

Health Issue Brief

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Marijuana Legalization: Public Health, Safety, and Economic Factors for States to Consider

As of September 2019, 11 states and Washington, DC, have legalized retail marijuana, or marijuana for recreational or “adult” use. States have had a wide variety of experiences with legalization, based in part on whether their retail program built on an existing medical marijuana program, how well expectations about market size lined up with actual demand in the first years of legalization, and how closely the state regulates sales and cultivation.

This brief discusses several factors that state and local governments should think about when deciding whether to legalize marijuana. Drawing from credible literature and the experiences of states that have legalized retail marijuana, we summarize considerations in four key domains where legalization is likely to have an effect: (1) tax revenue, (2) public health, (3) public safety, and (4) regulatory oversight. Within each domain, we discuss the factors that shape the short-term fiscal impacts of legalization; the complex, long-term effects; and areas where more research, education, or training is needed. We also describe an online tool developed by Mathematica to help states anticipate the short-term budgetary impact of retail marijuana legalization, including estimated tax revenues and the costs of establishing proper oversight.

The goal of this brief and the online tool is not to support or oppose marijuana legalization. Rather, our main goal is to educate states about the many economic, public health, and safety factors tied to legalization.

Background

Many states across the country are considering whether to legalize retail marijuana. Legalization can produce ample tax revenue, some of which states are using to fund health and social service programs—especially for communities disproportionately affected by marijuana-related arrests and detention. States are also using these funds to further study marijuana’s benefits and harms. But legalization can also impose major costs, such as the expense of statewide regulation; treatment for marijuana addiction and dependence; training for the police on dealing with marijuana-impaired driving; and public education about marijuana, including campaigns to prevent adolescent use.

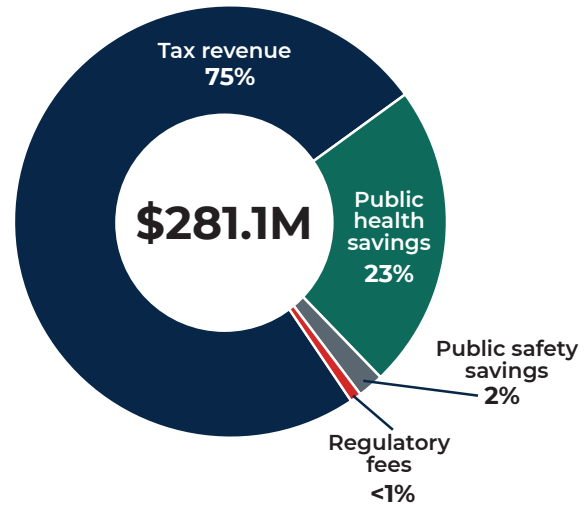
From 2017 to 2018, Mathematica predicted the short-term economic impacts of adding a retail marijuana program to the existing medical marijuana program in Massachusetts. As part of a Marijuana Baseline Health Study, led by the Massachusetts Department

of Public Health, we created a model that projected the net budgetary impact of legalization over two years in four key domains: (1) tax revenue, (2) public health, (3) public safety, and (4) regulatory oversight. For each domain, the model included inputs and assumptions informed by credible literature;¹ the experiences of states that have legalized retail sales;² secondary data from national, statewide, and local sources;³ and Mathematica's analysis of data provided by the Massachusetts Department of Public Health, including data from a survey that asked adults in Massachusetts about marijuana use and marijuana perceptions.

Using estimates from these data sources and simulation methods, we projected that Massachusetts would net about \$281 million in the first two years after retail sales began in 2018, with 75 percent of the gains coming from sales and business tax revenue (Figure 1). However, because the retail market has rolled out more slowly than expected, our projections may overestimate the short-term budgetary gains.⁴ We estimated net public health savings within the first two years, coming largely from the projected savings in Medicaid prescription drug spending (based on estimates from Bradford and Bradford 2017), and net public safety savings due to projected decreases in marijuana-related arrests, convictions, incarcerations, and paroles or probations.

The largest single cost that we projected for the state (amounting to \$12.5 million) would come from income tax losses due to marijuana addiction and dependence among young males. This estimate is based on research showing a 2 to 3 percent drop in hourly earnings among young males after the legalization of medical marijuana (Sabia and Nguyen 2016). But we estimated that these losses would be offset by income tax gains from some older adult workers, whose productivity may rise if they can use marijuana to control debilitating health problems (Nicholas and Maclean 2016). We also estimated that the costs of regulating marijuana in Massachusetts within the first two years would more or less equal the application fees and violation fines that the state would collect.

Figure 1. Estimated two-year budget gains in Massachusetts from retail marijuana legalization



Note: Percentages add up to more than 100 percent due to rounding.

Based on our research for the Marijuana Baseline Health Study in Massachusetts, we identified several factors that states should consider before legalizing marijuana (Table 1), which we discuss in the remainder of this brief. For more detailed information on our data sources, methods, and findings, see the final report from the study.⁵

Tax revenue

Historically, tax revenues from marijuana sales have varied from state to state, owing to differences in legislative statutes, tax rates, regulatory oversight, and consumer demographics. In most of the six states with marijuana retail sales that began more than a year ago, tax revenues in that first year of sales fell short of initial projections, in part because states underestimated how much time it would take for businesses to get licensed and begin operations. However, for most of these states, revenues rose substantially over time, even surpassing revenues from liquor and cigarettes in some years (Pew Charitable Trusts 2019).

