explain the treatment effect, and thus they strengthen the causal link between MMLs and local governments' borrowing costs.

4.5. Alternative identification II: discontinuity in the ballot outcomes

Our second alternative identification strategy relies on an arguably random change in marijuana liberalization by focusing on two states, one of which passed an MML by a small margin and the other that rejected it by a small margin. As Lee (2008) points out, the inherent uncertainty in a U.S. election vote count makes winning or losing a close election essentially "as good as random." In a similar sense, in our setting, the passage or rejection of a ballot-determined MML within a small margin at the decision threshold (e.g., 50%) likely approximates a random change. A state with a close margin below the approval threshold can thus serve as a valid counterfactual for a treated state that passes an MML with a narrow margin above the threshold. Because the two states are similar in terms of their citizens' voting preferences about medical marijuana, a difference between the changes in their borrowing costs around the MML is likely due to the law's passage rather than to changes in the institutional and political factors that could have initiated the regulation.

Appendix E provides details about U.S. medical marijuana ballots, including the year, the percentage voted for yes, and the final outcome, all collected from ballotpedia.org. We compare Arizona's 2010 ballot (approved with 50.1%) with Arkansas's 2012 ballot (defeated with 48.6%), because i) they were passed or rejected with the closest margins and ii) their respective votes occurred within a short time period (mitigating concerns about confounding effects due to time-variant factors). Because Arizona and Arkansas were not active in new bond issuance around the ballots, we use trading spreads to proxy for their borrowing costs. We compare changes in borrowing costs for Arizona and Arkansas during the six years around the Arizona ballot (i.e., the three years before and after the ballot month).

Table 7 presents the results. In Column (1), we use a base model with rating, state, and time (year-month) fixed effects, and we control for facility characteristics and local economic conditions, as in the model specification in Column (4) of Table 4, Panel B. We find that MML passage in Arizona leads to a 38 basis point increase in the state bond trading spreads relative to Arkansas. In Column (2), we examine the within-bond variation in trading spreads by replacing state fixed effects with facility

Table 7
Alternative identification II: Discontinuity in the ballot outcomes.

	(1) Trading Spread	(2) Trading Spread
MML	0.38***	0.31***
	(3.10)	(2.86)
Controls	Yes	Yes
Rating FE	Yes	No
State FE	Yes	No
Facility FE	No	Yes
YM FE	Yes	Yes
Obs.	3,817	3,784
Adj. R^2	0.49	0.63

This table presents the results for the second alternative identification strategy test, employing a discontinuity in ballot voting outcomes. We compare Arizona's 2010 ballot (approved with 50.1%) and Arkansas's 2012 ballot (defeated with 48.6%). Column 1 uses a model with state, rating, and time (year-month) fixed effects, with standard errors clustered by issue and time (year-month). Column 2 includes facility fixed effects, with standard errors clustered by facility and time (year-month). We use trading spreads to proxy for borrowing costs because, around the ballots, Arizona and Arkansas were not active in new bond issuance. *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

fixed effects, similar to Column (5) of Table 4, Panel B. In this test. Arizona's MML passage leads to a 31 basis point increase relative to Arkansas. These results mitigate the concern that our inference could be driven by changes in the underlying institutional and political factors leading to the MML, rather than the MML itself.[17]

In sum, the collective evidence of the staggered shock of MMLs presented above—using a sample of state bonds, five samples of neighboring-county bonds, and a discontinuity approach in state ballot votes, supplemented with a battery of robustness checks using alternative measures of borrowing costs—lends support to the causal inference that MMLs increase local governments' borrowing costs.[18]

5. Underlying mechanism

We conduct several analyses to support the mechanism that MMLs lead to higher local marijuana consumption, which heightens states' fiscal burdens, and thus, increases their default risk and borrowing costs.

5.1. Marijuana's increased consumption

5.1.1. Marijuana use rate

As discussed in Section 2.3, MML passage increases marijuana's availability and acceptance, thereby leading to greater marijuana consumption by both medical and illicit drug users. We provide direct evidence on how MMLs affect local governments' borrowing costs through an increase in their residents' marijuana use rate. We collect survey data on state-level marijuana use from the National Survey on Drug Use and Health (NSDUH). The data first became available in 2002, which limits the analysis to the 2002 to 2018 period. Using this limited sample, we perform two-stage regressions to quantify the impact of increased marijuana use on state bonds' spreads.

Table 8 presents the results. In the first stage, we use the *MML* indicator and other controls to predict the state-year marijuana use rates, measured as the percentage of the state population that are yearly marijuana users. In the second stage, the predicted value of marijuana use rates from the first stage becomes an independent variable that explains the bond spreads dependent variable. In Columns (1) and (2), we include bond contractual terms as control variables; in Columns (3) and (4), we add state economic conditions and bond rating fixed effects. The results from Columns (1) and (3) confirm a

[17] Nonetheless, the estimated coefficient is specific to Arkansas and Arizona, so we caution readers not to infer that the economic significance from this test applies to the overall population.

[18] The recent econometrics literature (see Baker et al. (2022) for a review) suggests that, in a staggered difference-in-differences (DiD), the potential use of already-treated units as an effective comparison group for later-treated units could bias the DiD estimate when the treatment effect is heterogenous. We discuss the relevance of this concern in our setting and provide a robustness check. First, our main sample starts six years before the first MML shock and ends when seventeen states had yet to pass MMLs. The relatively large size of the control observations and never-treated states makes our estimate less subject to the biases that arise from dynamic treatment effects. Second, our two additional identification strategies rely on different research designs and different samples, which mitigate the bias concern. Our first test uses the bonds of border counties, and we strictly match the treated counties with non-treated counties in the comparison period. The bond yields of the not-yet-treated counties are not subject to heterogeneous treatment effects and hence can serve as effective controls. Our second test that compares bond spreads between Arizona and Arkansas employs a standard two-by-two DiD design, which is not subject to the bias concern. Nonetheless, we conduct the stacked-regression analysis suggested by Baker et al. (2022); our inferences are unchanged.

Table 8
Effect of MMLs on offering spreads through marijuana use.

	(1)	(2)	(3)	(4)
	Marijuana Use	Off. Spread	Marijuana Use	Off. Spread
MML	1.18***		1.13***	
	(9.79)		(8.92)	
Predicted Marijuana Use		0.11***		0.07**
		(4.01)		(2.38)
Unemployment			0.04	0.03**
			(0.89)	(2.58)
Income			−0.14	−0.59*
			(−0.10)	(−1.76)
Population			0.01	−0.37*
			(0.01)	(−1.87)
Bond Controls	Yes	Yes	Yes	Yes
Rating FE	No	No	Yes	Yes
State FE	Yes	Yes	Yes	Yes
YM FE	Yes	Yes	Yes	Yes
Obs.	47,208	47,208	47,207	47,207
Adj. R^2	0.93	0.74	0.93	0.78

This table presents the effect of MMLs on offering spreads through an increase in marijuana use. We first predict the yearly marijuana use rates using MMLs and then examine the relation between the offering spreads and the predicted use rates. In Columns 1 and 2, we include bond characteristics, and state and time (year-month) fixed effects. In Columns 3 and 4, we further include state economic factors and bond rating fixed effects. We cluster standard errors by issue and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

significant increase in marijuana consumption after MML passage. Columns (2) and (4) suggest that an MML-induced, one-percentage-point increase in the state population that uses marijuana is associated with a bond yield increase of 11 and 7 basis points, respectively. The results provide more direct evidence on the positive relation between the increased marijuana consumption induced by MMLs and local governments' borrowing costs.

5.1.2. Cross-sectional tests: state contextual factors

The survey data on marijuana use rates from Section 5.1.1 have inherent limitations. In particular, coverage is limited to only the more recent time periods. To buttress our results, we investigate whether MMLs' effect on bond spreads is strengthened by state contextual features that previous studies show are associated with a greater increase in marijuana use after MMLs. These cross-sectional tests employ data for the full sample.

Table 9 presents the results. First, as part of MMLs, adequate regulation and enforcement are required for administrative processes, such as packaging, industry licensing, and local control (Kilmer and MacCoun 2017). States with more corruption tend to have lower law enforcement quality, and hence may fail to adequately regulate and enforce the processes designed to prevent MMLs' potential negative spillover effects (e.g., drug trafficking and straw purchases). To capture the cross-sectional

Table 9
Cross-sectional tests: State contextual factors.

Indicator =	Corrupt	Young	African American	Urban	Optimal Growing
	(1)	(2)	(3)	(4)	(5)
	Off. Spread	Off. Spread	Off. Spread	Off. Spread	Off. Spread
MML	0.01	0.04**	0.04**	−0.02	0.05***
	(0.66)	(1.98)	(2.40)	(−0.57)	(2.63)
MML x Indicator	0.12***	0.07**	0.05*	0.10***	0.06*
	(4.70)	(2.25)	(1.83)	(3.19)	(1.69)
Indicator	–	0.00	−0.10**	0.00	–
		(0.17)	(−2.47)	(0.13)	
Controls	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
YM FE	Yes	Yes	Yes	Yes	Yes
Obs.	111,188	113,723	113,723	113,723	113,546
Adj. R^2	0.84	0.84	0.84	0.84	0.84

This table presents the results for the cross-sectional analyses of the main test results using state contextual factors. Column 1 reports the effect of MMLs on state bonds for states with a higher perceived corruption index. Columns 2 to 4 present the results of cross-sectional variation in state socio-demographics. Column 2 shows the effect for states with lower-median-age population. Column 3 shows the effect for states where African Americans comprise a greater proportion of the population. Column 4 shows the effect for states where urban residents comprise a greater proportion of the population. Column 5 shows the effect for states with temperatures that are more optimal for marijuana cultivation. We cluster standard errors by issue and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

Table 10
Intertemporal tests: Institutional factors.

