NBER WORKING PAPER SERIES

FEDERALISM, PARTIAL PROHIBITION, AND CROSS-BORDER SALES: EVIDENCE FROM RECREATIONAL MARIJUANA

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Working Paper 23762
http://www.nber.org/papers/w23762

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
August 2017, Revised February 2020

Previously circulated as "The Grass is Greener on the Other Side: How Extensive is the Interstate Trafficking of Recreational Marijuana?" We thank Kendall Houghton for exemplary research assistance. We appreciate helpful comments from Amanda Agan, Mark Anderson, Sandra Black, Gordon Dahl, Jennifer Doleac, Edward Rubin, Michael Kuhn, Lars Lefgren, Jason Lindo, Grant McDermott, Jonathan Meer, Matthew Notowidigdo, Kevin Schnepel, Jeremy West, several anonymous referees, and participants at the NBER SI, WEAI, ISSDP Annual Meetings and seminars at BYU, RAND, San Diego State University, UC Santa Cruz, the University of Essex, and the University of Southern Denmark. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 23762
August 2017, Revised February 2020
JEL No. I12,I28,K14,K42

ABSTRACT

Marijuana is partially prohibited: though banned federally, it is available to 1 in 4 U.S. adults under state statutes. We measure the size of the interstate trade generated by state-level differences in legal status with a natural experiment: Oregon allowed stores to sell marijuana for recreational use on October 1, 2015, next to Washington where stores had been selling recreational marijuana since July 2014. Using administrative data covering the universe of Washington's sales and a differences-in-discontinuities approach, we find retailers along the Oregon border experienced a 36 percent decline in sales immediately after Oregon's market opened. We investigate the home location of recent online reviewers of marijuana retailers and find similar cross-border patterns. By the end of Washington's 2018 fiscal year, our results imply that Washington had earned between $44 million and $75 million in tax revenue from cross-border shoppers. These cross-border incentives may create a "race to legalize."

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1 Introduction

A long literature in public economics and finance has debated trade-offs created by federalized systems and the circumstances under which it is optimal for federal governments to set rules, regulations, and tax instruments, as opposed to leaving those decisions to local jurisdictions (Musgrave, 1959; Oates, 1972, 1999). Decentralization allows members to make welfare-maximizing choices, but these choices may have spillover effects that can be costly to neighbors. Indeed, while governments in different regions may wish to implement differentiated tax rates that correspond to local differences in preferences and endowments, the ability of consumers to engage in arbitrage across borders reduces the effectiveness of such differentiation (Mintz & Tulkens, 1986; Kanbur & Keen, 1993; Nielsen, 2001; Agrawal, 2015).

The challenges posed by arbitrage are particularly relevant in the context of sin goods. When borders are closed, local regulations or taxes on these goods can be light in regions with high consumer surplus net of externalities, and heavy in regions where the opposite is true.[1] When borders are open, cross-border shopping threatens the potential efficiency of decentralized regulation (Lovenheim, 2008; Merriman, 2010; Harding et al., 2012; DeCicca et al., 2013). Moreover, the *act* of arbitrage can lead to further externalities: Lovenheim & Slemrod (2010) find that evading local minimum-age drinking laws increases traffic fatalities. Cross-border shopping incentives depend on differences in local prices or availability. In the case of sin goods, these are often caused by regional differences in regulation and taxation.

Marijuana policy provides a stark example of these issues. The production and consumption of marijuana has been prohibited by the U.S. federal government since 1938.[2]

[1] Geographic variation in policies can also be motivated by differences in externalities across regions.

[2] Marijuana is currently a Schedule I drug, a substance with "no currently accepted medical use and a high potential for abuse." Other Schedule I drugs include methamphetamine and heroin.

