Recreational Marijuana Legalization and Educational Outcomes: Evidence from Washington State's Dispensary Lottery

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July 13, 2022

Abstract

Cannabis reform has been a growing issue in the United States, especially during the past decade. From a policy perspective, it is important to understand what consequences arise from legalizing recreational marijuana. In this paper, I estimate the effect of recreational marijuana legalization on educational outcomes using exogenous spatial variation in access to marijuana dispensaries in Washington. In November 2012, Washington passed Initiative-502, a referendum to legalize recreational marijuana. As part of the initiative, the state capped the number of dispensaries at 334. It held a lottery to assign licenses in localities where the number of license applicants exceeded the local dispensary quota, thus generating exogenous variation in dispensary locations. I use an instrumental variable strategy to estimate the effect of open dispensaries on educational outcomes, where the instrument for whether a school is within 10 minutes of an open dispensary is an indicator for whether it is within 10 minutes of a lottery winner. Using data on public high schools from Washington's Office of Superintendent of Public Instruction, I find that dropout rates increase by about 3 percentage points for 11th- and 12th-grade girls, 3.3 percentage points for 11th-grade boys, and 5.8 percentage points for 12th-grade boys. Chronic absenteeism increases by 10.9 and 7 percentage points for 11th-grade girls and boys, respectively. The effects on 12th-grade chronic absenteeism are slightly larger. I also find a 1.7 percentage point increase in the discipline rate for 12th-grade boys.

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Acknowledgements: I am grateful for the support and guidance of Gary Engelhardt, Amy Ellen Schwartz, and Maria Zhu. Thank you also to Xiuming Dong (University of Auckland) for helping with data acquisition and institutional questions. In addition, I thank my correspondents at Washington's Office of Superintendent of Public Instruction for answering my questions and providing data.

1 Introduction

Cannabis reform has been a growing issue in the United States, especially throughout the past decade. While marijuana is still classified as a Schedule I drug at the federal level, many states have decriminalized, or at least reduced the jail time for, marijuana possession, legalized marijuana for medical use, and/or made it legal for adults over the age of 21 to use it recreationally. As of March 2022, 26 states have decriminalized the possession of marijuana, 37 have legalized medical marijuana, and 18 have legalized recreational marijuana.[1] Several states, including Arkansas, Florida, Idaho, Mississippi, Missouri, Nevada, North Dakota, Ohio, and Maryland, will vote on proposed legalization measures this November.

One of the biggest reasons why states want to legalize recreational marijuana is so that they can collect taxes on legal marijuana sales. Indeed, Washington, for example, collected over $1.3 billion in revenues from its 37% marijuana excise tax between fiscal years 2015 and 2019. Marijuana tax revenues accounted for about 1.5% of the state's total revenues in each of those years. While marijuana legalization generates economic activity, it could also lead to negative effects like more crime, drugged driving, workplace injuries, and substance use. From a policy perspective, it is important to understand what consequences arise from legalizing recreational marijuana, especially with more states considering legalization measures.

This paper provides evidence on the effects of recreational marijuana legalization on educational outcomes. Using marijuana can impede brain function, which can affect student performance. Indeed, there is a well-established literature in public health that finds a negative correlation between using marijuana and educational attainment. Despite this, we know very little

[1] South Dakota voters approved a measure for recreational marijuana legalization in 2020, but the state's supreme court struck it down after the fact. A new bill proposing the legalization of recreational marijuana was introduced in February 2022 but was not passed by lawmakers.

about how legalization affects underage marijuana use and student outcomes. I fill this gap by estimating the causal effect of recreational marijuana legalization on student behavior and academic performance.

The primary challenge in identifying the effects of legalization is that places that legalize likely have higher latent demand for marijuana than places that do not. If latent demand is correlated with underage marijuana use and educational outcomes, then simple comparisons of average outcomes across places that legalize and those that do not would be biased. For example, if places that decide to legalize are those with a higher latent demand for marijuana and have lots of underage use and poor educational outcomes, then legalization will appear to have little effect, assuming of course that legalization and underage use are positively correlated. To solve this endogeneity problem, I exploit exogenous spatial variation in access to marijuana dispensaries in Washington.

Washington passed Initiative-502 in November 2012, which legalized the possession, use, and sale of recreational marijuana to adults over the age of 21. As part of the initiative, the Washington Liquor and Cannabis Board capped the number of marijuana dispensaries allowed to operate statewide at 334. For places where the number of applicants for dispensary licenses exceeded the established local quota, the state held a lottery to determine which applicants would receive licenses. This generated random variation in dispensary locations and thus access to marijuana. However, not all dispensaries opened, and some opened at different places than originally submitted in their applications. Since the decision to open is potentially endogenous, I estimate the effects of open dispensaries on educational outcomes using an instrumental variable strategy. Specifically, I instrument for whether a school is within 10 minutes of an open dispensary with an indicator for whether it is within 10 minutes of a lottery winner.

Using data on public high schools from Washington's Office of Superintendent of Public Instruction, I find that legalization has a negative impact on students, particularly on their behavioral outcomes. When a school is within 10 minutes of a dispensary that opens relative to one that is within 10 minutes of a dispensary that does not, 11th-grade girls' and boys' dropout rates increase by 2.9 and 3.3 percentage points, respectively. For girls, this is a 140% increase from the average of 2.1% prior to legalization. For boys, the effect is slightly smaller, 114%, because the average before legalization was 2.9%. The increase in dropout rates is smaller for 12th graders, but still quite large. The dropout rate for 12th-grade girls goes up by 2.8 percentage points, or 70% relative to the mean, which is 4.1%, while the dropout rate for 12th-grade boys goes up by 5.8 percentage points, or almost doubles relative to the average.

I also find large increases in chronic absenteeism for girls and boys in both grades. 11th-grade girls' chronic absenteeism goes up by 10.9 percentage points in schools within 10 minutes of an open marijuana dispensary. This is almost a 50% increase relative to 24%, the average rate of chronic absenteeism for high school girls across the state in 2014. Absenteeism increases by 7 percentage points for 11th-grade boys, a one-third increase compared to the 21% average for high school boys statewide in 2014. The effects are slightly larger for 12th graders. Chronic absenteeism increases by 11.9 and 8.1 percentage points for 12th-grade girls and boys, or 50% and 39% from the 2014 state averages, respectively.

I find little change in the discipline rate, or the percentage of students suspended or expelled from school. Discipline rates for 11th- and 12th-grade girls do not change in a statistically significant way when dispensaries open, but the discipline rate for both 11th- and 12th-grade boys increases by 1.7 percentage points for schools within 10 minutes of an open dispensary.

Additionally, I find that the shares of 11th-grade girls who are not proficient in math or ELA, as well as the share of 11th-grade boys who are not proficient in ELA, do not change in a statistically significant way when dispensaries open. There appears to be, however, a decline in the share of 11th-grade boys who are not proficient in math.[2]

The weight of the evidence suggests that recreational marijuana legalization in Washington leads to worse behavioral outcomes for 11th and 12th graders, both girls and boys. There are larger effects on dropout and chronic absenteeism rates for girls than boys, while discipline rates increase for boys but not girls.

The rest of the paper is organized as follows. In the next section, I discuss previous literature on the relationship between marijuana use, laws, and educational outcomes, as well as potential mechanisms. Section 3 provides background information on Initiative-502 and Washington's dispensary license lottery. In section 4, I describe the data on marijuana dispensaries and educational outcomes. Then, in section 5, I present my empirical framework and in section 6 I discuss the main results. Robustness checks and extensions are included in section 7. Finally, I conclude with a discussion of caveats and plans for future work.

2 Literature and Conceptual Framework

2.1 Marijuana Use, Laws, and Educational Outcomes

There is a large body of empirical work in economics that examines the relationship between risky behaviors – particularly substance use – and human capital accumulation. This work primarily stems from the Grossman model of human and health capital.[3] Most of this literature focuses on cigarette smoking and alcohol use, while only a small part examines the effect of

[2] The share of 11th-grade boys who are not proficient in math decreases by 7 percentage points. Math proficiency is not available prior to legalization, so I do not know whether this is a sizeable effect relative to the average.
[3] Grossman (1972) and Cawley and Ruhm (2011).

marijuana use. Generally, these papers have shown that there is a negative relationship between smoking marijuana and educational attainment. For instance, Chatterji (2006) finds that using marijuana in 10th and 12th grades leads to fewer year of school completed by age 26. In addition, McCaffrey, et al. (2010) find that marijuana use is associated with higher dropout rates, though they also show that the effect can be explained by cigarette use and family and peer effects from earlier in high school. See Yamada, Kendix, and Yamada (1996), Bray, et al. (2000), Register, Williams, and Grimes (2001), and Roebuck, French, and Dennis (2004) for more evidence of the negative relationship between marijuana use and educational outcomes.[4]

This negative relationship could be explained by the effects of tetrahydrocannabinol (THC), the psychoactive ingredient in marijuana that produces the drug's high, on brain function. The cognitive development literature has shown that using marijuana during adolescence has negative effects on a host of things, including cognition, short-term memory, attention, overall and verbal IQ, and abstract reasoning skills, and that the effects are more pronounced for those who start using earlier.[5] It is also possible that using marijuana decreases educational attainment indirectly. For example, some research suggests that marijuana is a gateway drug to alcohol and other illicit substances, and that using marijuana leads to worse mental health and greater participation in deviant and criminal behaviors, which can all have negative effects on educational outcomes.[6]

Given that researchers have consistently found that using marijuana is negatively associated with educational outcomes, it is somewhat surprising that there has been little research

[4] See also the following works from sociology and public health: Lynskey and Hall (2000), Ryan (2010), and Beverly, Castro, and Opara (2019).
[5] Pope, Gruber, and Yurgelun-Todd (1995) and Lisdahl, et al. (2013).
[6] Ellickson, Hays, and Bell (1992), Kandel, Yamaguchi, and Chen (1992), DeSimone (1998), Brook, et al. (1999), Green and Ritter (2000), Brook, et al. (2011), Brook, et al. (2013), and Epstein, et al. (2015).

on how marijuana laws affect underage marijuana use and student outcomes. Economists have done some work to understand how the legalization of medical and recreational marijuana within states across the U.S. has impacted access to marijuana and marijuana use for teens, with inconsistent results across studies. For example, Anderson, Hansen, and Rees (2015) find a slight, insignificant decrease in the probability of marijuana use after medical marijuana legalization, while Wen, Hockenberry, and Cummings (2015) find an increase.[7] Additionally, Cerda, et al. (2017) find an increase in marijuana use in Washington (but not Colorado) after recreational marijuana legalization, while Dilley, et al. (2019) show that teen marijuana use fell in Washington. Rusby, et al. (2018) find that marijuana use in a small sample of Oregon schools increased after legalization. In Jarrold-Grapes (2022), I show that 11th-grade girls used more marijuana after legalization in Oregon.

Even smaller still is the economics literature examining how marijuana laws affect educational outcomes. I only know of a single paper that does this, Jarrold-Grapes (2022), which finds a negative effect of recreational marijuana legalization on the educational outcomes of high school students (particularly girls) in Oregon. I build on that paper here by asking a similar question in a different context. While Oregon and Washington legalized recreational marijuana within just a couple years of each other, the ways that they decided to distribute marijuana dispensaries, tax marijuana sales, and allocate tax revenues were quite different. It is important to understand how the implementation of marijuana laws in different states affects underage marijuana use and student outcomes so other states can be more informed if or when they choose to legalize recreational marijuana.

[7] There are also conflicting results about access, use, and perceived riskiness in work by Khatapoush and Hallfors (2004), Wall, et al. (2011), Lynne-Landsman, Livingston, and Wagenaar (2013), Harper, Strumpf, and Kaufman (2012), Choo, et al. (2014), Schuermeyer, et al. (2014), and Cerda, et al. (2018).

2.2 Potential Mechanisms

Legalization of recreational marijuana can potentially make marijuana more accessible not only for those over 21 years old, but those under 21 as well. It is reasonable to think that making a purchase at a dispensary is easier than finding a seller in the illegal market, though this logic may not directly apply to underage users. It is possible that teens make purchases at dispensaries using fake IDs, but they could also get marijuana more easily from older friends and family members who purchase it legally. It could also be the case that teens still buy marijuana from sellers in the illegal market but that the sellers can get marijuana products easier than they could prior to legalization, translating to easier access for teens. If marijuana is easier for teens to get, then it is plausible that more of them would use it and/or previous users would use it more. This would lead to negative effects on educational outcomes like I described in the previous section. I discuss underage marijuana use in Washington in more detail in section 3.5.

There are also several reasons why legalization could lead to different effects on marijuana use and educational outcomes for boys and girls. First, it is well-established in the psychology literature that boys are more likely than girls to be risk-takers. Because of this, boys may have been using marijuana at a higher rate than girls before legalization. After legalization, marijuana could appear less harmful or risky to use, encouraging girls to use more while leaving boys largely unaffected.[8]

Second, it could be safer to access marijuana after legalization, which could lead to more use, specifically for girls. For example, meeting a dealer in an isolated area might be less risky for boys than girls, and legalization could alleviate that risk by offering an alternative way to get marijuana (i.e., with a fake ID at a dispensary or from older friends or family members). Third,

[8] Byrnes, J., Miller, D., and Schafer, W. (1999) and Harris, C., Jenkins, M., and Glaser, D. (2006).

legalization leads to higher quality marijuana products, which could lead to larger changes in use for girls than boys. The legal marijuana market is highly regulated; products have to undergo testing for contaminants and THC concentration. If girls were more concerned than boys about the prospect of smoking a bad batch of marijuana that was laced with toxins or other drugs prior to legalization, then more girls than boys may decide to use marijuana after legalization when the probability of this happening is much lower.