	(1)	(2)	(3)
	Off. Spread	Off. Spread	Off. Spread
MML	0.05***	0.06***	−0.03
	(2.85)	(2.94)	(−0.53)
MML × Dispensary Opening	0.05**		
	(2.28)		
MML × Cole Memo		0.05*	
		(1.70)	
MML × Acceptance Rate			0.24**
			(2.08)
Controls	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
YM FE	Yes	Yes	Yes
Obs.	113,723	113,723	113,723
Adj. R^2	0.84	0.84	0.84

This table presents the results for the intertemporal analyses of the main test results. Column 1 shows the incremental effect for states that open dispensaries after MML passage. Column 2 shows the results for the incremental effect of MMLs on state bonds' offering spreads after Deputy Attorney General James Cole issued a memorandum to deprioritize the use of funds to enforce marijuana prohibition under the Controlled Substances Act on August 29, 2013. Column 3 details the results for the effect of MMLs on state bonds' offering spreads by the public acceptance rate for marijuana. We obtain annual national acceptance rates for marijuana legalization from the General Social Survey conducted by the National Opinion Research Center at the University of Chicago. We cluster standard errors by issue and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

variation in states' level of corruption, we use the state-level corruption index from Saiz and Simonsohn (2013), which is based on corruption-related social phenomena exposed on the Internet.[19] Consistent with our expectation, Column (1) shows that the increase in offering spreads after MML passage is concentrated among states with higher levels of corruption.

Second, certain population groups are found to be more vulnerable to the spillover effect of MMLs. Hasin et al. (2015) report that the increased prevalence of marijuana use from 2001/02 to 2012/03 is more concentrated among younger people, African Americans, and urban residents. Columns (2) to (4) respectively indicate that the increase in offering spreads after the passage of MMLs is more pronounced for such states.

Third, states' natural environments affect the production costs of growing marijuana and hence its market supply. For instance, the ideal temperature for growing marijuana plants falls in a narrow range between 24 and 30 °C (75–86 °F) (Green 2010). We use this temperature range to separate states into two groups—those with more favorable versus less favorable growing conditions for marijuana plants. We obtain data on states' average monthly temperatures from the National Centers for Environmental Information.[20] Column (5) shows that the increase in states' borrowing costs is greater for those for which the average monthly temperatures tend to fall more often into the ideal temperature range. This finding suggests that bondholders are more concerned when the supply of marijuana is likely higher due to a better cultivation environment.

5.1.3. Intertemporal tests: institutional factors

In this section, we investigate three institutional factors that affect or at least correlate with MML-induced increases in marijuana consumption. First, we explore the staggered changes in states' MML implementation, using the opening of the first medical marijuana dispensaries in MML states, as a second shock that induces greater marijuana consumption. An attractive feature of this test is that these openings represent a specific consequence of an MML's passage. The second shock is not perfectly correlated with the MML passage dates. Appendix A presents both MMLs' passage dates and the opening dates for the first dispensaries by state. Of the thirty-three states and the District of Columbia with MMLs, twenty-five of them set up operational medical marijuana dispensaries by 2018. For example, Alaska passed an MML but did not allow the establishment of state-licensed dispensaries. For states that both passed MMLs and allowed dispensaries, the lag between the MML's passage date and the first dispensary's opening date ranges from less than a year to more than 10 years.[21]

Previous studies (Pacula et al., 2015; Baggio et al., 2020) provide evidence that the MML-induced greater marijuana consumption is magnified after the opening of dispensaries. As Column (1) of Table 10 shows, we also obtain consistent evidence that MMLs further increase a state's bond spreads after its first marijuana dispensary opens. This finding supports

[19] Saiz and Simonsohn (2013) measure the degree of corruption in a state by calculating the ratio of the number of internet documents containing "corruption" and the state name (using text proximity algorithms) to the total number of documents containing the state name. The logic is that a state with higher corruption receives more exposure online.

[20] https://www.ncdc.noaa.gov/cag/national/time-series (access date: March 6, 2022).

[21] Florida's first dispensary was opened several months before its MML passage by state voters. Prior to the vote, the Florida government passed the Right to Try Act, which allowed physicians to experimentally treat seriously-ill patients (Sanctuary Wellness Institute, 2022). Marijuana-based products were added to the list of approved medicines under this law. Our tabulated first-dispensary test includes Florida for completeness. The inferences are unchanged if we exclude Florida observations from this test.

the marijuana use mechanism and alleviates the concern that other confounding events that are associated with legalization but unrelated to marijuana liberalization explain our results.[22]

Second, MML passage creates a conflict between the federal ban on marijuana and the state's legalization of it, which potentially imposes legal risk on local residents and businesses that need to comply with federal laws. Thus, it is possible that the observed increase in bond spreads reflects heightened uncertainty about future prosecution (Pástor and Veronesi 2013). To investigate the possibility of such a pricing factor, we compare the effect of MMLs around an event that loosened the federal enforcement on marijuana prohibition. On August 29, 2013, U.S. Deputy Attorney General James Cole issued a memorandum to de-prioritize the use of funds to enforce cannabis prohibition under the Controlled Substances Act. The issuance of this memorandum greatly reduces the likelihood of federal intervention into local states' marijuana legalization, which should lower the degree of prosecution uncertainty and hence decrease bond spreads. Instead, Column (2) of Table 10 shows that MMLs increase bond spreads after the Cole memorandum, which does not support the idea that legal risk is the main driver of our results. We surmise that the reduced level of federal effort on marijuana prohibition associated with the Cole memorandum implicitly encouraged local residents' marijuana use, which intensified the spillover effect of marijuana liberalization.

Third, we examine how the impact of MMLs varies by marijuana's public acceptance, which we expect to be positively correlated with marijuana consumption. This test also addresses the possibility of an alternative investor preference explanation for our results. Hong and Kacperczyk (2009) argue that some investors prefer not to invest in so-called "sin" stocks, which are the stocks of firms involved in alcohol, tobacco, and gaming, and that as a result, these stocks exhibit higher expected returns.

If state bondholders simply prefer not to invest in 'marijuana' states that pass MMLs, the capital supply for their bonds would decrease, and the borrowing costs for MML states would increase. The investor preference explanation implies that marijuana is more likely to be associated with "sin" when its acceptance rate is lower. Hence, an increase in borrowing costs due to this investor preference would be stronger when marijuana is less publicly accepted. In contrast, if, as we surmise, MMLs induce higher consumption, we would expect the main effect to be stronger when the rate of public acceptance of marijuana is higher. We collect data on the national acceptance rate for marijuana from the General Social Survey conducted by the National Opinion Research Center at the University of Chicago.[23] Column (3) of Table 10 shows that the effect of MMLs is increasing in marijuana's public acceptance, which is more consistent with the idea of increased marijuana use as opposed to the investor preference explanation.[24]

Overall, the results of the three analyses concerning marijuana's increased use collectively lend credence to the mechanism that MML-induced increased marijuana use leads to higher state borrowing costs. By using institutional factors specific to MMLs, the results also help shed light on MMLs' heterogeneous effects across states and time.

5.2. States' heightened fiscal burdens

We conduct two analyses to further substantiate our mechanism that state governments that have passed MMLs incur higher expenditures in enforcing such laws and mitigating the potential negative social and economic consequences of increased marijuana use, which increase the government's probability of default and borrowing costs.

5.2.1. MML-related expenditures and programs

We directly investigate the impact of MMLs on state governments' spending in areas that are likely associated with the social consequences of increased marijuana use. As we have a relatively long sample period, spanning more than 25 years, some of the increased credit risk priced in municipal bonds as a result of MMLs could manifest itself in states' public budgets. We collect state expenditures data, starting in 1992, from the U.S. Census Bureau's Annual Survey of State and Local Government Finances.[25] Appendix C, which we previously mention, shows that prior studies tend to argue that MMLs affect residents' safety (e.g., the crime rate), health (e.g., drug use disorders), and potentially social welfare (e.g., school attainment and unprotected sex).

Table 11 presents the results. In Panel A, the *MML* coefficients from the regressions in Columns (1), (2), and (4) suggest that states that pass an MML respectively spend $8.73, $10.55, and $177.70 more per capita on police, correctional facilities, and public welfare. The total dollar increase of these MML-related expenditures sum to $196.98 per capita. We caution that these

[22] There are several other differences across marijuana laws at the state level but their variation is generally not as rich as that inherent to the establishment of dispensaries. For example, more than 90% of MML states impose a strict requirement on medical marijuana users, which requires medical users to register with the state's board of medical cannabis registry. Only California, Colorado, and Washington have less stringent requirements. In addition to the richer variation, previous studies (e.g., Powell et al. (2018); Baggio et al. (2020)) also suggest that active and legal dispensaries tend to have a larger social impact than the specific legal details of an MML.