Table 1. Factors for states to consider in key domains

Tax revenue	Public health	Public safety	Regulatory oversight
<ul style="list-style-type: none"> • Sales tax rate (and its effect on purchases in the retail vs. black market) • Demand, by type (for example, medical vs. retail, regular vs. heavy use, resident vs. tourist) • Impacts from other industries (for example, cultivation, transportation, and security) 	<ul style="list-style-type: none"> • Increases in marijuana addiction and dependence • Substitution of marijuana for prescription medications (including opioids) • Therapeutic benefits for some chronic conditions and symptoms • Changes in worker productivity • Public education campaigns and prevention of adolescent use 	<ul style="list-style-type: none"> • Reductions in criminal justice costs for marijuana-related offenses • Detection of marijuana-impaired driving • Impact on vehicular crashes (fatal and nonfatal) • Changes in neighborhood crime 	<ul style="list-style-type: none"> • Rulemaking, licensure, and enforcement • Seed-to-sale product tracking and quality control • Increasing marijuana potency

There are several important aspects of states’ retail marijuana programs and consumer demand that may affect sales, business, and income tax revenues. Besides the factors described below, the net effect of legalization on tax revenue may also depend on the extent to which legalization will affect job growth in related sectors, including production, cultivation, storage, transportation, and security.

Sales tax rate. Some states tax marijuana at much higher rates than others do, which affects the price of retail marijuana and, in turn, how much demand is met by retail sales versus the black market. In Washington State, which has a high marijuana tax (44 percent combined sales and excise tax rate, excluding local taxes), licensed sales account for only half of the total demand, even though the retail price of marijuana has dropped over time and is only slightly above black-market prices. The rest of the demand is met by the state’s loosely regulated medical marijuana market and black-market sales (Darnell et al. 2019). In Colorado, which has lower

taxes (27.9 percent combined tax rate, excluding local taxes), the retail market meets an estimated 60 percent of the demand, with legal homegrown marijuana meeting much of the remaining demand (Light et al. 2014). And in Massachusetts, where the combined tax rate is even lower (17 percent, excluding local taxes), it remains to be seen how much of the total demand will be met by the retail market. Although a higher tax rate guarantees greater revenues for states, it could also lead to more spending to deal with the unintended consequences of black-market sales.

Existing medical marijuana programs. The extent to which a state increases its tax revenue after introducing retail marijuana sales may also depend on whether the state already has a medical marijuana program, particularly if the state does not tax medical marijuana or if it greatly restricts its sale. For example, Massachusetts does not tax medical marijuana for patients who register with the state’s program. As a result, medical marijuana is likely

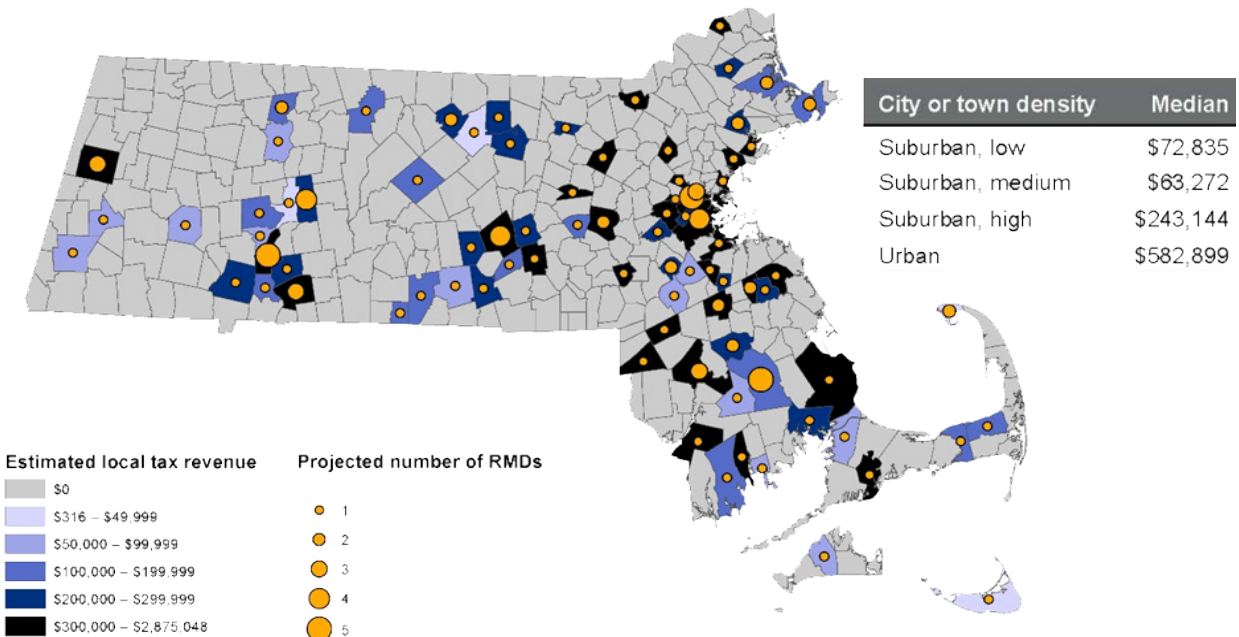
to cost less than retail marijuana, making it more appealing for people with qualifying conditions. However, because Massachusetts strictly regulates the cultivation and sale of medical marijuana, it may be less accessible—and therefore a less appealing option than retail marijuana. Of the 30 states with medical marijuana programs as of May 2018, Massachusetts had the 15th highest number of medical marijuana patients per 1,000 state residents (ProCon.org 2018).