If marijuana use for girls increases after legalization more than for boys, then it would make sense to see larger negative effects on educational outcomes for girls. Additionally, there are biological differences between males and females, like brain chemistry and hormone levels, that make them respond differently to THC in ways that could impact how well they perform in school. Neuroscientists have found that the amygdala, the part of the brain that regulates emotion, fear response, and memory, is larger in female than male marijuana users. This can lead to increased anxiety, depression, and short-term memory loss, particularly for females. Also, because of their estrogen levels, females are more sensitive to the pain-relieving effects of THC and develop a tolerance to the drug faster than males, leading to a greater probability of addiction. The sensitivity to THC is particularly strong during ovulation when estrogen levels have peaked.[9]

Since there is strong evidence pointing to possible differential effects of legalization by student gender, I estimate the effects for both boys and girls separately. It is important to note that I lack the data to distinguish which of these mechanisms described above are at play in this context, so what I am ultimately identifying are the *net* effects of legalization.

[9] Jacobus, J. and Tapert, S. (2014), Washington State University (2014), Weir, K. (2015), and Frontiers (2018).

3 Background on Marijuana Legalization in Washington

3.1 Initiative-502

Washington voters passed Initiative-502 (I-502) with a 55.7% majority vote on November 6, 2012, making Washington one of the first states to legalize recreational marijuana along with Colorado. I-502 established a legal market for marijuana where adults over the age of 21 could possess and use small amounts of marijuana that they purchased from state-licensed retailers.[10] "Small amount" is defined in the initiative as any combination of 1 ounce of useable (dried) marijuana, 16 ounces of marijuana-infused products in solid form, and 72 ounces of marijuana-infused products in liquid form. The law went into effect on December 6, 2012.

I-502 gave regulatory power to the Washington State Liquor Control Board, which has since been renamed the Washington State Liquor and Cannabis Board (WSLCB). By December 1, 2013, the WSLCB was required to have established guidelines for how producers, processors, and retailers could obtain licenses; the maximum number of retailers allowed to operate in a county; the amounts of marijuana products allowed at licensed locations; how products should be packaged and labeled; and the concentration of THC allowed in different kinds of products, as well as other testing requirements. In addition, the initiative placed restrictions on where licensed producers, processors, and retailers were allowed to advertise their products, required all facilities to submit samples of their marijuana products for laboratory testing, and extended the penalties for driving while intoxicated to driving when the THC concentration in the blood is 5 nanograms per milliliter of blood or more.

[10] Cultivation for personal use remained illegal.

3.2 Taxation and Revenue Distribution

Tax rates and distribution parameters were also documented in I-502. The initiative established a fund where all tax revenues, license fees, and other money paid to the state from marijuana business activities were to go. 25% excise taxes were levied on each of producers, processors, and retailers. The money in the fund was to be distributed every quarter by the WSLCB in the following manner. $125,000 was allocated to the Department of Social and Health Services to design, administer, and process the results of Washington's Healthy Youth Survey. Another $50,000 was allocated to the Department of Social and Health Services for performing cost-benefit analyses of legalization with the Washington State Institute for Public Policy. The University of Washington Alcohol and Drug Abuse Institute was allocated $5,000 to create and maintain publicly available educational materials about the risks of using marijuana. The WSLCB was allocated at most $1,250,000 to carry out the duties outlined in I-502. Any remaining revenues were to be distributed to seven entities: 15% to the Division of Behavioral Health and Recovery within the Department of Social Health Services to implement programs to prevent and reduce substance use for middle and high school students; 10% to the Department of Health to create and maintain a marijuana education and public health program; 0.6% to the University of Washington and 0.4% to Washington State University to do research on the effects of marijuana; 50% to the state's basic health plan trust account; 5% to the Washington State Health Care Authority to be spent on community health centers; 0.3% to the Office of Superintendent of Public Instruction to be used to fund grants to Building Bridges programs, which are designed to prevent middle and high school students from dropping out; and the remaining amount to the general fund.

As part of I-502, the tax structure was required to be reviewed regularly to make sure the legal market was drawing consumers away from the illegal market while still discouraging marijuana use. The legislature determined that the original implementation of I-502 did not meet these goals, so it passed House Bill 2136 (HB 2136), which went into effect on July 1, 2015. HB 2136 removed the excise taxes on producers and processors and raised the tax on retailers from 25% to 37%. It stated that the tax must be reflected in the price of the marijuana products sold and advertised to customers and that it must be paid by the buyer to the seller.

Tax revenues were still deposited into the marijuana fund, which was renamed the marijuana account, but on an annual rather than quarterly basis. With only a few exceptions, the recipients and allocations stayed the same as under the original law. Under HB 2136, the WSLCB was allocated *at least* instead of *at most* $1,250,000. The bill also stated that $23,750 was to go to the Department of Enterprise Services during the 2016 fiscal year only to make sure producer and processor buildings were up to code. The language surrounding the remaining funds changed from strict percentages to upper bounds, except for the allocations to the state's basic health plan trust account and the Washington State Health Care Authority, which stayed the same. In addition, the bill also specified that entities should have a certain number of funds allocated to them by July 1, 2016, and each year after. Beginning in fiscal year 2018, if excise tax revenues in the general fund from the prior year were greater than 25 million, then 30% of the prior year's revenues in the general fund was to be distributed to counties, cities, and towns – 30% based on number of dispensaries and 70% on a per capita basis.

3.3 Dispensary Lottery

Important for my identification strategy is that Washington limited the number of retail marijuana dispensaries allowed to operate to 334. The WSLCB was in charge of determining what the maximum number of dispensaries should be in each county and I-502 stated that the board should consider the following three things when making its decision: the population distribution in the state and county, safety and security issues, and the level of accessibility needed to discourage people from purchasing marijuana illegally. First, the WSLCB determined the number of dispensaries that could locate in each county by minimizing the average distance from past-month marijuana users to retail dispensaries. Then, it determined the number of dispensaries in a county that would be allocated to each city on the basis of population-share. Any remaining dispensaries were allocated to the unincorporated parts of the county.[11]

Starting in November of 2013, the WSLCB accepted applications for retail marijuana dispensaries for a 30-day period. Applicants were required to pay a $250 fee; participate in background checks; and submit verification of their age and state residency. They also needed to provide a proposed address for their business and verify that they had a right to the property. In addition, the proposed location could not be within 1,000 feet of a school, playground, recreation center, childcare center, public park, public transit center, library, or arcade allowing those under 21 years old. After this prescreening process, there were 1,176 eligible applicants vying for the 334 available licenses.

In localities where the number of applicants was less than or equal to the number of available licenses (i.e., the local quota), all applicants could receive a license. In localities where the number of applicants exceeded the local quota, the WSLCB decided to allocate licenses using a lottery system. There were 75 localities where the lottery was required and 48 where it was not. Of the 1,176 applicants, 1,128 were located in places where the lottery was necessary.

The lottery was held during the week of April 21, 2014. It was double-blind and conducted by the Kraght-Snell accounting firm in conjunction with Washington State University's Social and Economic Sciences Research Center. Kraght-Snell randomly assigned numbers *1-n* to applicants in each locality participating in the lottery, where *n* was the number of applicants in the locality.

[11] Caulkins and Dahlkemper (2013).

The numbers were then sent to Washington State University where researchers ranked the random numbers from 1 to *n*. The rankings were then sent back to Kraght-Snell and decoded. An applicant whose lottery ranking was less than or equal to the local license quota was considered a lottery winner while applicants ranked above the quota were considered lottery losers. Winners were allowed to receive a license while losers were not. The lottery results were posted by the WSLCB on May 2, 2014, and the first retail dispensaries opened on July 8, 2014.

3.4 Entry into the Market

It is important to note that not all lottery winners received a license. After the lottery was conducted, winners had to go through another screening process to double-check that their proposed location was far enough away from restricted entities (i.e., schools, childcare centers, etc.) and that their background checks were complete and satisfactory. If a winner was not allowed to receive a license after this screening process, then the license was awarded to the first applicant ranked above the license quota after the lottery.

In addition, not all licensed dispensaries opened at the same time, opened in their originally proposed location, or opened at all. Some localities placed moratoriums on marijuana business activities, meaning retail dispensaries were not allowed to operate until the moratoriums were lifted. In some cases, multiple lottery winners had proposed the same business address. When this happened, whichever winner secured a lease could locate there and the other winner was granted time to find a different location. Additionally, winners had time to find a new location if the property owner of their proposed place no longer wanted to lease out the building. Many of the dispensaries that opened in a different location from their proposed one opened in places that had been listed on other applications or down the street from their proposed location. Because of this, the lottery-winning locations are a good predictor of where dispensaries actually opened, which is important for my empirical strategy.

3.5 State Trends in Underage Marijuana Use

I would expect legalization to increase marijuana accessibility and use as a result. Legalization could increase underage marijuana use in a couple of ways. First, use could go up on the extensive margin; teens who previously did not use marijuana might decide to try it after it becomes legal. I would expect these kids to be in the middle of the performance distribution in school. Legalization could bump them to the lower end of the performance distribution or decrease their attendance, but I would not expect more of them to drop out of school. Second, use could increase on the intensive margin; previous users could use more after legalization. Teens already using marijuana are likely already performing poorly in school, as previous literature suggests. I would expect that these are the kids on the margin of dropping out, and that legalization pushes them to do so.

State-level trends in marijuana use are available from the Washington Healthy Youth Survey (WHYS). The WHYS is a biennial survey of students in grades 6, 8, 10, and 12 that is used by the state to assess school climate issues and adolescent health. It is implemented by the Health Care Authority's Division of Behavioral Health and Recovery, the Office of Superintendent of Public Instruction, the Department of Health, and the WSLCB. As part of the survey, students are asked about their marijuana use in the past month. Figure 1 shows the trends in past-month marijuana use from 2008 through 2018 for 12th-grade girls (dark green) and boys (light green). As the graph shows, girls were more likely to have used marijuana in the past month after legalization, while boys were less likely to have done do. The average percentage of girls and boys who used went up by 3.67 and down by 1.67 percentage points, respectively, after legalization.

Unfortunately, state trends in marijuana use on the *intensive* margin are unavailable. Additionally, I do not have access to the granular survey data, so I cannot estimate the causal effects on marijuana use. I can, however, look at what happens to educational outcomes directly.

4 Data

4.1 Lottery Results

The list of 1,176 dispensary license applicants is publicly available from the WSLCB. The applicants within each locality are listed with a unique application (license) number, business name, proposed location address, and lottery ranking for participating localities. In addition, the data include the number of licenses allowed in each locality and which dispensaries won the lottery or replaced a winner in instances where winners did not pass the second screening process. In my analysis, I treat original winners that pass the screening process and replacements for those that do not as my sample of applicants that won the lottery. I consider any other applicants in places where the lottery was held to be lottery losers. The total number of winners, substituting replacements for any original winners that failed the second screening process, was 253, and the number of losers was 875. Figure 2 shows where the lottery winners (green triangles) and losers (red triangles) had proposed to locate on their applications, as well as the dispensaries located in areas that did not need the lottery (black circles).

4.2 Dispensary Openings

In addition to the lottery data, the WSLCB also has publicly available information on sales and excise taxes due each month for operating dispensaries. This data identifies dispensaries with the same application or license number as in the lottery data, and also includes the reporting month, total sales, and excise taxes due. The data report sales for July 2014 through October 2017. I use this information to determine when dispensaries entered or exited the market. I consider the first month a dispensary has any sales as the month that it opened. For any dispensary that stops appearing in the data, I consider the last month it appears in the data as the last month it was open. In addition to this data, the WSLCB also provides the addresses for active dispensaries. I merge this data with the lottery data to determine which lottery winners actually opened and whether they opened in their originally proposed location.

I only use dispensaries that opened prior to the end of the 2015-16 school year (i.e., before June 2016) in my analysis.[12] Washington expanded the cap on the number of dispensaries from 334 to 556 in January 2016, and dispensaries that opened after this point did not have to be a part of the original lottery. Thus, I do not want to include them in my analysis. Of the 253 lottery winners, 177 opened between July 2014 and June 2016, while 64 did not. Figure 3 shows the lottery winners that did not open in red. Out of the ones that opened, 83 opened at the address listed in the original application (the green triangles in Figure 3), and 94 opened at a different location (the blue triangles in Figure 3).[13] Lottery winners and open dispensaries are concentrated in the Seattle, Tacoma, Vancouver, and Spokane areas because the local dispensary quotas were highest in these places.

4.3 Educational Outcomes

I collect information on schools from two sources: Washington's Office of Superintendent of Public Instruction (OSPI) and the Common Core of Data (CCD). The data on educational outcomes are publicly available from OSPI, and include dropout, chronic absenteeism, discipline, and math and ELA proficiency rates.

[12] I follow Thomas and Tian (2021) and Dong and Tyndall (2021).

[13] Out of the 177 winners that opened before June 2016, 8 opened after the cap was lifted to 556. My analysis includes these dispensaries. 7 lottery losers and 38 new applicants opened between February and June 2016.

The dropout rate is defined as the number of students who dropped out of their senior year of high school (either those who did not return after their junior year when they were supposed to or those who left during their senior year) divided by the number of students in the senior-year adjusted cohort (i.e., the number of kids who started at the school in ninth grade or transferred to the school during high school minus the number of kids who transferred to a different school). In addition to the 12th-grade dropout rate, I also have data on the 11th-grade dropout rate, which is defined analogously. Dropout rates are at the school level and are available for the 2011-12 through 2015-16 school years. They are also available for girls and boys separately.

The rate of chronic absenteeism is the percentage of students who missed at least 10% of the days they were enrolled in school. The data is available at the school-grade level starting in the 2014-15 school year and is available by student gender. I focus on 11th- and 12th-grade students.

OSPI also started collecting data on discipline actions in 2014-15. In particular, it calculated the discipline rate, which is defined as the number of students who received an out-of-school exclusionary action (i.e., a short- or long-term suspension, an expulsion, or an emergency expulsion) divided by enrollment.[14] This data is available at the school-grade level and by gender. Like absenteeism, I focus on 11th- and 12th-grade students.[15]

In addition to these behavioral outcomes, OSPI also has information on the proportion of students who did not meet, nearly met, met, and exceeded standards on standardized end-of-grade tests. High school students were tested in 10th grade between 2011-12 and 2013-14 and in 11th grade between 2014-15 and 2015-16. Prior to 2014-15, high school math tests were given at the end of courses rather than the end of 10th grade. While these scores are unavailable, I do have

[14] Students who are suspended or expelled multiple times during the year are only included in the calculation once.
[15] Some data is fully redacted because of small numbers of students. In other cases, the discipline rate is given as an upper bound, which I round to the limit (i.e., "<3%" becomes "3%").

school-level data on math proficiency on the end-of-grade tests for 2014-15 and 2015-16 across all students and by gender. Additionally, I have data on ELA proficiency at the school-level for the 2011-12 through 2015-16 school years across all students, and for girls and boys separately for 2012-13, 2014-15, and 2015-16.[16] I specifically use the proportion of students who did not meet or nearly met standards (i.e., those who scored below proficient) in each subject as my outcomes of interest.