[23] See https://www.norc.org/Research/Projects/Pages/general-social-survey.aspx (access date: March 6, 2021).

[24] We further note that while the investor preference story is certainly plausible, the impact of MMLs on borrowing costs is ex-ante less likely driven by investors' preferences to avoid "marijuana" states because the passage of MMLs is primarily determined by local citizens in ballot votes. Since a large portion of state bondholders are local citizens (because of the tax exemption benefits) who can also participate in voting of an MML, it would hence be a contradiction for an MML to be passed in a state where investors prefer to avoid marijuana.

[25] https://www.census.gov/programs-surveys/state.html (access date: March 6, 2021).

Table 11
State Government's expenditures and programs.

Panel A: States' Expenditures and Financial Strength

	MML-Related Expenditures				MML-Unrelated Expenditures			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Police Exp.	Corrections Exp.	Health Exp.	Public Welfare Exp.	Highways Exp.	Natural Resources Exp.	Parks & Recreation Exp.	Deficit
MML	8.73**	10.55**	22.86	177.7***	6.110	−1.200	−2.010	212.2**
	(2.48)	(2.15)	(1.49)	(3.51)	(0.32)	(−0.24)	(−1.36)	(2.05)
Unemployment	−0.1700	0.5100	−3.490	−2.890	5.170	1.180	−0.4300	57.07*
	(−0.31)	(0.42)	(−1.08)	(−0.24)	(0.58)	(0.74)	(−0.93)	(1.75)
Income	63.22***	161.6***	249.9*	186.4	953.1**	448.0***	61.51***	456.5
	(2.78)	(3.29)	(1.69)	(0.45)	(2.24)	(3.17)	(5.35)	(0.32)
Population	−27.21**	−53.60*	12.96	−1,171***	−80.75	−3.840	5.140	−2,143***
	(−2.15)	(−1.80)	(0.16)	(−4.96)	(−0.81)	(−0.11)	(0.59)	(−3.88)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,350	1,350	1,350	1,350	1,350	1,350	1,350	1,350
Adj. R^2	0.87	0.89	0.72	0.92	0.86	0.91	0.77	0.91

Panel B: Social Welfare Programs and Outcomes

	(1)	(2)	(3)	(4)	(5)	(6)
	Public Housing	Energy Subsidy	Food Stamp	High-School Graduation	College Degree	Drug-Induced Death
MML	1.29**	0.30*	0.37	−2.38***	−1.09***	2.94***
	(2.61)	(1.69)	(1.42)	(−2.68)	(−2.88)	(3.14)
Unemployment	−0.20	0.09*	0.67***	−0.55*	0.07	−0.49**
	(−1.01)	(1.82)	(6.69)	(−1.79)	(0.54)	(−2.05)
Income	2.09	0.04	−6.36***	−16.49**	−2.97	−19.50***
	(0.38)	(0.02)	(−3.49)	(−2.12)	(−0.74)	(−2.97)
Population	−3.70	−2.35*	−1.20	−6.70	−8.81***	−26.78***
	(−1.47)	(−2.00)	(−0.83)	(−0.94)	(−4.55)	(−3.62)
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1,479	1,479	1,479	1,450	1,479	1,020
Adj. R^2	0.47	0.71	0.82	0.83	0.93	0.80

This table presents the results for the effect of MMLs on states' expenditures and programs. Panel A presents the effect of MMLs on states' expenditures. Columns 1 to 4 respectively show the effect of MMLs on states' MML-related expenditures for police, corrections, health, and public welfare (per capita). Columns 5 to 7 respectively present the effect of MMLs on MML-unrelated expenditures for highways, natural resources, and parks and recreation expenditures (per capita). Column 8 presents the effect of MMLs on states' deficits (per capita). Panel B provides more support for Column 4 of Panel A with regard to states' various social welfare programs and outcomes. The columns detail the effect of MMLs on states' (1) population percentage that lives in public housing, (2) population percentage that receives energy subsidies, (3) population percentage that receives food stamps, (4) percentage of ninth-grade cohort that graduates in four years, (5) population percentage aged between 25 and 64 that has a college degree, and (6) number of drug-induced deaths per 100,000 people. We obtain the measures of public housing, energy subsidies, food stamps, and the college education rate from the Current Population Survey (CPS) March Supplements. We obtain high school graduation rates from America's Health Rankings from the United Health Foundation, and the drug-induced death rates from the Centers for Disease Control and Prevention (CDC). We control for the impact of state economic conditions and cluster standard errors by state. *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

particular tests represent associations and hence the estimates only serve as rough guides to the actual economic magnitudes. As additional checks, Columns (5) to (7) report that expenditures on activities unrelated to MMLs (i.e., highways, natural resources, and parks and recreation, respectively) do not change significantly. Column (8) suggests that MMLs increase states' deficits per capita by $212.20. These findings are consistent with the idea that after the law's passage, states incur more expenditures in those areas that are more likely to prevent and mitigate the negative social consequences of increased marijuana use. These greater expenditures constrain states' debt servicing capacity, which indicates greater credit risk and thus leads to higher borrowing costs.

We highlight that in Panel A, the public welfare expenditures, which fund a collection of categorical programs, including low-income public housing and energy assistance, and food stamp administration, experience the greatest increase. To supplement this finding, we investigate the percentage change in the population that receives these three types of public welfare programs, using data from the Current Population Survey (CPS) March Supplements. We present these results in Panel B of Table 11. Columns (1) to (3) indicate that after an MML, a significantly larger percentage of state residents are provided with public housing, energy subsidies, and food stamps. The expanded provisions of these services lend more credence to the observed increase in state governments' public welfare spending. Columns (4) and (5) provide evidence that MML passage is associated with a lower level of education attainment among local residents. Column (6) documents an increased number of drug-induced deaths in MML states, pointing to a potentially higher use of addictive drugs among MML state residents. These findings imply a potential reduction in labor productivity in MML states. Our results are corroborated by existing literature that documents the significantly negative impact of regular marijuana use on individuals' school attainment and lifetime achievements (Volkow et al., 2014). For example, increased marijuana use is associated with worsened school performance and an increased probability of dropping out of school (Bray et al., 2000; Marie and Zölitz 2017; Lynskey and Hall 2000). Marijuana use is also linked to poor career opportunities, lower income, and greater levels of welfare dependency (Fergusson and Boden 2008; Brook et al., 2013; Schmidt et al., 1998).

As untabulated additional analysis, we investigate how the associations between state expenditures and MML passage vary over time. Unlike the capital market effects, which are based on investor expectations and are more likely to occur relatively quickly, MMLs' state expenditure effects likely take more time to materialize because government spending may occur only after the problems with greater marijuana use have manifested. We estimate the same Table 11 specifications, but decompose the MML indicator into three variables that respectively indicate three time periods that follow MML passage: (1) the years 1–3, (2) the years 4–10, and (3) the years beyond year 10. Consistent with the idea that the longer-term effects on states' expenditures are generally stronger than the shorter-term effects, compared with the year-1-to-3 period, the estimated increased spending related to MMLs is generally higher in the year-4-to-10 period and the beyond-year-10 period.

In sum, given that marijuana liberalization is a multifaceted issue, it is challenging to enumerate all the possible MML outcomes that affect governments' financial health and bondholders' pricing decisions. That said, we believe that the findings of higher government expenditures in expected areas provide more support for our proposed mechanism that MMLs drive up states' expenditures, increase their fiscal burdens, and thus adversely affect states' debt servicing capacity and credit risk.

5.2.2. Bond characteristics

States' greater fiscal burdens after MML passage are likely to manifest in their heightened credit risk, which, as Schwert (2017) and Novy-Marx and Rauh (2012) document, is the primary factor that drives municipal bond spreads. The robustness test presented in Column (4) of Table 5 already confirms that states' credit ratings are lower after the passage of MMLs. To provide additional support for a link between states' fiscal spending and bond investors' pricing decisions, in Table 12 we conduct three cross-sectional tests that explore bond-level characteristics. Column (1) shows that the effect of MMLs on bond spreads is concentrated on GO bonds, which are backed by states' public budgets and hence should better reflect expectations of heightened state expenditures.[26] Column (2) suggests that the effect of MMLs is significantly larger for lower-rated bonds, which should also be more sensitive to expanded state government expenditures. This result also supports the idea that MMLs affect bond yields through the default channel. Column (3) finds that the increase in bond

Table 12
Bond characteristics.