Accessibility. Several factors at the local level can affect tax revenues from retail marijuana sales, including population size and density, the availability of marijuana in nearby towns, the distance to a dispensary, and the local sales tax on marijuana products.

In Massachusetts, revenue projections were much greater for areas with a denser population (Figure 2). For less-dense areas, we projected that tax revenues would largely come from consumers traveling from nearby cities and towns that do not have a dispensary (including towns that ban retail marijuana sales).⁶

Tourist demand. Another factor that affects tax revenues is whether retail or medical marijuana is legal in nearby states. If not, a state with legalized marijuana can generate as much as 7 to 12 percent of total tax revenues from marijuana-related tourism (Light et al. 2016; Cooper et al. 2016). These revenues will likely decrease if nearby states introduce medical or retail sales.

Figure 2. Estimated local tax revenue in Massachusetts over two years, by city or town with a registered marijuana dispensary



Source: Mathematica’s analysis of the impacts of legalized adult use of marijuana in Massachusetts, based on estimates from the literature, key stakeholder interviews, and primary and secondary data sources. For details on data sources used to inform these estimates, see the Marijuana Baseline Health Study (Massachusetts Department of Public Health 2019).

Notes: The figure shows projected estimates for cities and towns in which a registered marijuana dispensary is expected to open within the first two years of marijuana retail sales; no rural areas are expected to have a registered marijuana dispensary in this time frame. Using the number of people per square kilometer (km²), we defined density as suburban, low (100–500 people/km²); suburban, medium (500–1,000 people/km²); suburban, high (1,000–10,000 people/km²); and urban (more than 10,000 people/km²).

RMD = registered marijuana dispensary

Types of consumers. The net effect of legalization on tax revenues may also depend on worker demographics in the state, given the research showing that legalization may boost worker productivity among older adults (Nicholas and Maclean 2016) but reduce it among young adult males (Sabia and Nguyen 2016). The prevalence and type of marijuana use can also greatly affect revenues. In Massachusetts, we projected that adults who use marijuana heavily will generate 60 percent of sales tax revenues, despite making up only one-third of the users in the state.⁷ At the same time, heavy users may also impose greater fiscal costs on state and local governments, as heavy use is tied to higher rates of addiction, psychosis, and other health problems (National Academies of Sciences, Engineering, and Medicine 2017).

In Massachusetts, we also projected that 10 percent of sales tax revenues would come from purchases from retail dispensaries that are intended for adolescents. Although the literature on how marijuana legalization affects adolescent use is mixed, there is robust evidence of long-term brain changes and psychotic symptoms in adolescent users (National Academies of Sciences, Engineering, and Medicine 2017). Based on this evidence, states should dedicate funding to regulation and educational campaigns to prevent underage use.

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Public health

Although states may see a rise in tax revenue as a result of marijuana legalization, it is also important to consider the short- and long-term costs. For example, rigorous research has established links between the legalization of medical marijuana and increases in marijuana use disorder, dependence, and abuse

(Chu 2015; Wen et al. 2015; Hasin et al. 2017; Darnell and Bitney 2017). More work is needed to estimate the costs to states from rising rates of marijuana addiction and dependence; however, an in-depth analysis of government spending on the consequences of substance use disorders suggests that for every \$1 collected in alcohol and tobacco taxes, states spend \$7.23 dealing with the societal burden of substance abuse and addiction. These costs are largely a result of spending on the justice system, on health care, and on education programs in elementary and secondary schools (National Center on Addiction and Substance Abuse at Columbia University 2009).

The literature is mixed on the impact of marijuana legalization on rates of adolescent use. Wen and colleagues noted a rise in adolescent use of marijuana attributable to medical marijuana legalization. But other studies have shown no change or even declines in adolescent use after medical or retail marijuana legalization (Anderson et al. 2019).

Given the therapeutic effects of marijuana on chronic pain, chemotherapy-induced nausea, and spasticity symptoms (National Academies of Sciences, Engineering, and Medicine 2017), some people may opt to use marijuana instead of prescription medications for these issues. Bradford and Bradford (2017) found that Medicare and Medicaid beneficiaries in states with medical marijuana laws used fewer prescriptions than beneficiaries in states without such laws, and the declines in prescription use were statistically and economically meaningful.

More long-term research is needed to clarify how the availability of medical and retail marijuana affects opioid use and rates of addiction or dependence. A few studies show a link between the legalization of medical marijuana and reductions in opioid mortality (Powell et al. 2015; Bachhuber et al. 2014). However, when Shover et al. (2019) replicated the study by Bachhuber and colleagues using seven more years of data, they found that the association reversed over time and concluded that it was likely spurious. With respect to retail marijuana, Chan et al. (2019) reported declines in opioid mortality associated with legalization, mostly among Whites and females.

To ensure that the potential public health risks do not outweigh the possible clinical benefits, states that legalize marijuana should invest in public education campaigns that address substance use disorders and their long-term impacts, marijuana poisoning, and other harms. Hurley and Mazor (2013) recommend using the strategies that successfully reduced opioid deaths in Washington State to prevent marijuana exposure in children. One strategy was to educate parents, children, and health care providers via advertising, television, movies, video games, and other media in homes, schools, and hospitals. Another strategy was to encourage medical providers to ask their patients about marijuana use in the home and discuss the need to prevent access by children. The authors also promoted the use of child-resistant containers for marijuana-infused products—especially cookies, candies, brownies, and beverages.