I use data from the CCD for three main purposes. First, I use student and school characteristics, specifically the proportions of students who are free-or-reduced-price lunch eligible, Hispanic, Black, and Asian, and school locality to control for differences across schools in my analysis. The CCD classifies schools as being in one of the following locations based on U.S. Census Bureau definitions of urban and rural: small, midsize, or large cities; small, midsize, or large suburbs; remote, distant, or fringe towns; and remote, distant, or fringe rural areas. I create four location categories: city, suburb, town, and rural schools. Second, I use data on school level and type to restrict my analysis sample to schools with high school students, non-charter schools, and regular schools (i.e., non-alternative, non-special-ed, non-juvenile detention centers, etc.). This leaves me with 371 public high schools available for analysis. Due to small numbers of students, some schools have data redacted. I exclude schools that do not have information on both boys' and girls' outcomes so I can compare results for boys and girls without worrying about differences in samples driving the effects. Finally, the CCD includes street addresses for each school, which is important because it allows me to calculate how far away schools are from retail marijuana dispensaries. A map of the 371 high schools, as well as the distribution of dispensary

[16] The ELA test switched from the High School Proficiency Exam to the Smarter Balanced Test starting in 2014-15, but the testing standards remained aligned with Common Core standards adopted in 2010-11.

lottery winners and losers across the state is shown in Figure 4. There is quite a bit of overlap between school and dispensary locations, particularly in the major cities.

4.4 Drive-Time Between Schools and Dispensaries

I use the Google Distance-Matrix API to find the drive-time between my sample of high schools and lottery winners, losers, and winners that opened between July 2014 and June 2016. I input starting and ending addresses and the API uses Google Maps to calculate seconds of drive-time and meters of drive-distance between the two locations. I use the drive-time from schools to dispensaries to proxy for a student's access to marijuana. I assume that students at schools closer to dispensaries have greater access to marijuana, and are thus more likely to use it, than students at schools farther away from dispensaries.

5 Empirical Methodology

One of the difficulties in estimating the causal effect of recreational marijuana legalization on educational outcomes is that where marijuana dispensaries choose to locate is likely endogenous to local demand for marijuana, which is unobserved. If latent demand is correlated in any way with how students do in school, then simple comparisons of student outcomes in areas where dispensaries open and where they do not would be biased. Washington's lottery design helps get around this endogeneity problem. Areas around dispensary applicants likely have similar demand for marijuana, but some places are randomly selected to get a dispensary while others are not. By comparing student outcomes in areas around lottery winners and losers, I can estimate the causal effect of legalization.

Specifically, I can estimate two effects: the intention-to-treat effect (ITE) and the average treatment effect (ATE). Since not all lottery winners opened or opened at the location in their original application, comparing outcomes in areas around lottery winners and losers gives me the

ITE. To identify the ATE, I use the lottery results as an instrument for where a dispensary actually opened.

5.1 Control and Treatment Groups

I designate a school as “treated” if it is within 10 minutes of driving time to a lottery winner. “Control” schools are those that are within 10 minutes of a lottery loser *and* at least 10 minutes away from a lottery winner. In this set up, treated schools within 10 minutes of a winner *and* a loser are considered treated. Additionally, schools within 10 minutes of multiple winners are not considered any differently than schools within 10 minutes of a single winner. I test the robustness of my results to different treatment definitions in section 7. 179 schools in my sample are in the treatment group, while 39 make up the control group.

I use a cutoff of 10 minutes for a couple of reasons. First, for over half of the schools in my sample, it takes 10 minutes or less to get to the nearest lottery participant, so it seems like a natural time to consider. Second, times below 10 minutes result in a very small treatment group while those above drastically reduce the number of control schools. For instance, when I shrink the cutoff to 5 minutes, the number of treated schools falls from 179 to 59 while the number of controls remains about the same. If instead I use 15 minutes, the number of treated schools goes up by just over 25% while the control group falls by almost half.

5.2 Effect of the Lottery

To estimate the effect of the lottery, or ITE, on educational outcomes, I compare schools within a 10-minute drive-time of a winning dispensary to those within 10 minutes of a losing dispensary (and at least 10 minutes from a winner) after dispensaries open in Washington. First, I estimate a simple model given by the following regression equation:

$$E_{st} = \beta_0 + \beta_1 10MinsLottery_s + \varepsilon_{st} \quad (1)$$

E represents dropout, chronic absenteeism, discipline, or math or ELA non-proficiency rates in school *s* and year *t*. The treatment variable is *10MinsLottery* and takes a value of 1 for schools within 10 minutes of a lottery winner and 0 for schools within 10 minutes of loser and at least 10 minutes of a winner. ε is a random school-by-year error term. If $cov(\varepsilon_{st}, 10MinsLottery_s) = 0$, meaning that the lottery randomly assigned schools to treatment and control groups unconditional on covariates, then $\widehat{\beta_1}$ is the causal effect of being within 10 minutes of a lottery-winning dispensary after recreational marijuana is legalized.

However, the probability that a school is within 10 minutes of a lottery winner depends on how many dispensaries applied to locate within that area. In other words, the lottery randomly assigned schools to treatment and control groups *conditional* on the number of applicants within 10 minutes of the school. Thus, I estimate equation (2):

$$E_{st} = \beta_0 + \beta_1 10MinsLottery_s + \beta_2 10MinsApplicants_s + \varepsilon_{st} \quad (2)$$

The variable *10MinsApplicants* is the number of dispensaries that applied for licenses within 10 minutes of school *s*. The issue with this model is that the number of applicants is potentially endogenous to the latent demand for marijuana. There are likely to be more applicants where demand is high and fewer where demand is low. Thus, instead of controlling for the number of applicants directly, I proxy for the probability that a school is assigned to the treatment group with school characteristics, which are likely exogenous to the latent demand for marijuana. Specifically, I control for where the school is located – in a city, suburb, town, or rural area. Additionally, I control for school-level student characteristics, including the proportions of students who are eligible for free-or-reduced-price lunch, Black, Hispanic, and Asian. Differences in these characteristics between schools within 10 minutes of a lottery winner and those within 10 minutes of a loser pre-legalization are shown in Panel A of Table 1. Schools within 10 minutes of lottery winners are more likely to be in cities, and less likely to be in towns and rural areas relative to schools within 10 minutes of lottery losers. On average, 34% of schools near lottery winners, while only 20% near lottery losers, are located in cities. In addition, 12% of schools within 10 minutes of lottery winners, relative to 25% within 10 minutes of lottery losers, are rural schools. Not only do treatment and control schools differ in location, but they also differ in student demographics. Schools near lottery winners have fewer free-or-reduced-price lunch eligible students than those near lottery losers (42% compared to 46%), and they also have more Black and fewer Hispanic students on average.

The following regression equation, my preferred specification, controls for these school characteristics:

$$E_{st} = \beta_0 + \beta_1 10MinsLottery_s + \beta_2 X_{st} + \beta_3 W_s + \gamma_t + \varepsilon_{st} \tag{3}$$

X includes the proportions of students who are eligible for free-or-reduced-price lunch, Black, Hispanic, or Asian, while W includes indicators for whether the school is located in a city, town, or suburb. The omitted category is rural. In addition to these controls, I also include a year fixed effect, γ, to absorb any shocks across time that impacted all schools and could be related to educational outcomes. The coefficient of interest is β_1, which, assuming that $cov(\varepsilon_{st}, 10MinsLottery_s | X_{st}, W_s, \gamma_t) = 0$, is the causal effect of being within 10 minutes of a lottery-winning dispensary after recreational marijuana is legalized.

The primary identifying assumption of this model is that the lottery generated random variation in the proximity of marijuana dispensaries to schools conditional on the covariates in equation (3). To justify this assumption, I test whether there are differences in baseline educational outcomes between schools within 10 minutes of a lottery winner and schools within 10 minutes of a lottery loser (and at least 10 minutes of a winner). These differences are presented in Panel B of Table 1. I find no statistically significant difference between average outcomes in the treatment and control groups before legalization, except for 11^{th}-grade boys' dropout rates. In this case, schools within 10 minutes of a lottery winner have a higher dropout rate than those within 10 minutes of a lottery loser (3% compared to 2%). This table only includes baseline outcomes for 11^{th}- and 12^{th}-grade dropout rates as well as the share of 11^{th} graders who are not proficient in ELA because the chronic absenteeism, discipline, and math proficiency data are not available for the pre-legalization period. Given that five of the six other outcomes are not statistically different across treatment and control schools, it seems likely that the other outcomes would also not differ at baseline.

5.3 Identifying the ATE

As I explained before, not all dispensaries that won the lottery decided to open, not all opened at the address noted on their original applications, and not all opened at the same time. Whether winning dispensaries opened (and where and when) is potentially endogenous to latent demand for marijuana. In so far as these decisions are also related to educational outcomes, a regression like equation (3) above where the treatment variable captured 10 minutes to an open dispensary rather than a lottery winner would yield a biased estimate of β_1. To deal with this issue, I instrument for a school's proximity to an open dispensary with its proximity to a lottery winner and estimate the ATE using two-stage least squares. The IV estimation equation is as follows:

$$E_{st} = \delta_0 + \delta_1 10MinsOpen_{st} + \delta_2 X_{st} + \delta_3 W_s + \gamma_t + \mu_{st} \tag{4}$$

where *10MinsLottery* is the instrument for *10MinsOpen*, an indicator for whether school *s* in year *t* is within 10 minutes of an open marijuana dispensary.[17] The remaining terms are the same as those in equation (3).

One assumption of this IV estimation strategy is that being close to a lottery winner is a strong predictor of being close to a winner that actually opened, i.e., there is a strong first stage. This is plausible in this case because almost half of the lottery winners that opened in my sample period did so at the address listed in their applications, and many of the others located in places near their proposed addresses (see Figure 5). Table 10 shows the first stage estimates for 11th-grade dropout rates. Column (3), my preferred specification, shows that the probability of a school being within 10 minutes of an open dispensary after legalization increases by 35% when the school is within 10 minutes of a dispensary that won the lottery. The associated F-statistic is 11.28, which indicates that the instrument is strong.[18] The remaining first-stage estimates are included in the appendix, Tables A1-A4. In addition to a strong first-stage, the exclusion restriction needs to be satisfied. This means that being close to a lottery winner cannot be directly correlated with educational outcomes. Since winners are randomly selected (i.e., unconditional on educational outcomes), a dispensary's winning status is only related to outcomes in so far as it predicts which schools are near an open dispensary.

6 Main Results

6.1 Intention-to-Treat Effect of the Lottery

Tables 2-9 show the reduced form estimates of the lottery on dropout rates, chronic absenteeism, and discipline rates for 11th and 12th graders, as well as the effects on the shares of

[17] This can vary over time because not all dispensaries opened during the 2014-15 school year. As a robustness check, I estimate the model using only schools that are within 10 minutes of an open dispensary for both school years.
[18] Staiger and Stock (1997).

students who are not proficient in math or ELA. I present estimates for equations (1), (2), (3) with only school locale indicators and year effects, and then the full model with student characteristics to show how sensitive the estimates are to the addition of controls. I cluster standard errors by school, which are shown in parentheses. Along with one-sided p-values from the original estimation, I also show Romano-Wolf p-values that correct for multiple hypothesis testing since I use the same model to estimate effects on several outcomes.[19]

Dropout rates for both 11th-grade girls and boys increase after recreational marijuana is legalized. In the simple model with no controls, being within 10 minutes of a lottery-winning dispensary increases dropout rates by 0.01 for girls and 0.013 for boys (Table 2, columns (1) and (5)). These effects decline slightly to 0.009 and 0.012 when I control for the number of dispensary applicants within 10 minutes of the school, as shown in columns (2) and (6). However, the number of applicants near schools is likely endogenous to latent marijuana demand, so I use school characteristics as proxies for the likelihood that a school will be close to a lottery winner. In columns (3) and (7), when I include only indicators for school locale and year fixed effects, the effects of the lottery are 0.012 for girls and 0.013 for boys. The results are more sensitive to the addition of student characteristics in columns (4) and (8). For girls, the effect of the lottery is 0.01 (0.0032), and for boys, it is 0.011 (0.0051). Both of these are statistically significant at the 1% level after correcting for multiple hypothesis testing. Though the point estimates are similar for girls and boys, the effect is larger relative to the mean for girls. The average dropout rate for 11th-grade girls before legalization was 2.1%, meaning that the dropout rate increases by about half after legalization. For boys, the average pre-legalization dropout rate was higher, at 2.9%. The 1.1 percentage point increase thus translates to a 40% increase in the dropout rate for 11th-grade boys.

[19] For each outcome, I include the eight different reduced form specifications (four for females and four for males) in the Romano-Wolf step-down procedure and do 100 bootstrap replications.

Table 3 shows that 12th-grade dropout rates also increase for both girls and boys. Columns (1) and (5) show that, unconditional on covariates, dropout rates increase by 0.011 and 0.02 for girls and boys, respectively. Like the 11th-grade effects, the 12th-grade effects are most sensitive to the addition of student characteristics. In the saturated model, the effect of being within 10 minutes of a lottery winner on girls' dropout rates is 0.009 (0.0053), as shown in column (4), which is statistically significant at the 5% level after correcting for multiple hypothesis testing. For boys, the effect on dropout rates in the full model is 0.017 (0.0067), which is statistically significant at the 1% level (column (8)). Unlike 11th graders, the effects on dropout rates for 12th graders are larger for boys than girls relative to the mean. Before legalization, the dropout rate for 12th graders was 4.1% for girls and 5.9% for boys, meaning that dropout rates increased by about 22% and 29% for girls and boys, respectively.