Indicator =	GO	Below AA	Long Term
	(1)	(2)	(3)
	Off. Spread	Off. Spread	Off. Spread
MML	0.00	0.06***	0.02
	(0.17)	(3.17)	(0.91)
MML × Indicator	0.10***	0.07**	0.11***
	(4.06)	(2.42)	(6.90)
Indicator	−0.13***	–	0.08***
	(−8.69)		(9.40)
Controls	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes
State FE	Yes	Yes	Yes
YM FE	Yes	Yes	Yes
Obs.	113,723	97,113	113,723
Adj. R^2	0.84	0.87	0.84

This table presents the results for the cross-sectional analyses of the main test results using bond facility characteristics. Column 1 reports the main effect for general obligation (GO) bonds relative to revenue (RV) bonds. Column 2 presents the effect for state bonds according to whether bonds' credit ratings are higher or lower. Column 3 shows the effect of MMLs on the offering spreads of state bonds with longer or shorter terms to maturity. We cluster standard errors by issue and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All variables are defined in Appendix G.

[26] We conduct two additional untabulated analyses related to GO bonds. In a robustness test that limits the sample to GO bonds, we continue to find evidence that supports our main result that MMLs lead to increased borrowing costs. We also model the decision to issue GO versus non-GO bonds. The result suggests that the bond mix does not shift significantly after MML passage.

spreads is concentrated among bonds with longer maturities, which is consistent with the stronger long-term social and health impacts that arise from marijuana use, as argued by a synthesis of marijuana medical research (Volkow et al., 2014).

Taken together, the collective evidence presented in this section supports our mechanism that MMLs lead to greater marijuana consumption, which increases states' fiscal burdens and hence their borrowing costs.[27]

6. Recent state recreational marijuana laws

Our main analysis estimates the overall effect of marijuana liberalization using the initial legalization of marijuana for medical purpose use. Following this initial event, several states took steps to further liberalize marijuana by legalizing marijuana for recreational use. These laws generally allow for the commercial production, processing, and sale of marijuana, similar to that of alcohol and tobacco.[28] Between 2012 and 2018, a total of ten states (i.e., Alaska, California, Colorado, Maine, Massachusetts, Michigan, Nevada, Oregon, Vermont, and Washington) and the District of Columbia further allowed the recreational use of marijuana. Since then, Arizona, Guam, Illinois, Montana, New Jersey, New York, and South Dakota all passed legalization allowing recreational marijuana in 2020. As recreational marijuana was only recently legalized in a few states, the time series data following such laws' passage is extremely limited, and hence the public policy evidence on the outcomes of recreational marijuana laws is likely inconclusive.[29] With this caveat in mind, we conduct an additional analysis with the aim of providing preliminary evidence on recreational marijuana laws.

Table 13
Medical versus recreational marijuana laws.

	(1)	(2)
	Off. Spread	Off. Spread
Med	0.07***	0.01
	(4.03)	(0.51)
Rec	0.09**	−0.04
	(2.93)	(−1.09)
Med × GO Bond		0.09***
		(3.42)
Rec × GO Bond		0.20***
		(4.74)
Controls	Yes	Yes
Rating FE	Yes	Yes
State FE	Yes	Yes
YM FE	Yes	Yes
Obs.	113,723	113,723
Adj. R^2	0.84	0.84

This table presents the results for the impact of recreational marijuana laws on state bonds' offering spreads. We augment the regression specification used in Column 4 of Table 3. For states with both medical and recreational marijuana laws, we define two indicators, *Med* and *Rec*, based on each law's corresponding legalization period. *Med* is an indicator that equals one for a bond that is issued after the corresponding state's passage of its medical marijuana law and before subsequent passage of its recreational marijuana law (if any), and zero otherwise. *Rec* is an indicator that equals one for a bond that is issued after the corresponding state's passage of the recreational marijuana law (if any), and zero otherwise. Column 1 examines the overall effect of medical and recreational marijuana laws. Column 2 presents the medical and recreational marijuana laws' effect for general obligation (GO) bonds relative to non-general-obligation bonds. We cluster standard errors by issue and time (year-month). *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests. All other variables are defined in Appendix G.

[27] Our analyses in this section as well as in Section 5.1.2 allow us to identify eight subsamples for which we expect the effect of passing MMLs to be stronger. The first three subsamples from this section represent GO bonds, long-term bonds, and bonds with low ratings. The other five subsamples, from Section 5.1.2, consist of bonds in states with more corruption, younger people, more African Americans, more people living in urban areas, and optimal marijuana-growing conditions. We take advantage of these subsamples to revisit the parallel trends analyses using offering spreads as previously discussed in the context of Fig. 4 (see Section 4.3). In that analysis, the year-2, year-3, and year-6 coefficients in the post-MML period are positive as expected but insignificant. In untabulated analyses, we repeat the analyses conducted in footnote 15 across the eight subsamples, and as expected, the annual results are stronger. More specifically, we find that the year-2 coefficients are statistically significant in four subsamples, the year-3 coefficients are statistically significant in five subsamples, and the year-6 coefficients are statistically significant in all eight subsamples.

[28] For more details, see Table 1 of McGinty et al. (2017).

[29] Kerr et al. (2017) find that college students in Oregon increase their marijuana use after recreational marijuana legalization in 2014. Dragone et al. (2019) find a reduced incidence of rape and property crime in the District of Columbia after recreational marijuana legalization in 2014.

The impact of legalizing recreational marijuana on states' borrowing costs is ex-ante unclear. On the one hand, certain state officials and the media argue that allowing marijuana for recreational use yields several economic benefits, such as reduced law enforcement costs, increased tax revenues, and the creation of jobs by boosting the size of the marijuana industry (McGinty et al., 2016, 2017; Jacobi and Sovinsky 2016). Relative to medical marijuana, local governments can collect higher tax revenues on recreational marijuana, which should at least to some extent mitigate states' increased government expenditures and borrowing costs. On the other hand, the reasons for the higher borrowing costs that we document after MML passage are likely to be exacerbated by recreational marijuana laws due to the even greater expected marijuana consumption.

Table 13 presents the results of our analyses. We augment the regression specification used in Column 4 of Table 3. For states with both medical and recreational marijuana laws, we separately estimate the effects of marijuana legalization for two consecutive time periods—the initial passage of medical marijuana (*Med*) and the subsequent legalization of recreational marijuana (*Rec*). *Med* is an indicator that equals one for bonds issued after the state legalizes medical marijuana and before it further legalizes recreational marijuana (if any), zero otherwise. *Rec* is an indicator that equals one for bonds issued after the state further legalizes recreational marijuana (if any), zero otherwise.

Column (1) shows that relative to the pre-legalization period, states' borrowing costs increase after medical marijuana laws and climb slightly higher after recreational marijuana law passage. Using an untabulated F-test, the difference between the *Med* and *Rec* coefficients in Column (1), however, is not statistically significant at conventional levels. In Column (2), we allow GO bonds to have separate coefficients than other (i.e., revenue) bonds. The effect of *Med* on GO bonds' offering spreads is particularly strong ($0.01 + 0.09 = 0.10$); similarly, the effect of *Rec* for GO bonds is more pronounced ($-0.04 + 0.20 = 0.16$). The difference between the *Med* and *Rec* coefficients for GO bonds in this column is statistically significant (untabulated). These findings provide modest evidence that states' borrowing costs may have climbed even higher after the passage of recreational marijuana laws.[30]

As additional support for the above inference, we collect states' disclosures of marijuana tax revenues (available for states with legal retail marijuana markets before 2018). Appendix F presents these states' reported marijuana tax statistics. Despite proponents' claim about the significant taxing potential, states have only been able to collect a modest level of marijuana tax revenues, which on average account for 0.39% of their total revenues. These statistics are consistent with several news articles reporting that marijuana tax revenue has fallen short of expectations (e.g., Daniels and Aiello 2018; Frosch 2015). More importantly, these marijuana tax shortfalls support our inference that the passage of recreational marijuana laws increase (albeit modestly) borrowing costs.

We conclude this section by cautioning that our evidence is far from conclusive because, as mentioned above, our sample includes only limited post period data from ten states and the District of Columbia, all of which recently legalized recreational marijuana.

7. Conclusion

We provide the first evidence on an unmentioned cost of U.S. marijuana liberalization, one imposed by capital market investors. Using the staggered passage of states' medical marijuana laws, we show that legalizing marijuana for medical use increases state bonds' offering spreads by 7−9 basis points, trading spreads by 8 basis points, and underwriter gross spreads by 4 basis points. We find that the observed increase in states' borrowing costs is explained by greater marijuana consumption after MMLs. Moreover, this finding is consistent with economic theory on substance use suggesting that marijuana legalization for medical use expands marijuana's availability and reduces marijuana's perceived risks, and thus, leads to greater marijuana consumption by both medical and non-medical users, Further analyses show that states incur greater expenditures, likely in the enforcement of medical marijuana laws and to mitigate the potential negative social and economic consequences of increased marijuana consumption after MML passage. This expenditure increase hinders states' debt servicing capacity, adversely affects their credit quality, and thereby increases their borrowing costs. The collective findings indicate that municipal bond investors perceive a net cost rather than a net benefit from states' marijuana liberalization and impose higher borrowing costs on local governments.

We also provide preliminary evidence on states' recreational marijuana laws, suggesting that consistent with anecdotal evidence that marijuana tax revenues are modest, the borrowing costs for several states that further legalized marijuana for recreational use continue to remain at the elevated levels after such laws are passed.