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Public safety

Legalizing marijuana may reduce criminal justice caseloads, incarcerations, and the police resources needed for marijuana-related offenses. These reductions—which could be as great as 50 to 80 percent, according to expert stakeholders and data from Washington State (Darnell and Bitney 2017)—have both economic and societal implications.

Nguyen and Reuter (2012) found that adolescents, Blacks, and males have had unduly high rates of arrest for marijuana possession, with Blacks being arrested three times more often than Whites despite almost identical rates of marijuana use. Such offenses can have lifelong consequences for

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people who would otherwise have no criminal record, including the hundreds of thousands of adolescents who have been incarcerated for marijuana (American Academy of Pediatrics 2015). The consequences include ineligibility for financial aid, federal housing, and certain types of jobs; the destabilization of families; and an increase in poverty (New York State Department of Health 2018). Although early evidence suggests that legalization may not reduce the racial disparities in marijuana-related arrests (Reed 2016), it nevertheless reduces the overall number of arrests across all races.

At the same time, legalization also increases the burden on state and local governments to develop standards and means for marijuana-impaired driving, given a potential link between marijuana use and impairments in learning, memory, and attention (National Academies of Sciences, Engineering, and Medicine 2017). A meta-analysis of 21 studies showed a significant increase—about 20 to 30 percent—in the risk of vehicle crashes linked to marijuana use (Rogeberg and Elvik 2016). And according to a study on marijuana involvement in fatal crashes in Washington, the share of drivers testing positive for tetrahydrocannabinol (THC)—the main psychoactive ingredient in the cannabis plant—was fairly constant before and right after adult use became legal; then, about nine months after legalization, this share began to rise sharply at a rate of 9.7 percent per year (Tefft et al. 2016). Accordingly, the Washington State Patrol spent \$2.1 million to train employees on the topic of marijuana-impaired driving, which accounted for 77 percent of the increase in law enforcement costs due to legalization in the first five years (Washington Secretary of State Elections 2012).

On the other hand, two studies suggest that legalizing medical marijuana could reduce fatal crashes if legalization leads people to substitute marijuana for alcohol, given that alcohol is used outside the home more often than marijuana (Anderson et al. 2013; Santaela-Tenorio et al. 2017). But there is no consensus in the literature on whether people use marijuana instead of alcohol following legalization—or the extent to which they use the two together (Caulkins et al. 2015). As the evidence unfolds, states should consider dedicating resources to marijuana-specific “safe driving” campaigns and other public safety messaging.

Part of the difficulty in studying marijuana-impaired crashes is that the data on whether drivers who were involved in crashes used marijuana can be unreliable. Police do not always order blood tests for marijuana, particularly if the crash was nonfatal or if the driver also used alcohol, which can be detected more easily, using a breathalyzer instead of a blood test (Massachusetts Department of Public Health 2019). Even if blood or saliva tests are ordered, the tests cannot isolate recent marijuana use and may show a positive result long after impairment subsides.

New THC breathalyzers are being developed that not only target recent use—regardless of how marijuana was consumed (for example, as an edible versus smoked)—but also detect very low levels of THC. But even as these breathalyzers enter the market, more work will be needed to determine what THC concentrations (in breath, saliva, and blood) lead to impaired driving—and whether

the data from these new breathalyzers suggest a rise in impaired driving that can be attributed to marijuana legalization.

Another area of concern is the potential impact of legalization on neighborhood crime. Two recent studies examined crime rates in Denver, Colorado, and reported conflicting findings. Hughes et al. (2019) looked at rates of neighborhood crime and disorder around medical and retail marijuana dispensaries before and right after legalization. The study team found a significant rise in some types of crime (such as robbery and aggravated assault), even when controlling for neighborhood characteristics such as socioeconomic. In contrast, Brinkman and Mok-Lamme (2019), who analyzed changes in crime after openings and closings of medical and retail dispensaries, found that each additional dispensary within a jurisdiction was linked with a decline in the average crime rate.

Regulatory oversight

Regulating marijuana requires complex and adaptable strategies to manage rulemaking, licensure, and enforcement; lab accreditation; product tracking and quality control (to avoid dangerous contaminants and to monitor potency); and the distinctions between medical and retail use. There are notable differences in states’ regulatory operations, leading to a great deal of variation in regulatory needs and costs, even after accounting for population size and the number of registered marijuana dispensaries. For example, Washington State created a Liquor and Cannabis Board, incorporating marijuana regulation into the body that regulates alcohol. But Massachusetts created a new regulatory body—the Cannabis Control Commission—before introducing retail marijuana sales.

The presence or absence of a robust medical marijuana law or program can also affect how states regulate retail sales and production. When Washington State legalized retail marijuana, it did not have strong oversight of medical marijuana in place, even though medical marijuana had been legal since 1998.

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As a result, when the state began regulating medical marijuana more formally in 2015 (after retail sales began), it had to complete a second wave of regulatory work to put the Liquor and Cannabis Board in charge of overseeing the medical marijuana program.