Chronic absenteeism also increases for both 11th- and 12th-grade girls and boys after recreational marijuana legalization. Table 4 shows the results for 11th graders. With no controls, the effect of the lottery is 0.061 for girls and 0.049 for boys, as shown in columns (1) and (5). Controlling for the number of dispensary applicants in columns (2) and (6) reduces the effects to 0.057 and 0.035. When I remove the number of applicants and include indicators for school locale and year fixed effects, the effect of the lottery on girls' chronic absenteeism is 0.056, while the effect for boys is 0.042 (columns (3) and (7)). Adding student characteristics drops the effects by about 1.5 percentage points. For 11th-grade girls, chronic absenteeism increases by 0.04 (0.0177) as a result of the lottery, which is a 17% increase from the state average of 24% for high school girls in 2014, as shown in column (4). This effect is statistically significant at the 1% level. The increase is smaller for boys, and statistically significant at the 5% level. Column (8) shows that the effect of the lottery on 11th-grade boys is 0.026 (0.0164), which is a 12% increase from the state average of 21% for high school boys in 2014. I use state average chronic absenteeism in 2014 as the base because the school-level data is not available until 2015. Table 5 shows that chronic absenteeism increases a bit more for 12th than 11th graders. In column (4), the effect of the lottery on girls is 0.047 (0.019), or 20% from the same 24% base for high school girls before legalization. The effect on 12th-grade boys is 0.032 (0.0182), or a 15% increase from the 21% average (column (8)). Again, the effect on girls is statistically significant at the 1% level after correcting for multiple hypothesis testing, while the effect on boys is statistically significant at the 5% level.

In addition to dropout and chronic absenteeism rates, I also look at how legalization affects discipline rates for 11th and 12th graders. The results are presented in Tables 6 and 7. There is no statistically significant effect on 11th-grade discipline rates for girls or boys, or 12th-grade girls, but there is an increase in discipline rates for 12th-grade boys. Table 7, column (5) shows that the discipline rate for 12th-grade boys increases by 0.004 when there are no controls included in the model. This effect is not statistically significant at the standard levels. Adding the number of applicants within 10 minutes of the school does not change the point estimate but increases the standard error from 0.0048 to 0.0054. Again, I do not include the number of applicants in the final specifications because of endogeneity concerns, so I remove it and estimate the model with school locale indicators and year fixed effects in column (7). Doing so leads to a larger effect, 0.009, which is statistically significant at the 5% level. The result is sensitive to the addition of student characteristics in column (8) and falls to 0.007 (0.0045) but remains statistically significant at the 5% level.

To determine whether academic performance, not just behavior, changes after recreational marijuana legalization, I estimate equation (3) for the share of 11th-grade students who are not proficient in math or ELA. Tables 8 and 9 show that neither the proportion of students not proficient math, nor the proportion not proficient in ELA, for both girls and boys, changes in a statistically significant way as a result of the dispensary lottery.

6.2 IV Estimates of the Average Treatment Effect

Tables 11-20 show OLS and IV estimates of equation (4) with no controls and then with school locale indicators, student characteristics, and year fixed effects. Like the reduced form estimates, I cluster standard errors at the school level and present Romano-Wolf one-sided p-values that correct for multiple hypothesis testing.[20]

Table 11 shows the effects of legalization on 11th-grade girls' dropout rates. The OLS estimate of equation (4) with no controls is 0.005, as shown in column (1), and stays the same when the school controls are added in column (2). Like I discussed in the methodology section, the OLS estimate of being within 10 minutes of an open marijuana dispensary is likely biased because which dispensaries open (and where and when) is likely endogenous to unobserved demand for marijuana. Thus, I instrument for a school being within 10 minutes of an open dispensary with an indicator for whether it is within 10 minutes of a lottery-winning dispensary. The IV estimate with no controls is 0.025, as shown in column (3). When I add school locale indicators, student characteristics, and year effects, the estimate goes up slightly to 0.029 (0.0133), which is statistically significant at the 5% level after correcting for multiple hypothesis testing. This means that, relative to the pre-legalization average of 2.1%, 11th-grade girls' dropout rates increase by 140%. I perform a Hausman specification test and can conclude that the OLS and IV estimates in columns (2) and (4) are different at the 0.3% level. Like the reduced form effects, the

[20] For the dropout and chronic absenteeism rates by grade, the Romano-Wolf correction is computed using 12 specifications: the OLS estimation of equation (4) with no controls, with the number of applicants, and the school controls for both girls and boys; and the analogous IV estimation equations for both girls and boys. For discipline rates and the share of students not proficient in math or ELA, four specifications are used: the saturated OLS and IV models for girls and boys. All Romano-Wolf calculations use 100 bootstrap replications.

IV estimates for 11th-grade girls' dropout rates are larger than those for 11th-grade boys. Column (4) of Table 12 shows that the IV estimate of a dispensary opening within 10 minutes of a school is 0.033 (0.0179), which is statistically significant at the 10% level. Relative to the average dropout rate before legalization, 2.9%, the dropout rate for 11th-grade boys increases by 114%. Again, I perform a Hausman specification test and can reject the null that the OLS and IV estimates are equal at the 3% level.

Dropout rates for 12th graders, both girls and boys, also increase because of dispensaries opening within 10 minutes of their schools, though less than for 11th graders. The OLS estimate of equation (4) for 12th-grade girls is 0.005 (Table 13, column (2)), while the IV estimate is 0.028 (column (4)). The IV estimate is statistically significant at the 10% level and is roughly a 70% increase relative to the mean of 4.1%. For boys, the effect is even larger. Table 14 shows the OLS estimate of 0.01 in column (2) and the IV estimate of 0.058 in column (4). The average dropout rate for 12th-grade boys before legalization was 5.9%, which means that it doubles after dispensaries open. The IV estimate is statistically significant at the 5% level. The p-value from the Hausman test is 0.18 for girls and 0.03 for boys.

Tables 15 and 16 present estimates of dispensary openings on 11th-grade chronic absenteeism for girls and boys, respectively. The OLS estimate of equation (4) with all controls is 0.006 for girls, as shown in Table 15, column (2). When I instrument with the indicator for whether a school is within 10 minutes of a lottery winner, the effect increases substantially to 0.109 (0.0553) in column (4). This effect is statistically significant at the 5% level after correcting for multiple hypothesis testing. Like the reduced form effects on chronic absenteeism, I compare the IV effects to the state average of chronic absenteeism across high schools in 2014. For girls, this is 24%, which means that dispensary openings increase 11th-grade girls' chronic absenteeism rates by almost 50% on average. I do a Hausman specification test and can conclude that the OLS and IV estimates differ at the 2% significance level. The effect for 11^{th}-grade boys is smaller. Table 16, column (4) shows the IV estimate from equation (4). The effect of dispensary openings is 0.07 (0.0488), which is about a one-third increase from the state average of 21% in 2014. I can reject the null hypothesis that the effect is less than zero at the 10% level and the null hypothesis that the OLS and IV estimates are the same at the 13% level. The effects on 12^{th}-grade chronic absenteeism are slightly larger relative to the mean for both girls and boys compared to the effects on 11^{th}-grade chronic absenteeism. The results of both the OLS and IV estimation of equation (4) for 12^{th}-grade girls' and boys' chronic absenteeism rates are in Tables 17 and 18, respectively.

Like the reduced form estimates suggest, discipline rates for 11^{th}- and 12^{th}-grade girls do not change in a statistically significant way when dispensaries open. However, unlike the reduced form estimates, discipline rates increase for *both* 11^{th}- and 12^{th}-grade boys, not just 12^{th} graders, because of dispensary openings. Table 19 shows the OLS and IV estimates of equation (4) for girls and boys in both grades. The OLS estimate for 11^{th}-grade boys is 0.006 (column (3)), while the IV estimate is 0.017 (column (4)). The latter is statistically significant at the 10% level. The IV point-estimate is the same for 12^{th}-grade boys, as shown in column (8) and is statistically significant at the 5% level after correcting for multiple hypothesis testing. The p-value for the Hausman specification test for 11^{th}-grade boys is 0.42 and 0.32 for 12^{th}-grade boys.

The shares of 11^{th}-grade girls who are not proficient in math or ELA, as well as the share of 11^{th}-grade boys who are not proficient in ELA, do not change in a statistically significant way when dispensaries open. The share of 11^{th}-grade boys not proficient in math, however, appears to *decline* by 7 percentage points, as shown in Table 20, column (4), which means math scores actually increase as a result of dispensary openings. This effect is statistically significant at the

10% level. The Hausman specification test yields a particularly high p-value of 0.71. I cannot say how large this effect is relative to the average prior to recreational marijuana legalization because high schoolers were not tested in math at the end of 11th grade until the 2014-15 school year, which is the first year that dispensaries open.[21]

For each outcome, the OLS estimate of being within 10 minutes of an open dispensary is smaller than the IV estimate. This means that the OLS estimates are biased down. I interpret this as dispensaries choosing to open around schools where students are already using marijuana. Thus, their educational outcomes are already lower at baseline and would not change much as a result of a dispensary opening in close proximity to their school.

7 Robustness and Extensions

7.1 Accounting for Differences in Dispensary Opening Dates

Not all dispensaries opened at the same time. Only 14 of the 177 of the lottery winners that eventually open during my sample period did so immediately after dispensaries could open in July 2014. There were 73 open by the end of 2014 and 123 by the summer of 2015. The remaining 54 opened up during the 2015-16 school year. This variation is likely due to the following three reasons. First, it took longer to approve some licenses than others simply because retailers took longer to submit their necessary paperwork and complete background checks. Second, it took time for lottery winners who had to find a new location to do so. Finally, some localities placed a moratorium on when dispensaries could operate, so businesses had to wait to open.

Ideally, I would use this variation in when dispensaries became active to help identify the effects of legalization. However, while I do have the monthly data on when dispensaries opened,

[21] As I discussed in the data section, 11th graders were tested in math at the end of courses prior to the 2014-15 school year.

the educational outcomes I am interested in are at the annual level. Thus, in my analysis, whether a school is within 10 minutes of an open dispensary (*10MinsOpen*) is defined at the school-year level. A school is considered treated if it is within 10 minutes of an open dispensary at some point during the year, regardless of how long that dispensary is actually open. If students are exposed to dispensaries for different amounts of time, then my results would be an upper bound on the effects of dispensary openings. I calculate that each school within 10 minutes of an open dispensary is exposed to at least one open dispensary for nine months, or the entire school year (September-May). Thus, I do not need to worry about differential exposure to dispensaries for the schools in my analysis.

In addition, there are 54 dispensaries that open during the 2015-16 school year and 2 that close after the 2014-15 school year, meaning that a school's treatment status can change over time. Table 21 shows that the IV estimates of equation (4) change very little when I include only dispensaries that are open during both the 2014-15 and 2015-16 school years in my analysis.

7.2 Schools Near Multiple Dispensaries

In my main analysis, a school close to multiple dispensaries is assigned the same treatment as a school close to a single dispensary. However, access to marijuana, and thus marijuana use, is likely greater around schools near several dispensaries compared to schools around only one. I determine whether this impacts my results by redefining treatment as a continuous measure: the number of dispensaries within 10 minutes of a school. I re-estimate equations (3) and (4) using this new treatment measure and present the results in Table 22.

11th-grade girls' and boys' dropout rates increase when the number of lottery winners or open dispensaries within 10 minutes of their school goes up by one. Columns (2) and (4) show that being within 10 minutes of another open dispensary leads to an increase in dropout rates of 0.0046

(0.0023) and 0.0048 (0.0023) for girls and boys, respectively. Both effects are statistically significant at the 5% level. Unlike the main analysis, I do not find a statistically significant change in 12th-grade dropout rates.

Chronic absenteeism, however, increases for both 11th and 12th graders, with larger effects for the latter. Column (2) shows that chronic absenteeism increases by 0.0098 and 0.0132 for 11th- and 12th-grade girls when the number of open dispensaries within 10 minutes increases by one, respectively. The former is statistically significant at the 10% level, while the latter is significant at the 5% level. The effects are smaller for boys. The effects of one more open dispensary are 0.0068 and 0.0073 for 11th- and 12th-grade boys, respectively. Both are statistically significant at the 10% level.

In addition, discipline rates increase, but only for 12th-grade boys. The effect of one more dispensary opening within 10 minutes of a school on 12th-grade boys' discipline rates is 0.0026 (0.0017) and is statistically significant at the 10% level, as shown in column (4). The share of students who are not proficient in math or ELA does not change as a result of the lottery or when dispensaries open.

7.3 Heterogeneity of Effects by School Locality

Given that schools in cities and suburbs are more likely to be near a dispensary than schools in towns and rural areas, I look for whether there are heterogenous effects of legalization across localities. I remove the school locale controls and re-estimate equation (4) for city, suburban, and town and rural schools separately. I group the town and rural schools together for sample size reasons. The results are shown in Table 23.

It appears that a lot of the effects are being driven by schools in suburbs and town and rural areas. The effects of dispensary openings on 11th- and 12th-grade chronic absenteeism for both girls and boys are concentrated in suburban schools, as shown in columns (2) and (5). Discipline rates for 11th- and 12th-grade girls are largest in suburban schools, while they are higher for boys in town and rural schools (columns (2) and (6)). It is less clear, however, whether certain schools are driving the effects on dropout rates.

Interestingly, the effects on the share of girls and boys who are not proficient in math is large and negative in town and rural schools. This indicates that math proficiency is actually increasing in those schools when dispensaries open. Similarly, ELA proficiency, particularly for girls, gets better after legalization (column (3)). Since fewer dispensaries open around schools in rural areas, and if legalization drives illegal sellers out of business, then it could be the case that students in these areas are exposed to less marijuana overall and thus benefit from legalization.

8 Conclusion

This paper examines the effects of recreational marijuana legalization on educational outcomes in Washington. Overall, the results suggest that legalization has a negative effect on 11th- and 12th-grade students, particularly on their behavioral outcomes. There are larger effects on dropout and chronic absenteeism rates for girls than boys, while discipline rates increase for boys but not girls.