Our findings are relevant to policy makers (at both the federal and state levels) and to residents interested in evaluating the overall cost of liberalizing marijuana. We add to the debate by showing that municipal bondholders perceive marijuana liberalization as inducing a net economic cost to the state's fiscal health. We also contribute to the emerging literature on public health issues and the growing municipal research in accounting by documenting a public health policy's public finance effect.

[30] As an untabulated robustness check of our main results on the effect of MMLs on states' borrowing costs, we exclude the states that legalized both medical and recreational marijuana from the main tests; we continue to find that our inferences are unchanged.

Appendix

Appendix A. Dates of MML Approvals and First Dispensary Openings

This table lists the approval dates of medical marijuana laws (MMLs) and the dates when state-licensed dispensaries first opened (between 1996 and 2018).

State	MML	First Dispensary
California	11/05/1996	11/10/1996
Alaska	11/03/1998	
Oregon	11/03/1998	11/13/2009
Washington	11/03/1998	10/01/2009
Maine	11/02/1999	03/31/2011
Hawaii	04/25/2000	08/08/2017
Colorado	11/07/2000	10/01/2005
Nevada	11/07/2000	10/30/2009
Vermont	05/19/2004	06/21/2013
Montana	11/02/2004	03/01/2009
Rhode Island	01/03/2006	04/19/2013
New Mexico	03/13/2007	07/01/2009
Michigan	11/04/2008	06/15/2009
New Jersey	01/11/2010	12/06/2012
District of Columbia	05/04/2010	07/29/2013
Arizona	11/02/2010	12/06/2012
Delaware	05/11/2011	06/26/2015
Connecticut	05/04/2012	08/20/2014
Massachusetts	11/06/2012	06/24/2015
Illinois	05/17/2013	11/09/2015
New Hampshire	06/26/2013	04/30/2016
Maryland	04/07/2014	07/06/2017
Minnesota	05/16/2014	07/01/2015
New York	06/20/2014	01/07/2016
Pennsylvania	04/13/2016	
Louisiana	05/16/2016	
Ohio	05/25/2016	
Arkansas	11/08/2016	
Florida	11/08/2016	7/26/2016
North Dakota	11/08/2016	
West Virginia	04/06/2017	
Oklahoma	06/26/2018	9/16/2018
Missouri	11/06/2018	
Utah	11/06/2018	

Appendix B. Marijuana Use and Perceptions towards Marijuana

The economic theory of substance use (Becker and Murphy 1988; Grossman 2005) suggests that MML passage decreases the perceived health and legal risks associated with marijuana use, expands its availability, and thus induces greater local marijuana consumption. To validate these predictions, we examine MMLs' impact on states' marijuana use rates and residents' perceptions about marijuana. First, we estimate the effect on marijuana consumption by regressing the percentage of a state's population that uses marijuana on the staggered passage of MMLs. Next, we show the effects on residents' perceptions about marijuana's health risk, legal risk, and its availability, respectively, by regressing perceived harm, legal risk, and availability on MMLs. Finally, we regress states' marijuana use rates on both MMLs and residents' perception variables in the same regression. We obtain the outcome measures from the National Survey on Drug Use and Health (NSDUH), which first became available in 2002.

We estimate these effects, using an ordinary least squares (OLS) regression with the following specification:

$$y_{jt} = \alpha + \beta MML_{jt} + \delta' Z_{jt} + \eta_j + \mu_t + \varepsilon_{jt}$$

where j denotes the state, and t denotes the year. y_{jt} is the outcome variables described above for state j during year t. MML_{jt} is an indicator that equals one if state j passes a medical marijuana law, zero otherwise. Z_{jt} is a vector of state-year-level economic factors. We include state fixed effects (η_j) to account for state-specific and time-invariant characteristics, and year fixed effects (μ_t) to absorb time-varying economy-wide trends. The unit of analysis is at the state-year level. We cluster standard errors by state. The coefficient on MML_{jt} gauges MMLs' effect on states' marijuana use rates and residents' perceptions relative to the unaffected states.

We present the results of this analysis below. First, Columns (1) and (2) investigate the impact of MMLs on states' marijuana consumption. Column (1) uses, as an outcome variable, the percentage of a state's population that uses marijuana in the year prior to taking the survey. Column (2) employs, as a dependent variable, the percentage of a state's population that uses marijuana every day in the month before the survey. The MML_{jt} coefficients in the two columns indicate that MMLs increase yearly marijuana users by 0.96 percentage points and daily users by 0.70 percentage points, respectively, of a state's population. Given that the unconditional mean of the two rates are 11.87% and 2.35%, these increases represent 8% above the average of yearly users (0.96%/11.87%), and 30% above the average of daily users (0.70%/2.35%), respectively, suggesting that MMLs significantly increase both the number of users and the frequency of use.

Next, Columns (3) to (5) respectively examine whether MMLs alter residents' perceptions about marijuana's health risk, legal risk, and availability. Column (3) uses, as an outcome variable, the percentage of a state's population that agrees that smoking marijuana once or twice a week might cause harm. Column (4) employs, as a dependent variable, the percentage of a state's population that reports that their perception of their state of residence's maximum legal penalty for a first offense of possession of an ounce or less of marijuana for their own use is a prison sentence. The coefficients on MML_{jt} indicate that MML passage is associated with a 1.03 percentage point reduction in the population that believes that smoking marijuana once or twice a week might cause harm, and a 2.69 percentage point reduction in the population that reports that possessing marijuana for their own use could put them in jail. Column (5) uses, as an outcome variable, the percentage of a state's population that reports that it would be fairly or very easy for them to obtain marijuana if they want some. The coefficient on MML_{jt} indicates that MML passage is associated with a 2.54 percentage point increase in residents who report easier access to marijuana, suggesting that potential users have greater marijuana availability and lower search costs.

Finally, Column (6) presents the effect of MMLs on marijuana consumption after controlling for residents' perception variables. The significant coefficients on $PerceivedHarm_{jt}$, $PerceivedLegalRisk_{jt}$, and $PerceivedAvailability_{jt}$ indicate that these three perceptions explain the MML-induced increase in marijuana users. Further, the lower coefficient on MML_{jt} confirms that the effect of such laws is at least partially subsumed by residents' perception variables.

The collective evidence in this table suggests that MMLs have increased local marijuana consumption by lowering the health and legal risks and expanding marijuana availability. *, **, and *** respectively indicate statistical significance at the 10%, 5%, and 1% levels using two-tailed tests.

	(1)	(2)	(3)	(4)	(5)	(6)
	Yearly User	Daily User	Perceived Harm	Perceived Legal Risk	Perceived Availability	Yearly User
MML	0.96** (2.42)	0.70*** (5.17)	−1.03*** (−3.29)	−2.69*** (−3.17)	2.54*** (3.63)	0.36 (1.23)
Perceived Harm						−0.31*** (−6.63)
Perceived Legal Risk						−0.05*** (−3.45)
Perceived Availability						0.14*** (5.30)
Economic Controls	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	731	516	516	516	516	516
Adj. R^2	0.90	0.77	0.92	0.83	0.76	0.90

Appendix C. Summary of MMLs' Expected Outcomes

This table summarizes the benefits and costs of medical marijuana laws (MMLs) discussed in news articles and the existing literature.

Pros		Examples
1	Give patients in need access to a quality and safe product	Schlinkmann (2010)
2	Provide a safer choice than traditional opioid drugs, or narcotics, with less severe side effects	Worden (2015)
3	Develop the marijuana industry and create jobs	Wollan (2010)
4	Increase government revenue by charging permit fees and sales taxes	Wollan (2010)
5	Attract more residents and visitors to the counties with dispensaries	Brooks (2013)
Cons		**Examples**
1	Lead to more illicit use	Schlinkmann (2010)
2	Lead to more use of other hard drugs (e.g., opioid overdose)	Schlinkmann (2010) Shover et al. (2019)
3	Adversely change the perception and culture	Schlinkmann (2010)
4	Represent a slippery slope to full legalization	Holden (2012)
5	Encourage adolescent use	Goyena (2014) Pacula et al. (2015) Wen et al. (2015)
6	Increase crime rates	Goyena (2014)
7	Increase the potency of the marijuana products in the market	Goyena (2014)

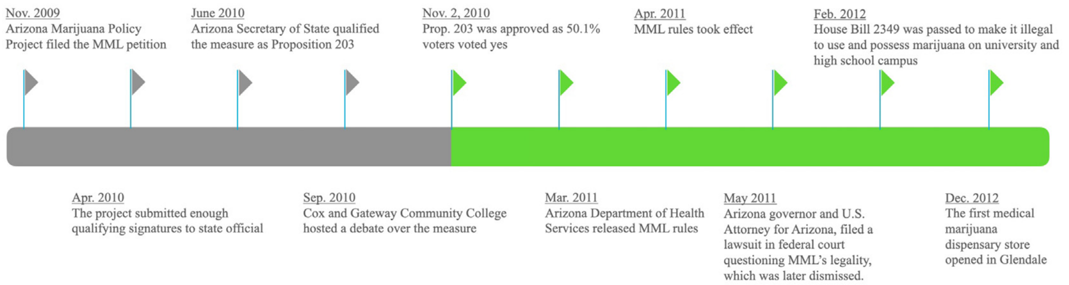
(*continued on next page*)

(*continued*)

Pros		Examples
8	Include ineffective controls and regulations	Gershman (2012)
9	Are based on limited knowledge about dosage and risk	Worden (2015)
10	Increase unprotected sex	Baggio et al. (2020)
11	Increase traffic fatalities	Li et al. (2013)

Appendix D. Timeline of Marijuana Legalization for Medical Use in Arizona

We use Arizona as an example to demonstrate the timeline of marijuana legalization for medical use. Typically, a ballot measure starts with a petition filed by state citizens or organizations. The petition is then circulated among citizens. After the required number of registered voters' signatures is reached, the petition receives approval by state officials to be on the ballot. Prior to the vote, the ballot measure is often debated in local media outlets and receives endorsements and oppositions from various organizations and parties. After the measure is approved, state officials prepare and release the rules. They may make amendments before implementing the final rules. There could be legal challenges to the rules. In some cases, additional rules are passed at a later time. In most cases, the state will allow state-licensed dispensaries to open. The timeline below presents the key events of Arizona's medical marijuana campaign as well as its subsequent implementation.