Another regulatory concern is the rising potency of marijuana. In the early 1990s, the average THC content of marijuana on the black market was 3.8 percent, compared with 12.2 percent in 2014 (National Institute on Drug Abuse n.d.). We need more information on how higher potency marijuana impacts public health and safety, and how the potency of the marijuana sold in retail dispensaries varies by product type. But studying the effects of higher potencies can be challenging because the research-grade cannabis that the National Institute on Drug Abuse gives to investigators is often less potent than the cannabis available in state-regulated markets (National Academies of Sciences, Engineering, and Medicine 2017). We also need more data on how rising potency affects marijuana use and tax revenues. The availability of marijuana with higher THC levels may depress tax revenues over time, given that users can buy smaller amounts of marijuana to achieve the same effect.⁸ Alternately, users may develop a tolerance for the higher potency, in which case their use may not change.

At the municipal level, governments have struggled to keep up with ongoing regulatory changes and the start-up costs of regulation, which they must often absorb. For example, local governments in Washington State needed to dedicate several staff to monitor state regulatory changes over time. A major factor that can affect a city's regulatory costs is whether the city focuses on marijuana production versus sales. For cities or towns with many marijuana producers—which are largely located in rural areas—regulation will involve odor and environmental issues related to waste disposal and wastewater. For cities or towns with many retailers—which are often concentrated in urban areas—regulation will include processes to trace marijuana from seed to

sale. (The tracing process, which can be costly, is necessary to ensure product safety, verify compliance with state laws regarding purity and potency, and prevent marijuana sales to minors.) For some cities and towns that have banned retail marijuana sales altogether, resources were needed to respond to lawsuits brought by businesses wanting to open a dispensary. In Washington State, the costs that local governments incurred to regulate businesses were eventually offset by the fees they collected on licenses, according to expert stakeholders.

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Expanding our knowledge

This brief discusses a broad set of considerations for states that are contemplating marijuana legalization, but there are many unanswered questions. For example, much of the evidence on this subject is based on medical marijuana—not retail marijuana—including how legalization affects marijuana use, purchasing behaviors, public health, and public safety. And there is little evidence that legalization directly results in changes to such outcomes. Moreover, the first states to allow retail marijuana sales did so only five years ago. It will take more time—possibly decades—to assess the full impact of retail legalization on health and public systems. These impacts could include how increases in marijuana use disorder affect rates of domestic violence and child welfare, and how reductions in marijuana-related criminal justice involvement affect productivity, socioeconomic status, and family and community cohesion.

Estimating budgetary impact

Based on Mathematica's analysis of the potential economic impacts of legalizing marijuana in Massachusetts, the company developed the Marijuana Tax Revenue and Cost Estimator (mTRACE).

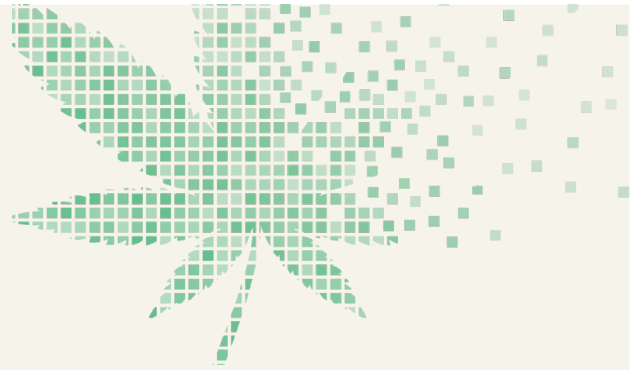
The mTRACE tool is intended to help states project the short-term budgetary impact of legalization, including the costs of establishing proper oversight of retail marijuana. The tool's dynamic interface enables users to see how revenues and costs or losses vary when they enter different marijuana tax rates or fine-tune the estimated rates of marijuana use.

To estimate tax revenues, the tool uses information on state population size and demographics (based on five-year estimates from the 2017 American Community Survey), marijuana pricing (based on data from priceofweed.com as of August 2019), and estimates of the prevalence and frequency of marijuana use among adults and adolescents (based on the 2016–2017 National Survey on Drug Use and Health). The mTRACE tool also estimates short-term, direct costs or losses in the following four areas, informed by our findings from the Marijuana Baseline Health Study:

- 1. Regulatory costs.** The estimates draw on data from Washington State and Colorado on the start-up costs for regulation and the regulatory costs incurred in the first two years after legalization, which we standardized by the number of people with past-month marijuana use in each state.
- 2. State spending on treatment for marijuana addiction or dependence.** The estimates draw on data on the costs to states for treatment for substance use disorders, the proportion of treatment admissions that are primarily for marijuana, and the estimated percent change in admissions for marijuana-related treatment, based on Chu (2015), Wen et al. (2015), Hasin et al. (2017), and Darnell and Bitney (2017).
- 3. Losses in alcohol taxes due to the substitution of alcohol for marijuana.** The estimates draw on data on the state's alcohol tax revenues, based on data from the 2018 Economic Census, and the estimated percent change in alcohol sales after legalization, based on Anderson et al. (2013).
- 4. Losses in income taxes due to declines in worker productivity among young adult males.** The estimates draw on data on the number of young adult male workers in the state, their average income tax burden, and the estimated percent change in their hourly earnings, based on Sabia and Nguyen (2016).