These results are tempered by the following caveats. First, the estimates may not be indicative of the effects of legalization over time. Washington increased the number of dispensaries allowed in the state to 556 in January 2016 so medical marijuana users could have better access to dispensaries. While the WSLCB prioritized previous applicants when distributing licenses, there was no stipulation that these additional dispensary licenses had to be chosen from the original pool of applicants, making the lottery a weaker instrument. Additionally, new dispensary licenses were issued on a first-come first-served basis; there was no secondary lottery to exploit. A few things could happen as more dispensaries open. Accessibility could increase, driving educational outcomes down further over time, or outcomes could reach a new baseline and plateau as dispensaries become less novel. It could also be the case that outcomes start to climb back up over time if programs implemented to combat teen marijuana use after legalization offset the negative effects of dispensaries.

Second, there are external validity concerns. The way that Washington implemented I-502 and distributed marijuana dispensaries is different than how a lot of other states implemented their recreational marijuana laws. Lotteries for dispensary licenses were only held in two of the other 17 states that have legalized: Arizona and Illinois. In addition, Washington has the highest tax rate on marijuana sales, set at 37%, but does not give a lot of the revenues directly to schools, like other states do. Only a small percentage of revenues are allocated for grants to Building Bridges programs, which are designed to prevent middle and high school students from dropping out. In Oregon, however, the tax rate is 17% on marijuana sales and 40% of the revenues are given back to schools. In Jarrold-Grapes (2022), I find that school district spending in Oregon increased by $700 per pupil on average after legalization, which could be offsetting some of the negative effects I find on educational outcomes. As another example, Colorado allocates the greater of 90% or $40 million of the revenues from its 15% excise tax to the Building Excellent Schools Today program. This money helps fund grants for school construction, like projects to fix roofs, remove asbestos, improve ventilation, and relieve overcrowding. All of this is to say that the effects of legalization on educational outcomes could differ across states because of how they decide to implement their laws, though I do find that recreational marijuana legalization also increases dropout rates and chronic absenteeism in Oregon in Jarrold-Grapes (2022).

In future work, I plan to request the student-level WHYS data to assess whether legalization affected teen marijuana use. This student-level data includes where students went to school, which will allow me to determine whether they were near a lottery winner or an open dispensary. I will then be able to do an equivalent analysis to the one in this paper. The survey also asks students about marijuana accessibility and riskiness. Examining whether these things change will provide some insight into what is driving any changes in use. In addition to the survey data, I plan to request administrative student-level data from OSPI. This data includes more detailed information about student attendance (daily attendance, truancy, and chronic absenteeism), discipline (specifics about the incidents themselves, not just the resulting punishment), test scores (raw scores rather than proficiency), and student characteristics. These granular data would help me to better address heterogeneity in effects for different kinds of students and, for example, whether effects are more pronounced for different parts of the distribution of student test scores.

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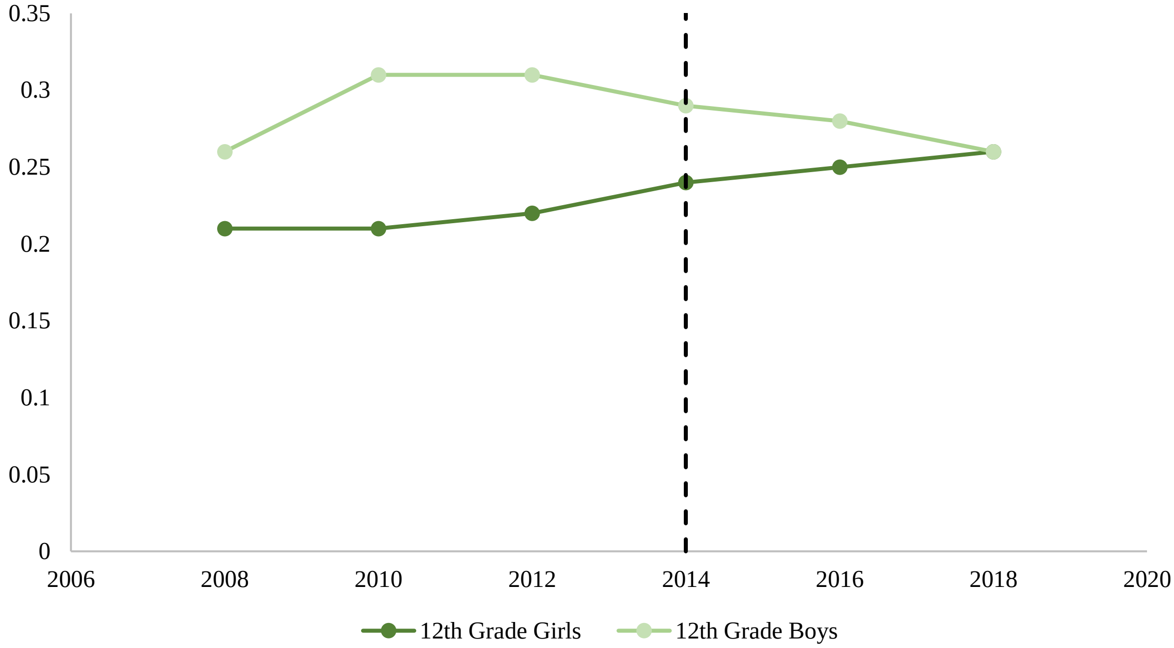
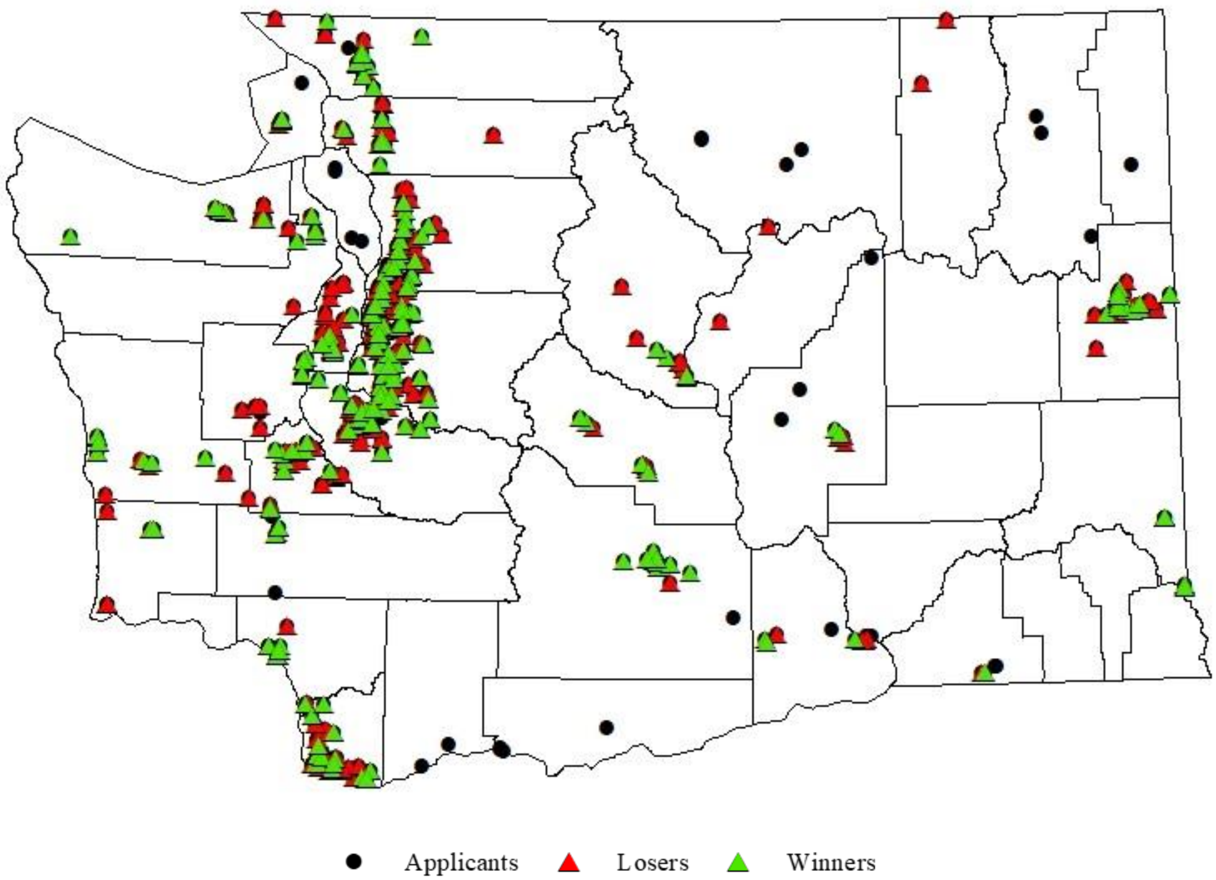
Figures

Figure 1: Trends in the Average Percentage of 12th-Grade Students in Washington who Used Marijuana in the Past Month



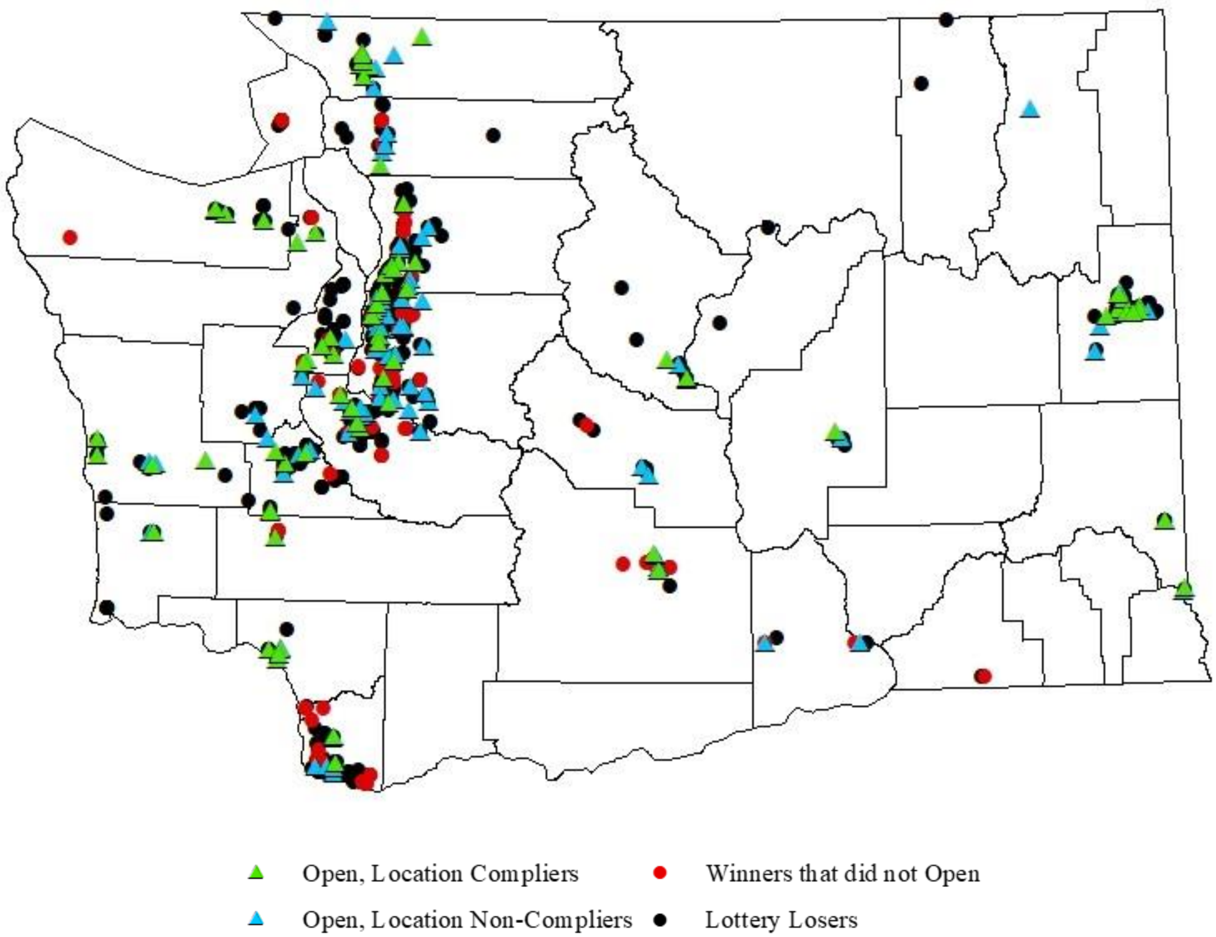
Notes: This figure shows the average percentage of 12th-grade boys (light green) and girls (dark green) who used marijuana in the past month in Washington. The fall semester is on the x-axis and the vertical dashed line marks the semester when recreational marijuana dispensaries were first open. The data come from the Washington Healthy Youth Survey.