Appendix E. List of Medical Marijuana Initiatives in the U.S.

This table lists the ballot dates and outcomes (both approvals and defeats) for the eighteen states that have passed medical marijuana by ballots. We compare the two states with the closest margin to the decision rule (50%)—Arizona's 2010 ballot (approved with 50.1%) and Arkansas's 2012 ballot (defeated with 48.6%) in Section 4.5.

State	Name of Measure	Year	Outcome	Yes %
California	Marijuana Legalization, Proposition 19	1972	Defeated	33.5%
California	Proposition 215, the Medical Marijuana Initiative	1996	Approved	55.6%
Alaska	Medical Marijuana Act, Measure 8	1998	Approved	58.7%
Nevada	Medical Marijuana Act, Question 9	1998	Approved	58.7%
Oregon	Medical Marijuana, Measure 67	1998	Approved	54.6%
Washington	Medical Marijuana, Initiative 692	1998	Approved	59.0%
Maine	Medical Marijuana for Specific Illnesses, Question 2	1999	Approved	61.4%
Colorado	Medical Use of Marijuana, Initiative 20	2000	Approved	53.5%
Nevada*	Medical Marijuana Act, Question 9	2000	Approved	65.4%
Arizona	Marijuana Legalization, Proposition 203	2002	Defeated	42.7%
Montana	Medical Marijuana Allowance, Measure I-148	2004	Approved	61.8%
South Dakota	Measure 4, Medical Marijuana	2006	Defeated	47.7%
Michigan	Medical Marijuana Initiative, Proposal 1	2008	Approved	63.0%
Arizona	Medical Marijuana Question, Proposition 203	2010	Approved	50.1%
South Dakota	Medical Marijuana Act, Initiated Measure 13	2010	Defeated	36.7%
Arkansas	Medical Marijuana Question, Issue 5	2012	Defeated	48.6%
Massachusetts	Medical Marijuana Initiative, Question 3	2012	Approved	63.3%
Florida†	Right to Medical Marijuana Initiative, Amendment 2	2014	Defeated	57.6%
Arkansas	Medical Marijuana Amendment, Issue 6	2016	Approved	53.1%
Florida	Medical Marijuana Legalization, Amendment 2	2016	Approved	71.3%
North Dakota	Medical Marijuana Legalization, Initiated Statutory Measure 5	2016	Approved	63.8%
Missouri	Amendment 2, Medical Marijuana and Veteran Healthcare Services Initiative	2018	Approved	65.6%
Oklahoma	Question 788, Medical Marijuana Legalization Initiative	2018	Approved	56.9%
Utah	Proposition 2, Medical Marijuana Initiative	2018	Approved	52.8%

*In Nevada, it requires approval in consecutive elections for a constitutional amendment to be enacted.
†In Florida, it takes a supermajority vote (60%) for a constitutional amendment to be enacted.

Appendix F. State Marijuana Tax Revenue after the Passage of Recreational Marijuana Laws

This table reports the annual tax revenue that state governments collected from related marijuana businesses after the passage of recreational marijuana laws. In Section 6, we provide preliminary analysis on the incremental effect of recreational marijuana laws.

State	Year	Marijuana Tax Revenue ($millions)	Percentage over Total Government Revenue
Colorado	2014	67.59	0.24%
	2015	130.41	0.43%
	2016	193.60	0.61%
	2017	247.37	0.78%
	2018	266.53	0.76%
Washington	2015	64.88	0.16%
	2016	185.67	0.43%
	2017	314.84	0.68%
	2018	367.40	0.75%
Oregon	2016	20.65	0.08%
	2017	70.26	0.25%
	2018	82.20	0.28%
Alaska	2017	1.75	0.01%
	2018	10.80	0.08%
California	2018	395.30	0.13%
Nevada	2018	69.70	0.57%
Average			0.39%

Appendix G. Variable Definitions

Variable	Definition
Acceptance rate	Acceptance rate for marijuana legalization in the bond's issuance year, obtained from General Social Survey conducted by the National Opinion Research Center at the University of Chicago.
Ad Valorem	Indicator that equals one if the bond is repaid by ad valorem taxes, and zero otherwise
AMT	Indicator that equals one if the bond's interest is subject to alternative minimum tax (AMT), and zero otherwise
BQ	Indicator that equals one if the bond is a bank qualified bond, and zero otherwise
Callable	Indicator that equals one if the bond has an embedded call option, and zero otherwise
Competitive Bid	Indicator that equals one if the bond is sold to underwriters through competitive bidding, and zero otherwise
Corrupt	Indicator that equals one if the bond is issued by a state with an above-median corruption index obtained from Saiz and Simonsohn (2013), and zero otherwise
Credit Rating	Standard & Poor's bond ratings at issuance, which are converted to numerical values by assigning a value of 21 to the highest credit rating (AAA), a value of 20 to the next-highest rating (AA+), and so forth
Fed Exempt	Indicator that equals one if the bond's interest is not subject to federal income tax, and zero otherwise
GO Bond	Indicator that equals one if the bond is a general obligation bond, and zero otherwise
Gross Spread	Bond's issuance underwriter discount cost disclosed by the underwriter in an official statement, measured as a percentage of the total issued amount; an official statement is a document prepared by or on behalf of a state or local government for a new issuance of municipal securities
Income	Log transformation of the annual income per capita in the state or the county for a given year
Insurance	Indicator that equals one if the bond is insured, and zero otherwise
Long Term	Indicator that equals one if the bond's time to maturity is above the sample median, and zero otherwise
Low College	Indicator that equals one if the bond is issued by a state for which a below-median percentage of the population has some college, or an Associate, Bachelor, Graduate or professional degree in the most recent census, and zero otherwise
African American	Indicator that equals one if the bond is issued by a state that has an above-median percentage of African Americans relative to the total population in the most recent census, and zero otherwise
MML	Indicator that equals one if the bond is issued after the corresponding state's approval date of its medical marijuana law, and zero otherwise
Offering Yield	Discount rate that makes the expected coupons and principal repayments equal to the price at issuance
Offering Spread	Offering yield adjusted by the interpolated treasury rates for corresponding maturity terms
Optimal Growing	Indicator that equals one if the bond is issued by a state with an above-median percentage of months with an average temperature ideal for marijuana cultivation (between 75 to 86 degrees Fahrenheit) in 1990–2018
Population	Log transformation of the population in the state or county for a given year
Puttable	Indicator that equals one if the bond has an embedded put option, and zero otherwise
Refunding	Indicator that equals one if the bond is refunded after the issuance, and zero otherwise
Sinkable	Indicator that equals one if the bond is backed by a sinking fund, and zero otherwise
Size	Bond's issue amount; the log transformation of this amount is used in the regressions
State Exempt	Indicator that equals one if the bond's interest is not subject to state income tax, and zero otherwise
Tax-Adjusted Offering Spread	Offering yield adjusted based on the bond's tax-exempt status under the assumption of the highest federal and state income tax rates, less the interpolated treasury rates for corresponding maturity terms, following Schwert (2017)

(*continued on next page*)

(*continued*)

Variable	Definition
Time to Maturity	Number of years between the bond's issuance date and its maturity date
Trading Yield	Value-weighted average of trading yields in the secondary market for the bond's customer-buy transactions in a given month
Trading Spread	Secondary market trading yield adjusted by the interpolated treasury rates for corresponding maturity terms
Unemployment	Unemployment rate in the state or county for a given year
Young	Indicator that equals one if the bond is issued by a state that has an above-median percentage of its population aged 30 and below in the most recent census, and zero otherwise