State officials have reported lacking much of the information needed to forecast marijuana-related revenues (Pew Charitable Trusts 2019). The mTRACE tool helps fill this gap by bringing together several publicly available data sources to estimate short-term revenues and costs. The tool also links to reports that states themselves have commissioned on the budgetary impact of marijuana legalization. However, as we discuss in this brief, there are a number of indirect, long-term, and societal impacts of legalization. Translating those impacts into state-level costs and gains will require much more information on the causal effects of legalization than currently exists in the literature.

For a demonstration of the mTRACE tool, contact Mathematica at info@mathematica-mpr.com.




Several efforts are under way to learn more about the complex effects that marijuana legalization can trigger. Through the Multi-State Marijuana and Public Health Learning Collaborative, the Centers for Disease Control and Prevention is working with states and communities to help them translate for the public the best science available on marijuana use and its health impacts, with the goal of preventing marijuana-related harms.⁹ The collaborative brings together leaders from state public health agencies to collect information from states that have already legalized retail marijuana, to standardize and share resources, and to identify best practices to protect public health. At the state level, Colorado, Washington, Massachusetts, and others have set aside marijuana-generated funds to support research and education on the impacts of marijuana on health and safety. And studies like the Massachusetts Marijuana Baseline Health Study are providing new evidence on marijuana use patterns and benchmarks to better understand the impacts of legalization.

Looking ahead

Legalizing marijuana can yield economic and societal benefits, but it also brings fiscal and societal costs as well as a greater need for regulation. States that legalize marijuana will need to create robust oversight bodies and effective, evidence-based public education campaigns to protect public health and safety.

States should also think about the complex interactions between economic considerations and health and safety concerns. For example, setting a high tax on marijuana will produce more revenue, but it can also drive more consumers to the black market. Black-market marijuana may be cut with other substances, including illicit drugs, which could harm users' health, spur the need for more policing of black-market dealers, and raise the costs of prosecuting such crimes. To avoid these consequences, careful planning, monitoring, and cross-agency coordination are needed. Data sharing between agencies can also help states understand the effect of legalization on the sale of other controlled

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substances (including alcohol, tobacco, and prescription pain and other medications) and the availability and use of illicit substances.

As retail marijuana programs unfold, more research will be needed on the direct, indirect, and unintended effects of marijuana legalization. For example, regulators can use analyses of administrative data from medical and retail marijuana programs, coupled with surveys of retail dispensary operators and customers, to learn whether marijuana potency differs between medical and retail markets and by product type. Regulators can also use such data to assess whether marijuana prices and tax revenues fall as the retail industry matures and to see how the black market adapts to these changes. Given the recent rise in serious lung illnesses tied to vaping, states also need to better understand how different modes of consumption (such as vaping versus smoking marijuana) affect THC uptake, impairment, and health risks. And states can use evaluations of public education campaigns and other programs funded by marijuana-generated tax revenue to identify which strategies work best to deter adolescent use of marijuana and reduce marijuana-related impaired driving.

Finally, states should think about how to set up the information channels needed to promote public health and safety and to avoid unintended consequences of legalization. States should ensure open lines of communication between agencies for program coordination, to researchers and community partners for data collection and evaluation, and to the general public for outreach and education.

Disclaimer

Mathematica is a nonpartisan company dedicated to building evidence to improve public health and well-being; the company neither supports nor opposes marijuana legalization. Some of the findings in this brief were derived from research supported by the Massachusetts Department of Public Health as part of an award to Mathematica to assist with the Marijuana Baseline Health Study, funded by the Medical Marijuana Trust Fund. The content of the brief is solely the responsibility of the authors and does not necessarily represent the official views of the Commonwealth of Massachusetts.