Figure 2: Dispensary Applicants and Lottery Winners



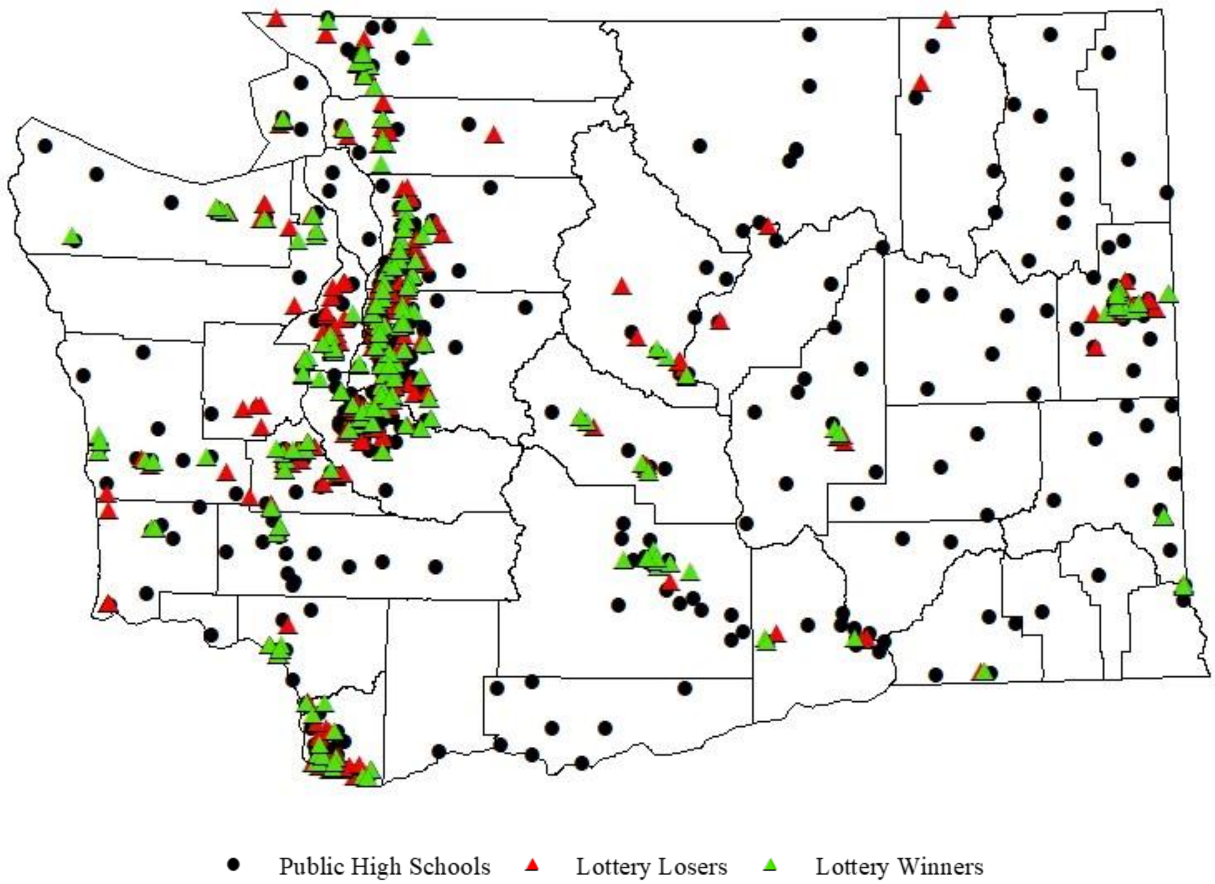
Notes: This figure shows Washington dispensaries that won the lottery (green triangles), lost the lottery (red triangles), and the applicants in places where the lottery was not necessary (black circles).

Figure 3: Dispensaries that Opened between July 2014 and May 2016



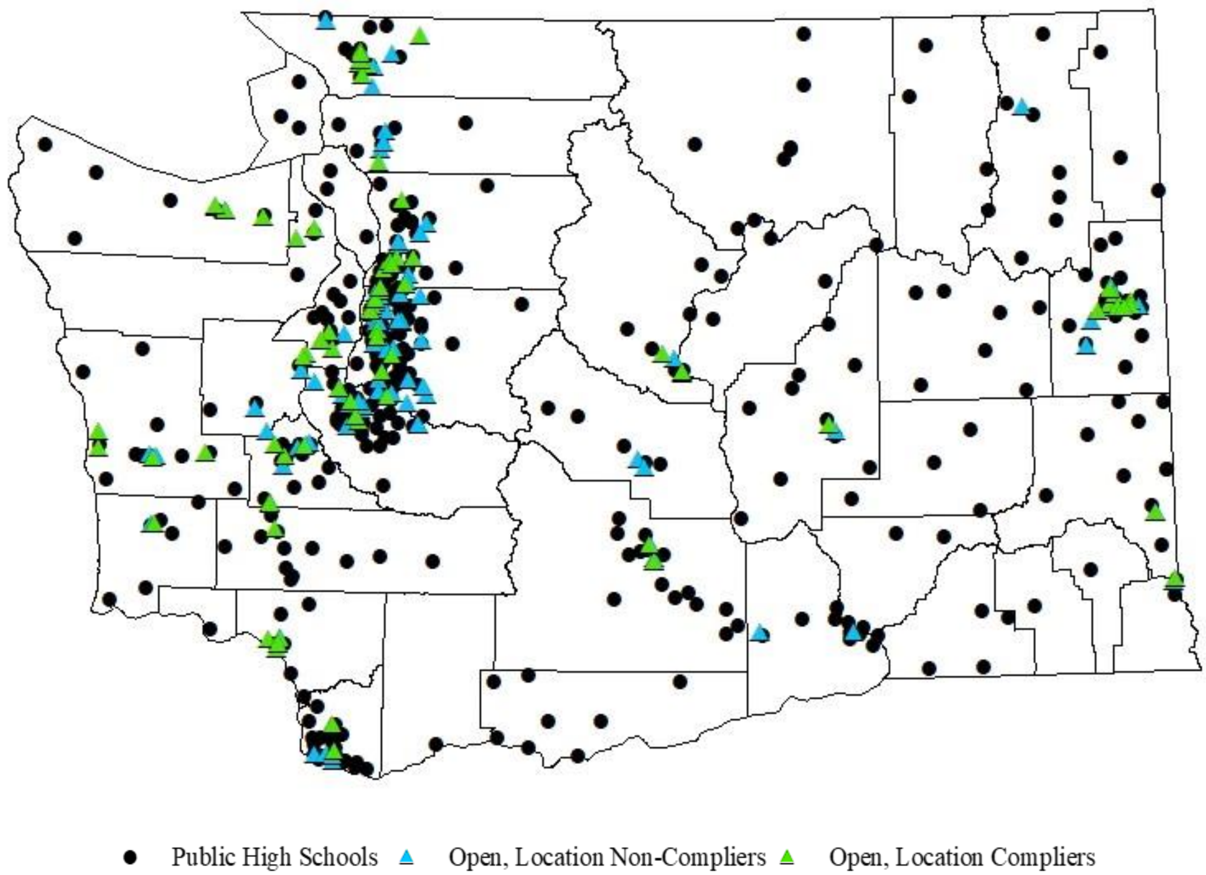
Notes: This figure shows Washington dispensaries that lost the lottery (black circles), dispensaries that won the lottery but did not open between July 2014 and May 2016 (red circles), dispensaries that won the lottery and opened at the location listed on their original applications (green triangles), and dispensaries that won the lottery and opened at an alternative location (blue triangles).

Figure 4: Public High Schools, Lottery Winners, and Lottery Losers



Notes: This figure shows Washington dispensaries that won the lottery (green triangles), lost the lottery (red triangles) and the public high schools included in my analysis sample (black circles).

Figure 5: Public High Schools and Open Dispensaries



Notes: This figure shows Washington dispensaries that won the lottery and opened at the location listed on their original applications (green triangles), and dispensaries that won the lottery and opened at an alternative location (blue triangles), and the public high schools included in my analysis sample (black circles).

Tables

Table 1: Baseline Average School Characteristics and Outcomes for Schools within 10 Minutes of a Lottery Winner or within 10 Minutes of a Lottery Loser

	10 Minutes within Lottery Winner	10 Minutes within Lottery Loser	Difference	Two-Sided P-Value
Panel A: School Characteristics				
FRPL	0.42	0.46	-0.04	0.11
Black	0.06	0.04	0.02	0.01
Hispanic	0.16	0.22	-0.06	0.0004
Asian	0.08	0.08	0	0.95
City	0.34	0.2	0.14	0.004
Suburb	0.41	0.36	0.05	0.29
Town	0.13	0.18	-0.05	0.12
Rural	0.12	0.25	-0.13	0.0001
Panel B: School Outcomes				
Dropout 11th Female	0.02	0.02	0.00	0.29
Dropout 11th Male	0.03	0.02	0.01	0.07
Dropout 12th Female	0.05	0.04	0.01	0.63
Dropout 12th Male	0.07	0.06	0.01	0.46
ELA Female	0.11	0.12	-0.01	0.64
ELA Male	0.17	0.19	-0.02	0.51

Notes: This table reports average school characteristics (Panel A) and school outcomes (Panel B) for schools within 10 minutes of a lottery winner or 10 minutes of a lottery loser, as well as the difference between the averages and the two-sided p-value from a t-test of the difference. Schools within 10 minutes of a lottery loser are also within at least 10 minutes of a lottery winner. All variables are proportions. FRPL stands for free-or-reduced-price lunch eligible. ELA outcomes are the proportions of students who are *not* proficient in ELA. The years included are 2011-12, 2012-13, and 2013-14, except for the ELA outcomes, which only include 2012-13 due to data availability. Math proficiency, chronic absenteeism, and discipline rates are not available prior to recreational marijuana legalization and are thus not included in this table.

Table 2: Reduced Form Estimates of the Washington Marijuana Dispensary Lottery on 11th-Grade Dropout Rates

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of a Lottery Winner	0.010	0.009	0.012	0.010	0.013	0.012	0.013	0.011
	(0.0030)	(0.0036)	(0.0035)	(0.0032)	(0.0049)	(0.0050)	(0.0048)	(0.0051)
	[0.001]	[0.008]	[0.0004]	[0.001]	[0.005]	[0.009]	[0.003]	[0.014]
	{0.005}	{0.005}	{0.005}	{0.005}	{0.005}	{0.005}	{0.005}	{0.005}
# Dispensary License Applicants in 10 Mins		X				X		
School Locale Indicators and Year FEs			X	X			X	X
Student Characteristics				X				X
Dependent Mean Pre-Legalization	.021	.021	.021	.021	.029	.029	.029	.029
Observations	246	246	246	246	246	246	246	246

Notes: This table reports marginal effects from the estimation of equations (1), (2), and (3). The preferred specifications are in columns (4) and (8). All specifications include the 2014-15 and 2015-16 school years. School locale indicators include those for city, suburb, and town, and the omitted category is rural. Student characteristics include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Average dropout rates for the schools in the sample prior to recreational marijuana legalization (i.e., the 2011-12 through 2013-14 school years) are also included.

Table 3: Reduced Form Estimates of the Washington Marijuana Dispensary Lottery on 12^{th}-Grade Dropout Rates

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of a Lottery Winner	0.011	0.010	0.012	0.009	0.020	0.022	0.021	0.017
	(0.0056)	(0.0057)	(0.0056)	(0.0053)	(0.0065)	(0.0072)	(0.0066)	(0.0067)
	[0.023]	[0.036]	[0.015]	[0.057]	[0.001]	[0.001]	[0.001]	[0.005]
	{0.010}	{0.015}	{0.005}	{0.020}	{0.005}	{0.005}	{0.005}	{0.005}
# Dispensary License Applicants in 10 Mins		X				X		
School Locale Indicators and Year FEs			X	X			X	X
Student Characteristics				X				X
Dependent Mean Pre-Legalization	0.041	0.041	0.041	0.041	0.059	0.059	0.059	0.059
Observations	333	333	333	333	333	333	333	333

Notes: This table reports marginal effects from the estimation of equations (1), (2), and (3). The preferred specifications are in columns (4) and (8). All specifications include the 2014-15 and 2015-16 school years. School locale indicators include those for city, suburb, and town, and the omitted category is rural. Student characteristics include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Average dropout rates for the schools in the sample prior to recreational marijuana legalization (i.e., the 2011-12 through 2013-14 school years) are also included.

Table 4: Reduced Form Estimates of the Washington Marijuana Dispensary Lottery on 11th-Grade Chronic Absenteeism

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of a Lottery Winner	0.061	0.057	0.056	0.040	0.049	0.035	0.042	0.026
	(0.0188)	(0.0207)	(0.0187)	(0.0177)	(0.0173)	(0.0188)	(0.0177)	(0.0164)
	[0.001]	[0.004]	[0.002]	[0.012]	[0.003]	[0.032]	[0.010]	[0.059]
	{0.005}	{0.005}	{0.005}	{0.005}	{0.005}	{0.010}	{0.005}	{0.015}
# Dispensary License Applicants in 10 Mins		X				X		
School Locale Indicators and Year FEs			X	X			X	X
Student Characteristics				X				X
State-Level Mean Across Public High Schools in 2014	0.24	0.24	0.24	0.24	0.21	0.21	0.21	0.21
Observations	316	316	316	316	316	316	316	316

Notes: This table reports marginal effects from the estimation of equations (1), (2), and (3). The preferred specifications are in columns (4) and (8). All specifications include the 2014-15 and 2015-16 school years. School locale indicators include those for city, suburb, and town, and the omitted category is rural. Student characteristics include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Average high school chronic absenteeism rates from the 2013-14 school year across all public high schools in the state are also included.

Table 5: Reduced Form Estimates of the Washington Marijuana Dispensary Lottery on 12th-Grade Chronic Absenteeism

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of a Lottery Winner	0.067	0.054	0.058	0.047	0.051	0.036	0.042	0.032
	(0.0205)	(0.0220)	(0.0207)	(0.0190)	(0.0196)	(0.0209)	(0.0197)	(0.0182)
	[0.001]	[0.008]	[0.003]	[0.007]	[0.005]	[0.044]	[0.018]	[0.040]
	{0.005}	{0.005}	{0.005}	{0.005}	{0.005}	{0.015}	{0.010}	{0.025}
# Dispensary License Applicants in 10 Mins		X				X		
School Locale Indicators and Year FEs			X	X			X	X
Student Characteristics				X				X
State-Level Mean Across Public High Schools in 2014	0.24	0.24	0.24	0.24	0.21	0.21	0.21	0.21
Observations	324	324	324	324	324	324	324	324

Notes: This table reports marginal effects from the estimation of equations (1), (2), and (3). The preferred specifications are in columns (4) and (8). All specifications include the 2014-15 and 2015-16 school years. School locale indicators include those for city, suburb, and town, and the omitted category is rural. Student characteristics include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Average high school chronic absenteeism rates from the 2013-14 school year across all public high schools are also included.