References

Andrews, N., 2020, Dec. House passes bill decriminalizing marijuana at federal level. Wall St. J. https://www.wsj.com/articles/house-passes-bill-decriminalizing-marijuana-at-federal-level-11607107693.
Ang, A., Green, R.C., 2011. Lowering Borrowing Costs for States and Municipalities through CommonMuni. *Unpublished Working Paper*.
Atanasov, V., Black, B., 2016. Shock-based causal inference in corporate finance and accounting research. Critical Finance Review 5 (2), 207–304. https://doi.org/10.1561/104.00000036.
Baggio, M., Chong, A., Simon, D., 2020. Sex, marijuana and baby booms. J. Health Econ. 70, 102283. https://doi.org/10.1016/j.jhealeco.2019.102283.
Baker, A., Larcker, D.F., Wang, C.C.Y., 2022. How much should we trust staggered difference-in-differences estimates? J. Financ. Econ. 144 (2), 370–395. https://doi.org/10.1016/j.jfineco.2022.01.004.
Barco, M., 2009, Dec. Los Angeles Aims to Close Some Pot Dispensaries. National Public Radio. https://www.npr.org/templates/story/story.php?storyId=121433422.
Beatty, A., Gillette, J., Petacchi, R., Weber, J., 2019. Do rating agencies benefit from providing higher ratings? Evidence from the consequences of municipal bond ratings recalibration. J. Account. Res. 57 (2), 323–354. https://doi.org/10.1111/1475-679X.12263.
Beck, A.W., 2018. Opportunistic financial reporting around municipal bond issues. Rev. Account. Stud. 23 (3), 785–826. https://doi.org/10.1007/s11142-018-9454-2.
Becker, G.S., Murphy, K.M., 1988. A theory of rational addiction. J. Polit. Econ. 96 (4), 675–700. https://www.jstor.org/stable/1830469?seq=1&cid=pdf-reference#references_tab_contents.
Bray, J.W., Zarkin, G.A., Ringwalt, C., Qi, J., 2000. The relationship between marijuana initiation and dropping out of high school. Health Econ. 9 (1), 9–18. https://doi.org/10.1002/(SICI)1099-1050(200001)9:1<9::AID-HEC471>3.0.CO;2-Z.
Brook, J.S., Lee, J.Y., Finch, S.J., Seltzer, N., Brook, D.W., 2013. Adult work commitment, financial stability, and social environment as related to trajectories of marijuana use beginning in adolescence. Subst. Abuse 34 (3), 298–305. https://doi.org/10.1080/08897077.2013.775092.
Brooks, J., 2013, Dec. Drive for pot may be long, Minnesota's eight medical marijuana centers won't be conveniently located for many outside the Twin Cities. Star. Trib. (Minneap. MN). https://doi.org/10.1017/CBO9781107415324.004.
Butler, A.W., Fauver, L., Mortal, S., 2009. Corruption, political connections, and municipal finance. Rev. Financ. Stud. 22 (7), 2873–2905. https://doi.org/10.1093/rfs/hhp010.
Butler, A.W., Yi, H., 2022. Aging and public financing costs: evidence from U.S. municipal bond markets. J. Publ. Econ. 211, 104665. https://doi.org/10.1016/j.jpubeco.2022.104665.
Carliner, H., Brown, Q.L., Sarvet, A.L., Hasin, D.S., 2017. Cannabis use, attitudes, and legal status in the U.S.: a review. Prev. Med. 104, 13–23. https://doi.org/10.1016/j.ypmed.2017.07.008.
Cerdá, M., Wall, M., Keyes, K.M., Galea, S., Hasin, D., 2012. Medical marijuana laws in 50 states: investigating the relationship between state legalization of medical marijuana and marijuana use, abuse and dependence. Drug Alcohol Depend. 120 (1–3), 22–27. https://doi.org/10.1016/j.drugalcdep.2011.06.011.
Chen, C., Li, L., Lu, L.Y., Wang, R., 2022. Flu Fallout: Information Production Constraints and Corporate Disclosure. *Unpublished Working Paper*.
Chu, Y.W.L., Townsend, W., 2019. Joint culpability: the effects of medical marijuana laws on crime. J. Econ. Behav. Organ. 159, 502–525. https://doi.org/10.1016/j.jebo.2018.07.003.
Cornaggia, K.R., Hund, J., Nguyen, G., Ye, Z., 2022. Opioid crisis effects on municipal finance. Rev. Financ. Stud. 35 (4), 2019–2066. https://doi.org/10.1093/rfs/hhab066.
Costello, A.M., Petacchi, R., Weber, J.P., 2017. The impact of balanced budget restrictions on states' fiscal actions. Account. Rev. 92 (1), 51–71. https://doi.org/10.2308/accr-51521.
Cuny, C., 2016. Voluntary disclosure incentives: evidence from the municipal bond market. J. Account. Econ. 62 (1), 87–102. https://doi.org/10.1016/j.jacceco.2016.04.004.
Cuny, C., 2018. When knowledge is power: evidence from the municipal bond market. J. Account. Econ. 65 (1), 109–128. https://doi.org/10.1016/j.jacceco.2017.11.002.
Cuny, C., Even-Tov, O., Watts, E.M., 2021. From implicit to explicit: the impact of disclosure requirements on hidden transaction costs. J. Account. Res. 59 (1), 215–242. https://doi.org/10.1111/1475-679X.12340.
Daniels, J., Aiello, C., 2018, May. California Says Pot Revenue Is Coming in 'slower than Expected '. Consumer News and Business *Channel (CNBC)*. https://www.cnbc.com/2018/05/10/california-gov-brown-could-slash-cannabis-tax-revenue-forecasts.html.
Dougal, C., Gao, P., Mayew, W.J., Parsons, C.A., 2019. What's in a (school) name? Racial discrimination in higher education bond markets. J. Financ. Econ. 134 (3), 570–590. https://doi.org/10.1016/j.jfineco.2019.05.010.
Dragone, D., Prarolo, G., Vanin, P., Zanella, G., 2019. Crime and the legalization of recreational marijuana. J. Econ. Behav. Organ. 159, 488–501. https://doi.org/10.1016/j.jebo.2018.02.005.
Dube, A., Lester, T.W., Reich, M., 2010. Minimum wage effects across state borders: estimates using contiguous counties. Rev. Econ. Stat. 92 (4), 945–964. https://doi.org/10.1162/REST_a_00039.
Fergusson, D.M., Boden, J.M., 2008. Cannabis use and later life outcomes. Addiction 103 (6), 969–976. https://doi.org/10.1111/j.1360-0443.2008.02221.x.
Frosch, D., 2015, Jan. Colorado, Legal Pot Fails to Meet Predictions of Supporters, Critics. Wall Street J. https://www.wsj.com/articles/in-colorado-pot-legalization-fails-to-match-predictions-of-backers-critics-1420830972.
Galenianos, M., Pacula, R.L., Persico, N., 2012. A search-theoretic model of the retail market for illicit drugs. Rev. Econ. Stud. 79 (3), 1239–1269. https://doi.org/10.1093/restud/rds007.
Gao, P., Lee, C., Murphy, D., 2019. Municipal borrowing costs and state policies for distressed municipalities. J. Financ. Econ. 132 (2), 404–426. https://doi.org/10.1016/j.jfineco.2018.10.009.
Gao, P., Lee, C., Murphy, D., 2020. Financing dies in darkness? The impact of newspaper closures on public finance. J. Financ. Econ. 135 (2), 445–467. https://doi.org/10.1016/j.jfineco.2019.06.003.
Gershman, J., 2012, Apr. Medical-pot debate rises in Albany. Wall St. J.