References

- American Academy of Pediatrics. "The Impact of Marijuana Policies on Youth: Clinical, Research, and Legal Update." *Pediatrics*, vol. 135, no. 3, March 2015, pp. 584–587. doi:10.1542/peds.2014-4146
- Anderson, D.M., B. Hansen, and D.I. Rees. "Association of Marijuana Laws with Teen Marijuana Use: New Estimates from the Youth Risk Behavior Surveys." *JAMA Pediatrics*, vol. 173, no. 9, July 2019, pp. 879–881. doi:10.1001/jamapediatrics.2019.1720
- Anderson, D.M., B. Hansen, and D.I. Rees. "Medical Marijuana Laws, Traffic Fatalities, and Alcohol Consumption." *The Journal of Law and Economics*, vol. 56, no. 2, May 2013, pp. 333–369. doi:10.1086/668812
- Bachhuber, M.A., B. Saloner, C.O. Cunningham, and C.L. Barry. "Medical Cannabis Laws and Opioid Analgesic Overdose Mortality in the United States, 1999–2010." *JAMA Internal Medicine*, vol. 174, no. 10, 2014, pp. 1668–1673. doi:10.1001/jamainternmed.2014.4005
- Bradford, A.C., and W.D. Bradford. "Medical Marijuana Laws May Be Associated with a Decline in the Number of Prescriptions for Medicaid Enrollees." *Health Affairs (Project Hope)*, vol. 36, no. 5, 2017, pp. 945–951. doi:10.1377/hlthaff.2016.1135
- Brinkman, J., and D. Mok-Lamme. "Not in My Backyard? Not So Fast. The Effect of Marijuana Legalization on Neighborhood Crime." *Regional Science and Urban Economics*, vol. 78, September 2019, pp. 1–23. doi:10.1016/j.regsciurbeco.2019.103460
- Caulkins, J.P., B. Kilmer, M.A.R. Kleiman, R.J. MacCoun, G. Midgette, P. Oglesby, R.L. Pacula, and P.H. Reuter. "Considering Marijuana Legalization: Insights for Vermont and Other Jurisdictions." Santa Monica, CA: RAND Corporation, 2015. Available at https://www.rand.org/pubs/research_reports/RR864.html. Accessed October 4, 2019.
- Chan, N.W., J. Burkhardt, and M. Flyr. "The Effects of Recreational Marijuana Legalization and Dispensing on Opioid Mortality." *Economic Inquiry*, August 2019. doi:10.1111/ecin.12819
- Chu, Y.W.L. "Do Medical Marijuana Laws Increase Hard-drug Use?" *The Journal of Law and Economics*, vol. 58, no. 2, 2015, pp. 481–517. doi:10.1086/684043
- Cooper, W., E. Johnston, and K. Segal. "The Economic Impacts of Marijuana Sales in the State of California." April 2016. Available at <https://www.icf.com/resources/white-papers/2016/economic-impact-of-marijuana-sales-in-california>. Accessed October 28, 2019.
- Darnell, A. J., and K. Bitney. "I-502 Evaluation and Benefit-cost Analysis: Second Required Report (Document 17-09-3201)." 2017. Olympia: Washington State Institute for Public Policy. Available at http://www.wsipp.wa.gov/ReportFile/1670/Wsipp_I-502-Evaluation-and-Benefit-Cost-Analysis-Second-Required-Report_Report.pdf. Accessed October 29, 2019.
- Darnell, A.J., M. Hirsch, and P. Wanner. "Suppressing Illicit Cannabis Markets After State Marijuana Legalization." Olympia, WA: Washington State Institute for Public Policy, 2019. Available at http://www.wsipp.wa.gov/Report-File/1708/Wsipp_Suppressing-Illicit-Cannabis-Markets-After-State-Marijuana-Legalization_Report.pdf. Accessed November 4, 2019.
- Hasin, D.S., A.L. Sarvet, M. Cerdá, K.M. Keyes, M. Stohl, S. Galea, and M.M. Wall. "U.S. Adult Illicit Cannabis Use, Cannabis Use Disorder, and Medical Marijuana Laws: 1991–1992 to 2012–2013." *JAMA Psychiatry*, vol. 74, no. 6, 2017, pp. 579–588. doi:10.1001/jamapsychiatry.2017.0724
- Hughes, L.A., L.M. Schaible, and K. Jimmerson. "Marijuana Dispensaries and Neighborhood Crime and Disorder in Denver, Colorado." *Justice Quarterly*, February 2019. doi:10.1080/07418825.2019.1567807
- Hurley, W., and S. Mazor. "Anticipated Medical Effects on Children from Legalization of Marijuana in Colorado and Washington State: A Poison Center Perspective." *JAMA Pediatrics*, vol. 167, no. 7, July 2013, pp. 602–603. doi:10.1001/jamapediatrics.2013.2273
- Kilmer, B., J.P. Caulkins, G. Midgette, L. Dahlkemper, R.J. MacCoun, and R.L. Pacula. "Before the Grand Opening: Measuring Washington State's Marijuana Market in the Last Year Before Legalized Commercial Sales." 2013. Available at https://www.rand.org/pubs/research_reports/RR466.html. Accessed October 7, 2019.
- Light, M., A. Orens, J. Rowberry, and C.W. Saloga. "The Economic Impact of Marijuana Legalization in Colorado." October 2016. Available at <http://mjpolicygroup.com/pubs/MPG%20Impact%20of%20Marijuana%20on%20Colorado-Final.pdf>. Accessed October 28, 2019.

Light, M.K., A. Orens, B. Lewandowski, and T. Pickton. "Market Size and Demand for Marijuana in Colorado." July 2014. Available at <https://www.colorado.gov/pacific/sites/default/files/Market%20Size%20and%20Demand%20Study%2C%20July%2009%2C%202014%5B1%5D.pdf>. Accessed November 4, 2019.

Massachusetts Department of Public Health. "Marijuana Baseline Health Study: Final Report." July 2019. Available at <https://www.mass.gov/report/massachusetts-department-of-public-health-marijuana-research>. Accessed September 23, 2019.

National Academies of Sciences, Engineering, and Medicine. "The Health Effects of Cannabis and Cannabinoids: The Current State of Evidence and Recommendations for Research." January 2017. Available at <http://nationalacademies.org/hmd/Reports/2017/health-effects-of-cannabis-and-cannabinoids.aspx>. Accessed September 23, 2019.

National Center on Addiction and Substance Abuse at Columbia University. "Shoveling Up II: The Impact of Substance Abuse on Federal, State and Local Budgets." May 2009. Available at <https://www.centeronaddiction.org/addiction-research/reports/shoveling-ii-impact-substance-abuse-federal-state-and-local-budgets>. Accessed October 22, 2019.

National Institute on Drug Abuse. "Is Marijuana Addictive?" n.d. Available at <https://www.drugabuse.gov/publications/research-reports/marijuana/marijuana-addictive>. Accessed October 4, 2019.

New York State Department of Health. "Assessment of the Potential Impact of Regulated Marijuana in New York State." July 2018. Available at https://www.health.ny.gov/regulations/regulated_marijuana/docs/marijuana_legalization_impact_assessment.pdf. Accessed November 4, 2019.