Table 6: Reduced Form Estimates of the Washington Marijuana Dispensary Lottery on 11th-Grade Discipline Rates

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of a Lottery Winner	0.001	-0.0003	0.005	0.003	0.005	0.005	0.010	0.006
	(0.0054)	(0.0056)	(0.0043)	(0.0043)	(0.0058)	(0.0066)	(0.0058)	(0.0054)
	[0.459]	[0.476]	[0.132]	[0.255]	[0.172]	[0.213]	[0.049]	[0.123]
	{0.500}	{0.500}	{0.144}	{0.292}	{0.258}	{0.307}	{0.035}	{0.144}
# Dispensary License Applicants in 10 Mins		X				X		
School Locale Indicators and Year FEs			X	X			X	X
Student Characteristics				X				X
Observations	422	422	422	422	422	422	422	422

Notes: This table reports marginal effects from the estimation of equations (1), (2), and (3). The preferred specifications are in columns (4) and (8). All specifications include the 2014-15 and 2015-16 school years. School locale indicators include those for city, suburb, and town, and the omitted category is rural. Student characteristics include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets.

Table 7: Reduced Form Estimates of the Washington Marijuana Dispensary Lottery on 12th-Grade Discipline Rates

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of a Lottery Winner	-0.001	-0.001	0.004	0.004	0.004	0.004	0.009	0.007
	(0.0056)	(0.0058)	(0.0042)	(0.0043)	(0.0048)	(0.0054)	(0.0045)	(0.0045)
	[0.436]	[0.415]	[0.149]	[0.199]	[0.217]	[0.209]	[0.023]	[0.069]
	{0.490}	{0.476}	{0.158}	{0.243}	{0.258}	{0.253}	{0.010}	{0.035}
# Dispensary License Applicants in 10 Mins		X				X		
School Locale Indicators and Year FEs			X	X			X	X
Student Characteristics				X				X
Observations	422	422	422	422	422	422	422	422

Notes: This table reports marginal effects from the estimation of equations (1), (2), and (3). The preferred specifications are in columns (4) and (8). All specifications include the 2014-15 and 2015-16 school years. School locale indicators include those for city, suburb, and town, and the omitted category is rural. Student characteristics include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets.

Table 8: Reduced Form Estimates of the Washington Marijuana Dispensary Lottery on the Share of 11th-Graders who are Not Proficient in Math

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of a Lottery Winner	-0.041	-0.018	-0.022	-0.015	-0.058	-0.034	-0.037	-0.029
	(0.0389)	(0.0410)	(0.0361)	(0.0273)	(0.0375)	(0.0395)	(0.0354)	(0.0269)
	[0.146]	[0.335]	[0.268]	[0.294]	[0.063]	[0.199]	[0.149]	[0.138]
	{0.144}	{0.322}	{0.282}	{0.297}	{0.015}	{0.213}	{0.153}	{0.144}
# Dispensary License Applicants in 10 Mins		X				X		
School Locale Indicators and Year FEs			X	X			X	X
Student Characteristics				X				X
Observations	338	338	338	338	338	338	338	338

Notes: This table reports marginal effects from the estimation of equations (1), (2), and (3). The preferred specifications are in columns (4) and (8). The dependent variable is the proportion of 11th-grade students *not* proficient in math. All specifications include the 2014-15 and 2015-16 school years. School locale indicators include those for city, suburb, and town, and the omitted category is rural. Student characteristics include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets.

Table 9: Reduced Form Estimates of the Washington Marijuana Dispensary Lottery on the Share of 11th-Graders who are Not Proficient in ELA

	Female				Male			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of a Lottery Winner	-0.013	-0.009	0.004	0.003	-0.022	-0.016	-0.008	-0.009
	(0.0336)	(0.0349)	(0.0315)	(0.0244)	(0.0346)	(0.0367)	(0.0342)	(0.0278)
	[0.345]	[0.395]	[0.456]	[0.445]	[0.261]	[0.332]	[0.403]	[0.370]
	{0.441}	{0.471}	{0.495}	{0.495}	{0.342}	{0.436}	{0.475}	{0.475}
# Dispensary License Applicants in 10 Mins		X				X		
School Locale Indicators and Year FEs			X	X			X	X
Student Characteristics				X				X
Dependent Mean Pre-Legalization	0.12	0.12	0.12	0.12	0.18	0.18	0.18	0.18
Observations	320	320	320	320	320	320	320	320

Notes: This table reports marginal effects from the estimation of equations (1), (2), and (3). The preferred specifications are in columns (4) and (8). The dependent variable is the proportion of 11th-grade students *not* proficient in ELA. All specifications include the 2014-15 and 2015-16 school years. School locale indicators include those for city, suburb, and town, and the omitted category is rural. Student characteristics include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Average proportions of students not proficient in ELA for the schools in the sample prior to recreational marijuana legalization (i.e., the 2012-13 school year) are also included.

Table 10: First-Stage Regression Estimates of whether a School is within 10 Minutes of an Open Dispensary on whether a School is within 10 Minutes of a Lottery Winner for the Sample Used in the 11th-Grade Dropout Rate Regressions

	(1)	(2)	(3)
School is within 10 Mins of an Open Dispensary	0.387	0.260	0.348
	(0.1029)	(0.1109)	(0.1036)
# Dispensary License Applicants in 10 Mins		X	
School Locale Indicators, Student Characteristics, Year FEs			X
First-Stage F-statistic	14.10	5.50	11.28
Observations	246	246	246

Notes: This table reports marginal effects from the estimation of the first stage of the IV estimation of equation (4). Each column represents a regression of 10MinsOpen on 10MinsLottery and covariates for the sample of schools used in the dropout rate regressions for 11th graders. Linear probability models are used for estimation. All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. Kleibergen-Paap F-statistics from a test for weak instruments are also reported.

Table 11: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on 11th-Grade Female Dropout Rates

	OLS		IV	
	(1)	(2)	(3)	(4)
School is within 10 Mins of an Open Dispensary	0.005	0.005	0.025	0.029
	(0.0035)	(0.0036)	(0.0106)	(0.0133)
	[0.070]	[0.075]	[0.008]	[0.014]
	{0.069}	{0.069}	{0.010}	{0.020}
School Locale Indicators, Student Characteristics, Year FEs		X		X
First-Stage F-statistic			14.10	11.28
Hausman p-value			0.002	0.003
Dependent Mean Pre-Legalization	.021	.021	.021	.021
Observations	246	246	246	246

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (3) and (4). The preferred specification is in column (4). All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (3) and (4), and the corresponding first stage estimates are in Table A1. The p-value for the Hausman specification tests between columns (1) and (3), and (2) and (4) are included in columns (3) and (4), respectively. Average dropout rates for the schools in the sample prior to recreational marijuana legalization (i.e., the 2011-12 through 2013-14 school years) are also included.

Table 12: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on 11th-Grade Male Dropout Rates

	OLS		IV	
	(1)	(2)	(3)	(4)
School is within 10 Mins of an Open Dispensary	0.009	0.005	0.033	0.033
	(0.0050)	(0.0042)	(0.0156)	(0.0179)
	[0.046]	[0.106]	[0.019]	[0.034]
	{0.069}	{0.069}	{0.035}	{0.069}
School Locale Indicators, Student Characteristics, Year FEs		X		X
First-Stage F-statistic			14.10	11.28
Hausman p-value			0.01	0.03
Dependent Mean Pre-Legalization	.029	.029	.029	.029
Observations	246	246	246	246

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (3) and (4). The preferred specification is in column (4). All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (3) and (4), and the corresponding first stage estimates are in Table A1. The p-value for the Hausman specification tests between columns (1) and (3), and (2) and (4) are included in columns (3) and (4), respectively. Average dropout rates for the schools in the sample prior to recreational marijuana legalization (i.e., the 2011-12 through 2013-14 school years) are also included.

Table 13: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on 12th-Grade Female Dropout Rates

	OLS		IV	
	(1)	(2)	(3)	(4)
School is within 10 Mins of an Open Dispensary	0.007	0.005	0.033	0.028
	(0.0052)	(0.0043)	(0.0189)	(0.0201)
	[0.081]	[0.111]	[0.043]	[0.080]
	{0.064}	{0.064}	{0.030}	{0.064}
School Locale Indicators, Student Characteristics, Year FEs		X		X
First-Stage F-statistic			13.18	9.03
Hausman p-value			0.08	0.18
Dependent Mean Pre-Legalization	0.041	0.041	0.041	0.041
Observations	333	333	333	333

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (3) and (4). The preferred specification is in column (4). All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (3) and (4), and the corresponding first stage estimates are in Table A1. The p-value for the Hausman specification tests between columns (1) and (3), and (2) and (4) are included in columns (3) and (4), respectively. Average dropout rates for the schools in the sample prior to recreational marijuana legalization (i.e., the 2011-12 through 2013-14 school years) are also included.

Table 14: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on 12th-Grade Male Dropout Rates

	OLS		IV	
	(1)	(2)	(3)	(4)
School is within 10 Mins of an Open Dispensary	0.011	0.010	0.057	0.058
	(0.0067)	(0.0061)	(0.0254)	(0.0298)
	[0.058]	[0.052]	[0.013]	[0.026]
	{0.035}	{0.030}	{0.020}	{0.020}
School Locale Indicators, Student Characteristics, Year FEs		X		X
First-Stage F-statistic			13.18	9.03
Hausman p-value			0.01	0.03
Dependent Mean Pre-Legalization	0.059	0.059	0.059	0.059
Observations	333	333	333	333

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (3) and (4). The preferred specification is in column (4). All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (3) and (4), and the corresponding first stage estimates are in Table A1. The p-value for the Hausman specification tests between columns (1) and (3), and (2) and (4) are included in columns (3) and (4), respectively. Average dropout rates for the schools in the sample prior to recreational marijuana legalization (i.e., the 2011-12 through 2013-14 school years) are also included.

Table 15: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on 11th-Grade Female Chronic Absenteeism

	OLS		IV	
	(1)	(2)	(3)	(4)
School is within 10 Mins of an Open Dispensary	0.029	0.006	0.139	0.109
	(0.0180)	(0.0164)	(0.0516)	(0.0553)
	[0.053]	[0.358]	[0.004]	[0.024]
	{0.040}	{0.411}	{0.005}	{0.015}
School Locale Indicators, Student Characteristics, Year FEs		X		X
First-Stage F-statistic			23.17	15.19
Hausman p-value			0.01	0.02
Dependent Mean Pre-Legalization	0.24	0.24	0.24	0.24
Observations	316	316	316	316

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (3) and (4). The preferred specification is in column (4). All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (3) and (4), and the corresponding first stage estimates are in Table A2. The p-value for the Hausman specification tests between columns (1) and (3), and (2) and (4) are included in columns (3) and (4), respectively. Average high school chronic absenteeism rates from the 2013-14 school year across all public high schools are also included.

Table 16: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on 11th-Grade Male Chronic Absenteeism

	OLS		IV	
	(1)	(2)	(3)	(4)
School is within 10 Mins of an Open Dispensary	0.030	0.005	0.112	0.070
	(0.0170)	(0.0145)	(0.0468)	(0.0488)
	[0.041]	[0.356]	[0.008]	[0.075]
	{0.025}	{0.411}	{0.005}	{0.069}
School Locale Indicators, Student Characteristics, Year FEs		X		X
First-Stage F-statistic			23.17	15.19
Hausman p-value			0.03	0.13
Dependent Mean Pre-Legalization	0.21	0.21	0.21	0.21
Observations	316	316	316	316

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (3) and (4). The preferred specification is in column (4). All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (3) and (4), and the corresponding first stage estimates are in Table A2. The p-value for the Hausman specification tests between columns (1) and (3), and (2) and (4) are included in columns (3) and (4), respectively. Average high school chronic absenteeism rates from the 2013-14 school year across all public high schools are also included.

Table 17: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on 12th-Grade Female Chronic Absenteeism

	OLS		IV	
	(1)	(2)	(3)	(4)
School is within 10 Mins of an Open Dispensary	0.048	0.028	0.148	0.119
	(0.0186)	(0.0166)	(0.0521)	(0.0533)
	[0.005]	[0.049]	[0.002]	[0.013]
	{0.005}	{0.025}	{0.005}	{0.005}
School Locale Indicators, Student Characteristics, Year FEs		X		X
First-Stage F-statistic			25.07	18.95
Hausman p-value			0.02	0.05
Dependent Mean Pre-Legalization	0.24	0.24	0.24	0.24
Observations	324	324	324	324

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (3) and (4). The preferred specification is in column (4). All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (3) and (4), and the corresponding first stage estimates are in Table A2. The p-value for the Hausman specification tests between columns (1) and (3), and (2) and (4) are included in columns (3) and (4), respectively. Average high school chronic absenteeism rates from the 2013-14 school year across all public high schools are also included.

Table 18: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on 12th-Grade Male Chronic Absenteeism

	OLS		IV	
	(1)	(2)	(3)	(4)
School is within 10 Mins of an Open Dispensary	0.037	0.013	0.113	0.081
	(0.0175)	(0.0155)	(0.0482)	(0.0490)
	[0.018]	[0.210]	[0.010]	[0.050]
	{0.005}	{0.109}	{0.005}	{0.025}
School Locale Indicators, Student Characteristics, Year FEs		X		X
First-Stage F-statistic			25.07	18.95
Hausman p-value			0.06	0.12
Dependent Mean Pre-Legalization	0.21	0.21	0.21	0.21
Observations	324	324	324	324

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (3) and (4). The preferred specification is in column (4). All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (3) and (4), and the corresponding first stage estimates are in Table A2. The p-value for the Hausman specification tests between columns (1) and (3), and (2) and (4) are included in columns (3) and (4), respectively. Average high school chronic absenteeism rates from the 2013-14 school year across all public high schools are also included.

Table 19: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on Discipline Rates

	11th Grade				12th Grade			
	Female		Male		Female		Male	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of an Open Dispensary	0.002	0.007	0.006	0.017	0.004	0.010	0.007	0.017
	(0.0039)	(0.0115)	(0.0054)	(0.0146)	(0.0036)	(0.0115)	(0.0046)	(0.0122)
	[0.292]	[0.257]	[0.127]	[0.128]	[0.167]	[0.204]	[0.075]	[0.077]
	{0.243}	{0.243}	{0.099}	{0.099}	{0.119}	{0.119}	{0.045}	{0.045}
First-Stage F-statistic		19.65		19.65		20.19		20.19
Hausman p-value		0.59		0.42		0.55		0.32
Observations	422	422	422	422	422	422	422	422

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (2), (4), (6), and (8). All specifications include the 2014-15 and 2015-16 school years, as well as controls for the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Year fixed effects are also included each column. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (2), (4), (6), and (8), and the corresponding first stage estimates are in Table A3. The p-value for the Hausman specification tests between the OLS and IV estimates are also included in columns (2), (4), (6), and (8).