Government Finance Officers Association, 2020. ESG considerations for governmental issuers: understanding ESG opportunities and risk factors and why governments should make them a priority. https://gfoaorg.cdn.prismic.io/gfoaorg/915e145a-6ad4-437d-a3b9-e0b4b4ff9122_ESGResearchReport_GFOA2020.pdf. (Accessed April 2021).
Goyena, R., 2014, Jun. Pot Foes Get Billionaire Ally. Tampa Bay Times.
Green, G., 2010. The Cannabis Grow Bible: the Definitive Guide to Growing Marijuana for Recreational and Medical Use, second ed. Green Candy Press, San Francisco.
Grossman, M., 2005. Individual behaviours and substance use: the role of price. In: Substance Use: Individual Behaviour, Social Interactions, Markets and Politics, vol 16. Emerald Group Publishing Limited, UK. https://doi.org/10.1016/S0731-2199(05)16002-6.
Hasin, D.S., Saha, T.D., Kerridge, B.T., Goldstein, R.B., Chou, S.P., Zhang, H., Jung, J., Pickering, R.P., Ruan, J., Smith, S.M., Huang, B., Grant, B.F., 2015. Prevalence of marijuana use disorders in the United States between 2001-2002 and 2012-2013. JAMA Psychiatr. 72 (12), 1235–1242. https://doi.org/10.1001/jamapsychiatry.2015.1858.
Hasin, D.S., Sarvet, A.L., Cerdá, M., Keyes, K.M., Stohl, M., Galea, S., Wall, M.M., 2017. US adult illicit cannabis use, cannabis use disorder, and medical marijuana laws: 1991-1992 to 2012-2013. JAMA Psychiatr. 74 (6), 579–588. https://doi.org/10.1001/jamapsychiatry.2017.0724.
Holden, D., 2012, Apr. Smokeless in Seattle. The New York Times.
Holmes, T.J., 1998. The effect of state policies on the location of manufacturing: evidence from state borders. J. Polit. Econ. 106 (4), 667–705. https://doi.org/10.1086/250026.
Hong, H., Kacperczyk, M., 2009. The price of sin: the effects of social norms on markets. J. Financ. Econ. 93 (1), 15–36. https://doi.org/10.1016/j.jfineco.2008.09.001.
Huang, R.R., 2008. Evaluating the real effect of bank branching deregulation: comparing contiguous counties across US state borders. J. Financ. Econ. 87 (3), 678–705. https://doi.org/10.1016/j.jfineco.2007.01.004.
Jacobi, L., Sovinsky, M., 2016. Marijuana on main street? Estimating demand in markets with limited access. Am. Econ. Rev. 106 (8), 2009–2045. https://doi.org/10.1257/aer.20131032.
Karpoff, J.M., Wittry, M.D., 2018. Institutional and legal context in natural experiments: the case of state antitakeover laws. J. Finance 73 (2), 657–714. https://doi.org/10.1111/jofi.12600.
Kerr, D.C., Bae, H., Phibbs, S., Kern, A.C., 2017. Changes in undergraduates' marijuana, heavy alcohol and cigarette use following legalization of recreational marijuana use in Oregon. Addiction 112 (11), 1992–2001. https://doi.org/10.1111/add.13906.
Kido, N., Petacchi, R., Weber, J., 2012. The influence of elections on the accounting choices of governmental entities. J. Account. Res. 50 (2), 443–476. https://doi.org/10.1111/j.1475-679X.2012.00447.x.
Kilmer, B., MacCoun, R.J., 2017. How medical marijuana smoothed the transition to marijuana legalization in the United States. Annu. Rev. Law Soc. Sci. 13 (1), 181–202. https://doi.org/10.1146/annurev-lawsocsci-110615-084851.
Lane, C., 2009, Oct. "Medical Marijuana" Is a Trojan Horse. The Washington Post. https://doi.org/10.1515/bejeap-2015-0167.
Larcker, D.F., Watts, E.M., 2020. Where's the greenium? J. Account. Econ. 69 (2–3), 101312. https://doi.org/10.1016/j.jacceco.2020.101312.
Lee, D.S., 2008. Randomized experiments from non-random selection in U.S. House elections. J. Econom. 142 (2), 675–697. https://doi.org/10.1016/j.jeconom.2007.05.004.
Li, G., Brady, J.E., Chen, Q., 2013. Drug use and fatal motor vehicle crashes: a case-control study. Accid. Anal. Prev. 60, 205–210. https://doi.org/10.1016/j.aap.2013.09.001.
Lofton, J., 2019. Law enforcement problems associated with medical marijuana legalization: a Missouri perspective. Mo. Med. 116 (4), 265–269.
Lynskey, M., Hall, W., 2000. The effects of adolescent cannabis use on educational attainment: a review. Addiction 95 (11), 1621–1630. https://doi.org/10.1046/j.1360-0443.2000.951116213.x.
Marie, O., Zölitz, U., 2017. "High" achievers? Cannabis access and academic performance. Rev. Econ. Stud. 84 (3), 1210–1237. https://doi.org/10.1093/restud/rdx020.
McGinty, E.E., Niederdeppe, J., Heley, K., Barry, C.L., 2017. Public perceptions of arguments supporting and opposing recreational marijuana legalization. Prev. Med. 99, 80–86. https://doi.org/10.1016/j.ypmed.2017.01.024.
McGinty, E.E., Samples, H., Bandara, S.N., Saloner, B., Bachhuber, M.A., Barry, C.L., 2016. The emerging public discourse on state legalization of marijuana for recreational use in the US: analysis of news media coverage, 2010-2014. Prev. Med. 90, 114–120. https://doi.org/10.1016/j.ypmed.2016.06.040.
Mikos, R.A., 2011. A critical appraisal of the Department of Justice's new approach to medical marijuana. Stanford Law Pol. Rev. 22 (2), 633–669. https://doi.org/10.1146/annurev.publhealth.27.021405.102100.
Musto, D.F., 1991. Opium, cocaine and marijuana in American history. Sci. Am. 265 (1), 40–47. https://doi.org/10.1038/scientificamerican0791-40.
Naughton, J., Petacchi, R., Weber, J., 2015. Public pension accounting rules and economic outcomes. J. Account. Econ. 59 (2–3), 221–241. https://doi.org/10.1016/j.jacceco.2015.02.002.
Novy-Marx, R., Rauh, J.D., 2012. Fiscal imbalances and borrowing costs: evidence from state investment losses. Am. Econ. J. Econ. Pol. 4 (2), 182–213. https://doi.org/10.1257/pol.4.2.182.
O'Hara, N., 2012. The Fundamentals of Municipal Bonds, 6 ed. Wiley, New Jersey.
Pacula, R.L., Kilmer, B., Grossman, M., Chaloupka, F.J., 2010. Risks and prices: the role of user sanctions in marijuana markets. B E J. Econ. Anal. Pol. 10 (1). https://doi.org/10.2202/1935-1682.1992.
Pacula, R.L., Powell, D., Heaton, P., Sevigny, E.L., 2015. Assessing the effects of medical marijuana laws on marijuana use: the devil is in the details. J. Pol. Anal. Manag. 34 (1), 7–31. https://doi.org/10.1002/pam.21804.
Painter, M., 2020. An inconvenient cost: the effects of climate change on municipal bonds. J. Financ. Econ. 135 (2), 468–482. https://doi.org/10.1016/j.jfineco.2019.06.006.
Pástor, u., Veronesi, P., 2013. Political uncertainty and risk premia. J. Financ. Econ. 110 (3), 520–545. https://doi.org/10.1016/j.jfineco.2013.08.007.
Powell, D., Pacula, R.L., Jacobson, M., 2018. Do medical marijuana laws reduce addictions and deaths related to pain killers? J. Health Econ. 58, 29–42. https://doi.org/10.1016/j.jhealeco.2017.12.007.
Saiz, A., Simonsohn, U., 2013. Proxying for unobservable variables with internet document-frequency. J. Eur. Econ. Assoc. 11 (1), 137–165. https://doi.org/10.1111/j.1542-4774.2012.01110.x.
Sanctuary Wellness Institute, 2022. The history of medical marijuana in Florida. https://sanctuarywellnessinstitute.com/cannabis/florida/legistrative-history.php. (Accessed January 2022).
Schlinkmann, M., 2010, feb. Residents to Offer Opinion on Medical Marijuana Cottleville's Nonbinding Vote Will Send a Recommendation to the Legislature. St. Louis Post-Dispatch. https://doi.org/10.1017/CBO9781107415324.004.
Schmidt, L., Weisner, C., Wiley, J., 1998. Substance abuse and the course of welfare dependency. Am. J. Publ. Health 88 (11), 1616–1622. https://doi.org/10.2105/AJPH.88.11.1616.
Schwert, M., 2017, aug. Municipal bond liquidity and default risk. J. Finance 72 (4), 1683–1722. https://doi.org/10.1111/jofi.12511.
Shover, C.L., Davis, C.S., Gordon, S.C., Humphreys, K., 2019. Association between medical cannabis laws and opioid overdose mortality has reversed over time. Proc. Natl. Acad. Sci. U.S.A. 116 (26), 12624–12626. https://doi.org/10.1073/pnas.1903434116.
Substance Abuse and Mental Health Services Administration, 2018. Results from the 2010 National Survey on Drug Use and Health: Detailed Tables Prevalence Estimates, Standard Errors, P Values, and Sample Sizes. Substance Abuse and Mental Health Services Administration, Rockville, MD.
Treaster, J.B., 1993, Nov. Healing Herb or Narcotic? Marijuana as Medication; Underground Networks Supplying the Sick. The New York Times.
Tulchinsky, T.H., Varavikova, E.A., 2000. The New Public Health: an Introduction for the 21st Century. Academic Press, San Diego. https://doi.org/10.1016/B978-0-12-703350-1.X5000-1.

Volkow, N.D., Baler, R.D., Compton, W.M., Weiss, S.R., 2014. Adverse health effects of marijuana use. N. Engl. J. Med. 370, 2219–2227. https://doi.org/10.1056/NEJMra1402309.

Wen, H., Hockenberry, J.M., Cummings, J.R., 2015. The effect of medical marijuana laws on adolescent and adult use of marijuana, alcohol, and other substances. J. Health Econ. 42, 64–80. https://doi.org/10.1371/journal.pone.0092816.

Williams, J., Pacula, R.L., Smart, R., 2019. De facto or de jure? Ethnic differences in quit responses to legal protections of medical marijuana dispensaries. https://doi.org/10.3386/w25555. *Unpublished Working Paper.*

Wollan, M., 2010, Jul. Oakland, Seeking Financial Lift, Approves Giant Marijuana Farms. The New York Times.

Worden, A., 2015, Feb. Could Medical Marijuana Soon Be Legal in PA? the Philadelphia Inquirer.

World Economic Forum, 2020. Measuring stakeholder capitalism towards common metrics and consistent reporting of sustainable value creation. http://www3.weforum.org/docs/WEF_IBC_Measuring_Stakeholder_Capitalism_Report_2020.pdf. (Accessed April 2021).