Nguyen, H., and P. Reuter. "How Risky Is Marijuana Possession? Considering the Role of Age, Race, and Gender." *Crime & Delinquency*, vol. 58, no. 6, November 2012, pp. 879–910. doi:10.1177/0011128712461122

Nicholas, L.H., and J.C. Maclean. "The Impact of Medical Marijuana Laws on the Labor Supply and Health of Older Adults: Evidence from the Health and Retirement Study." NBER Working Paper w22688. Cambridge, MA: National Bureau of Economic Research, 2016. Available at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2846904. Accessed September 23, 2019.

Pew Charitable Trusts. "Forecasts Hazy for State Marijuana Revenue: Unknown Price and Demand, Lack of Historical Data Leave Planners with Limited Information." August 2019. Available at https://www.pewtrusts.org/-/media/assets/2019/08/marijuana-brief_v2.pdf. Accessed October 30, 2019.

Powell, D., R.L. Pacula, and M. Jacobson. "Do Medical Marijuana Laws Reduce Addictions and Deaths Related to Painkillers?" NBER Working Paper w21345. Cambridge, MA: National Bureau of Economic Research, 2015. doi:10.3386/w21345

ProCon.org. "Number of Legal Medical Marijuana Patients." May 2018. Available at https://medicalmarijuana.procon.org/view_resource.php?resourceID=005889. Accessed October 4, 2019.

Reed, J.K. "Marijuana Legalization in Colorado: Early Findings." March 2016. Available at <http://cdpsdocs.state.co.us/ors/docs/reports/2016-SB13-283-Rpt.pdf>. Accessed November 4, 2019.

Rogeberg, Ole, and Rune Elvik. "The Effects of Cannabis Intoxication on Motor Vehicle Collision Revisited and Revised." *Addiction*, vol. 111, no. 8, 2016, pp. 1348–1359. doi:10.1111/add.13347

Sabia, J., and T.T. Nguyen. "The Effect of Medical Marijuana Laws on Labor Market Outcomes." IZA Discussion Paper 9831. March 2016. Available at <http://ftp.iza.org/dp9831.pdf>. Accessed September 23, 2019.

Santaella-Tenorio, J., C. Mauro, M. Wall, J. Kim, and S. Martins. "Reductions in Traffic Fatalities Rates Across States with Operational Dispensaries of Marijuana." *Drug and Alcohol Dependence*, vol. 171, 2017, p. e182. doi:10.1016/j.drugalcdep.2016.08.500

Shover C.L., C.S. Davis, S.C. Gordon, and K. Humphreys. "Association Between Medical Cannabis Laws and Opioid Overdose Mortality has Reversed over Time." *PNAS*, vol. 116, no. 26, June 2019, pp. 12624–12626. doi:10.1073/pnas.1903434116

Tefft, B.C., L.S. Arnold, and J.G. Grabowski. "Prevalence of Marijuana Use Among Drivers in Fatal Crashes: Washington, 2010–2014." Washington, DC: AAA Foundation for Traffic Safety, 2016. Available at <https://aaafoundation.org/prevalence-marijuana-use-among-drivers-fatal-crashes-washington-2010-2014/>. Accessed September 23, 2019.

Washington Secretary of State Elections. "I-502—Fiscal Impact Statement." 2012. Available at <http://www.vote.wa.gov/guides/2012/I-502-Fiscal-Impact.html>. Accessed November 10, 2019.

Wen, H., J.M. Hockenberry, and J.R. Cummings. "The Effect of Medical Marijuana Laws on Adolescent and Adult Use of Marijuana, Alcohol, and Other Substances." *Journal of Health Economics*, vol. 42, 2015, pp. 64–80. doi:10.1016/j.jhealeco.2015.03.007

Endnotes

¹ We identified credible literature using guidelines from the Clearinghouse for Labor Evaluation and Research (CLEAR). The U.S. Department of Labor established CLEAR to provide a central and trusted source of research evidence and thereby promote informed decision making and policy development.

² To understand differences in the policy contexts and retail sales programs in different states, we reviewed published reports and interviewed government and academic stakeholders who had detailed knowledge of marijuana use patterns, medical marijuana program operations, regulatory needs, health effects, and law enforcement activities.

³ These data captured the prevalence of marijuana use, marijuana pricing, regulatory costs and revenues, and public health and safety impacts.

⁴ In Massachusetts, retail sales were expected to begin on July 1, 2018, but began on November 20, 2018. Whereas our model assumed that 40 registered marijuana dispensaries would open in the first year of retail sales (based on application approval dates), only 24 dispensaries have opened as of September 2019.

⁵ The report is available at <https://www.mass.gov/report/massachusetts-department-of-public-health-marijuana-research>

⁶ We projected that all individuals in Massachusetts would live within 10 to 20 miles of a dispensary, based on the locations of registered marijuana dispensaries expected to open within the first two years of retail sales.

⁷ Based on the methodology used by Kilmer et al. (2013), we defined “heavy use” as using marijuana an average of 21 days or more each month.

⁸ Illinois—the most recent state to legalize retail marijuana—is attempting to address this concern by implementing a tax scheme based on marijuana potency and product type, imposing higher taxes for higher-potency products.

⁹ To access data and resources on marijuana and public health, visit <https://www.cdc.gov/marijuana/index.htm>.

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