Table 20: Ordinary Least Squares and Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on the Shares of 11th-Graders who are Not Proficient in Math or ELA

	Math				ELA			
	Female		Male		Female		Male	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
School is within 10 Mins of an Open Dispensary	-0.033	-0.035	-0.048	-0.070	-0.041	0.010	-0.050	-0.026
	(0.0252)	(0.0646)	(0.0242)	(0.0650)	(0.0215)	(0.0681)	(0.0252)	(0.0765)
	[0.095]	[0.293]	[0.025]	[0.142]	[0.029]	[0.444]	[0.025]	[0.366]
	{0.064}	{0.213}	{0.010}	{0.074}	{0.015}	{0.451}	{0.015}	{0.371}
First-Stage F-statistic		22.24		22.24		14.65		14.65
Hausman p-value		0.97		0.71		0.44		0.75
Dependent Mean Pre-Legalization					0.12	0.12	0.18	0.18
Observations	338	338	338	338	320	320	320	320

Notes: This table reports marginal effects from the OLS and IV estimation of equation (4). 10MinsLottery is the instrument for 10MinsOpen in columns (2), (4), (6), and (8). The dependent variables are the proportions of 11th-grade students *not* proficient in math or ELA. All specifications include the 2014-15 and 2015-16 school years, as well as controls for the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Year fixed effects are also included in each column. Standard errors clustered by school are in parentheses. One-sided p-values from the original estimation are in square brackets, while one-sided Romano-Wolf p-values correcting for multiple hypothesis testing are in curly brackets. Kleibergen-Paap F-statistics from a test for weak instruments are reported in columns (2), (4), (6), and (8), and the corresponding first stage estimates are in Table A4. The p-value for the Hausman specification tests between the OLS and IV estimates are also included in columns (2), (4), (6), and (8). Average proportions of students not proficient in ELA for the schools in the sample prior to recreational marijuana legalization (i.e., the 2012-13 school year) are included in columns (5)-(8).

Table 21: Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on All Outcomes using only Dispensaries Open During both the 2014-15 and 2015-16 School Years

Dependent Variable	Female (1)	Male (2)
11th Grade Dropout Rate	0.034	0.038
	(0.0164)	(0.0214)
	[0.020]	[0.040]
12th Grade Dropout Rate	0.030	0.061
	(0.0220)	(0.0318)
	[0.087]	[0.028]
11th Grade Chronic Absenteeism	0.112	0.072
	(0.0562)	(0.0508)
	[0.023]	[0.078]
12th Grade Chronic Absenteeism	0.124	0.084
	(0.0554)	(0.0514)
	[0.012]	[0.051]
11th Grade Discipline Rate	0.008	0.018
	(0.0121)	(0.0158)
	[0.257]	[0.134]
12th Grade Discipline Rate	0.010	0.019
	(0.0122)	(0.0132)
	[0.204]	[0.081]
Not Proficient in Math	-0.037	-0.074
	(0.0678)	(0.0683)
	[0.292]	[0.140]
Not Proficient in ELA	0.010	-0.028
	(0.0737)	(0.0821)
	[0.445]	[0.366]

Notes: This table reports IV estimates of equation (4). The sample of dispensaries used to define whether a school is within 10 minutes of an open dispensary (10MinsOpen) are those open in both the 2014-15 and 2015-16 school years. All specifications include the 2014-15 and 2015-16 school years, as well as controls for the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Each column also includes year fixed effects. Standard errors clustered by school are in parentheses and one-sided p-values are in square brackets.

Table 22: Reduced Form and Instrumental Variable Estimates of the Effect of the Number of Recreational Marijuana Dispensaries within 10 Minutes of a School on All Outcomes

	Female		Male	
	Reduced Form	IV	Reduced Form	IV
Dependent Variable	(1)	(2)	(3)	(4)
11th Grade Dropout Rate	0.0026	0.0046	0.0027	0.0048
	(0.0013)	(0.0023)	(0.0014)	(0.0023)
	[0.023]	[0.023]	[0.024]	[0.021]
12th Grade Dropout Rate	0.0008	0.0013	0.0004	0.0007
	(0.0014)	(0.0024)	(0.0014)	(0.0024)
	[0.293]	[0.288]	[0.381]	[0.379]
11th Grade Chronic Absenteeism	0.0058	0.0098	0.0041	0.0068
	(0.0039)	(0.0064)	(0.0032)	(0.0053)
	[0.070]	[0.063]	[0.105]	[0.099]
12th Grade Chronic Absenteeism	0.0078	0.0132	0.0043	0.0073
	(0.0038)	(0.0064)	(0.0032)	(0.0054)
	[0.021]	[0.019]	[0.092]	[0.089]
11th Grade Discipline Rate	0.0011	0.0018	0.0014	0.0025
	(0.0010)	(0.0017)	(0.0014)	(0.0024)
	[0.134]	[0.137]	[0.150]	[0.155]
12th Grade Discipline Rate	0.0010	0.0016	0.0015	0.0026
	(0.0010)	(0.0016)	(0.0010)	(0.0017)
	[0.161]	[0.156]	[0.059]	[0.066]
Not Proficient in Math	-0.0055	-0.0102	-0.0058	-0.0107
	(0.0057)	(0.0102)	(0.0060)	(0.0107)
	[0.168]	[0.159]	[0.168]	[0.157]
Not Proficient in ELA	-0.0004	-0.0007	-0.0025	-0.0047
	(0.0052)	(0.0096)	(0.0057)	(0.0105)
	[0.470]	[0.469]	[0.331]	[0.327]

Notes: This table reports estimates of equations (3) and (4) where the treatment variable is the number of recreational marijuana dispensaries, either those that won the lottery or opened, within 10 minutes of a school. All specifications include the 2014-15 and 2015-16 school years, as well as controls for the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Each column also includes year fixed effects. Standard errors clustered by school are in parentheses and one-sided p-values are in square brackets.

Table 23: Instrumental Variable Estimates of the Effects of Recreational Marijuana Dispensaries on All Outcomes by School Locality

	Female			Male		
	City	Suburb	Town/Rural	City	Suburb	Town/Rural
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
11th-Grade Dropout Rate	0.038	0.022	0.044	0.025	0.047	0.041
	(0.0387)	(0.0100)	(0.0424)	(0.0533)	(0.0199)	(0.0368)
	[0.161]	[0.015]	[0.148]	[0.321]	[0.009]	[0.132]
	92	100	54	92	100	54
12th-Grade Dropout Rate	0.059	0.021	0.048	0.070	0.025	0.091
	(0.0631)	(0.0310)	(0.0457)	(0.0627)	(0.0533)	(0.0698)
	[0.177]	[0.253]	[0.148]	[0.133]	[0.323]	[0.098]
	121	147	65	121	147	65
11th-Grade Chronic Absenteeism	-0.035	0.281	0.034	-0.028	0.255	-0.018
	(0.1380)	(0.2050)	(0.0664)	(0.1130)	(0.1890)	(0.0657)
	[0.401]	[0.086]	[0.307]	[0.403]	[0.089]	[0.393]
	124	138	54	124	138	54
12th-Grade Chronic Absenteeism	-0.041	0.254	0.080	0.012	0.201	0.009
	(0.1480)	(0.1540)	(0.0625)	(0.1520)	(0.1280)	(0.0591)
	[0.391]	[0.050]	[0.101]	[0.468]	[0.058]	[0.441]
	120	137	67	120	137	67
11th-Grade Discipline Rate	0.007	0.047	-0.015	-0.013	0.003	0.035
	(0.0142)	(0.0252)	(0.0161)	(0.0339)	(0.0258)	(0.0220)
	[0.307]	[0.031]	[0.171]	[0.350]	[0.449]	[0.057]
	142	170	110	142	170	110
12th-Grade Discipline Rate	0.018	0.050	-0.020	0.001	0.009	0.031
	(0.0178)	(0.0245)	(0.0172)	(0.0195)	(0.0204)	(0.0213)
	[0.151]	[0.020]	[0.129]	[0.490]	[0.330]	[0.075]
	140	172	110	140	172	110
Not Proficient in Math	0.052	0.005	-0.176	0.017	-0.102	-0.150
	(0.0746)	(0.1200)	(0.0992)	(0.0845)	(0.1400)	(0.0878)
	[0.245]	[0.485]	[0.039]	[0.423]	[0.233]	[0.044]
	107	142	89	107	142	89
Not Proficient in ELA	0.326	0.038	-0.163	0.144	-0.038	-0.131
	(0.3860)	(0.1180)	(0.0929)	(0.3360)	(0.1430)	(0.1120)
	[0.199]	[0.375]	[0.040]	[0.335]	[0.396]	[0.122]
	109	139	72	109	139	72

Notes: This table reports IV estimates from equation (4). 10MinsLottery is the instrument for 10MinsOpen. Each column includes the 2014-15 and 2015-16 school years, year fixed effects, and controls for the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students. Standard errors clustered by school are in parentheses. One-sided p-values are in square brackets. The number of observations is listed beneath the p-values.

Appendix

Table A1: First-Stage Regression Estimates of whether a School is within 10 Minutes of an Open Dispensary on whether a School is within 10 Minutes of a Lottery Winner for the Samples Used in the Dropout Rate Regressions

	11th			12th		
	(1)	(2)	(3)	(4)	(5)	(6)
School is within 10 Mins of an Open Dispensary	0.387	0.260	0.348	0.349	0.223	0.300
	(0.1029)	(0.1109)	(0.1036)	(0.0961)	(0.1025)	(0.0997)
# Dispensary License Applicants in 10 Mins		X			X	
School Locale Indicators, Student Characteristics, Year FEs			X			X
First-Stage F-statistic	14.10	5.50	11.28	13.18	4.72	9.03
Observations	246	246	246	333	333	333

Notes: This table reports marginal effects from the estimation of the first stage of the IV estimation of equation (4). Each column represents a regression of 10MinsOpen on 10MinsLottery and covariates for the sample of schools used in the dropout rate regressions for either 11^{th}- or 12^{th}-grade. Linear probability models are used for estimation. All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. Kleibergen-Paap F-statistics from a test for weak instruments are also reported.

Table A2: First-Stage Regression Estimates of whether a School is within 10 Minutes of an Open Dispensary on whether a School is within 10 Minutes of a Lottery Winner for the Samples Used in the Chronic Absenteeism Rate Regressions

	11th			12th		
	(1)	(2)	(3)	(4)	(5)	(6)
School is within 10 Mins of an Open Dispensary	0.437	0.302	0.367	0.441	0.310	0.394
	(0.0908)	(0.0987)	(0.0942)	(0.0881)	(0.0957)	(0.0905)
# Dispensary License Applicants in 10 Mins		X			X	
School Locale Indicators, Student Characteristics, Year FEs			X			X
First-Stage F-statistic	23.17	9.35	15.19	25.07	10.47	18.95
Observations	316	316	316	324	324	324

Notes: This table reports marginal effects from the estimation of the first stage of the IV estimation of equation (4). Each column represents a regression of 10MinsOpen on 10MinsLottery and covariates for the sample of schools used in the chronic absenteeism rate regressions for either 11^{th}- or 12^{th}-grade. Linear probability models are used for estimation. All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. Kleibergen-Paap F-statistics from a test for weak instruments are also reported.

Table A3: First-Stage Regression Estimates of whether a School is within 10 Minutes of an Open Dispensary on whether a School is within 10 Minutes of a Lottery Winner for the Samples Used in the Discipline Rate Regressions

	11th			12th		
	(1)	(2)	(3)	(4)	(5)	(6)
School is within 10 Mins of an Open Dispensary	0.442	0.316	0.376	0.445	0.322	0.381
	(0.0817)	(0.0881)	(0.0848)	(0.0816)	(0.0879)	(0.0848)
# Dispensary License Applicants in 10 Mins		X			X	
School Locale Indicators, Student Characteristics, Year FEs			X			X
First-Stage F-statistic	29.27	12.87	19.65	29.72	13.41	20.19
Observations	422	422	422	422	422	422

Notes: This table reports marginal effects from the estimation of the first stage of the IV estimation of equation (4). Each column represents a regression of 10MinsOpen on 10MinsLottery and covariates for the sample of schools used in the discipline rate regressions for either 11th- or 12th-grade. Linear probability models are used for estimation. All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. Kleibergen-Paap F-statistics from a test for weak instruments are also reported.

Table A4: First-Stage Regression Estimates of whether a School is within 10 Minutes of an Open Dispensary on whether a School is within 10 Minutes of a Lottery Winner for the Samples Used in the Math and ELA Regressions

	Math			ELA		
	(1)	(2)	(3)	(4)	(5)	(6)
School is within 10 Mins of an Open Dispensary	0.484	0.372	0.422	0.410	0.283	0.354
	(0.0848)	(0.0918)	(0.0894)	(0.0898)	(0.0964)	(0.0924)
# Dispensary License Applicants in 10 Mins		X			X	
School Locale Indicators, Student Characteristics, Year FEs			X			X
First-Stage F-statistic	32.54	16.39	22.24	20.85	8.62	14.65
Observations	338	338	338	320	320	320

Notes: This table reports marginal effects from the estimation of the first stage of the IV estimation of equation (4). Each column represents a regression of 10MinsOpen on 10MinsLottery and covariates for the sample of schools used in the math and ELA proficiency rate regressions. Linear probability models are used for estimation. All specifications include the 2014-15 and 2015-16 school years. School controls include the proportions of free-or-reduced-price lunch, Black, Hispanic, and Asian students, and indicators for whether the school is in a city, town, or suburb. The omitted locale is rural. Standard errors clustered by school are in parentheses. Kleibergen-Paap F-statistics from a test for weak instruments are also reported.