However, since 1996, many states have opted to legalize marijuana for medical use ("medical marijuana"), and since 2012 some have additionally chosen to legalize marijuana for recreational use ("recreational marijuana"). The federal government has semi-formally recognized this environment of partial prohibition by deprioritizing the enforcement of federal prohibition laws in states where marijuana is legal (Cole, 2013). This environment has generated state-level conflict, as states whose neighbors have legalized have claimed that cross-border behavior has led to significant externalities (Graf, 2013; Ingold, 2014). Indeed, Hao & Cowan (2017) and Lu (2017) find that arrests for marijuana possession increase in states bordering newly legal recreational markets.[3]

We contribute to this discussion by estimating the share of sales that are due to cross-border shopping in states where marijuana is legal. This illuminates both the costs of the partial prohibition regime – by quantifying the volume of potential spillovers – and the benefits – through measuring the revenues captured by a legalizer from other states' residents. Our setting is Washington state, where retail sales of recreational marijuana began in July 2014. Washington neighbors Oregon – which permitted medical marijuana sales at the time of Washington's legalization – and Idaho – where marijuana is illegal for all purposes. We measure cross-border sales using administrative data on the universe of Washington's recreational marijuana sales. We focus on the Washington-Oregon border, where retail sales of recreational marijuana began unexpectedly on October 1, 2015. Using a differences-in-discontinuities approach, we test whether Washington's sales fell along the Oregon border and interpret any fall as evidence of cross-border shopping in Washington by

[3]This increase, however, occurs before legal retailers open – implying that their observations may be driven by increased law enforcement efforts as opposed to cross-border behavior alone. Indeed, Rubin (2018) finds that local police endogenously change enforcement of state drug laws after local marijuana legalization.

Oregonians.

We find that Oregon's market opening prompted a 36 percent decrease in sales along the border. Furthermore, we find these decreases in sales are largely driven by declines in "large" transactions. We conclude that between 8.1 percent and 11.5 percent of the marijuana sold in Washington in the months leading up to Oregon's market opening was sold to cross-border shoppers.

We supplement these quasi-experimental estimates with a study of online reviews for retailers in Washington, Oregon and Massachusetts. For each location, we sample recent Google reviews and determine the probable home state of the reviewer from their other reviews. We find that 38 percent of the recent reviewers for Washington-Idaho border stores likely reside out-of-state. Likewise, 81 percent of recent reviewers of stores on the Idaho-Oregon border and 55 percent of recent reviewers for the Massachusetts border stores likely reside elsewhere.

These findings suggest that legalization in one state increases access to marijuana for residents of nearby states where marijuana is illegal (or "less" legal). By considering the relative population size of counties along state borders, we compare the relative visitation patterns of locals (for whom access is legal) and those nearby. We find that prior to Oregon's legalization, nearby Oregonians visited stores in Washington at 18 percent of the frequency of local buyers. The relative visitation rate for the Idaho-Washington border is 73 percent, for the Idaho-Oregon border it is 53 percent, and consumers in the region bordering Massachusetts visit marijuana retailers at 44 percent of the frequency of Massachusetts residents. The lower levels in Oregon are unsurprising as Oregon was already more "legalized" than Idaho or the Northeastern United States given Oregon's liberal medical marijuana markets and

thriving black market. This result emphasizes the unique effect of cross-border shopping in an environment of partial prohibition: rather than simply reducing revenue in the state with stricter controls, cross-border shopping may effectively prevent a state from enforcing bans or regulations and thus might create additional legal and enforcement costs for neighboring regions. This result also has significant implications for research on the public health and other impacts of marijuana policy liberalization efforts: differences-in-differences approaches which rely on border states for controls are likely to have estimates biased toward zero (see, for example, Anderson et al., 2013, 2015; Dills et al., 2017; Marie & Zölitz, 2017; Aydelotte et al., 2017; Cerdá et al., 2017).

Our results also highlight the fiscal incentives offered to early adopters from cross-border shopping. Out of the $923 million in excise tax revenue earned by Washington between its market opening and June 30, 2018 (the end of Washington's fiscal year) we estimate that between $43.6 and $74.8 million came from out-of-state consumers. Just as tax competition pressures states and local jurisdictions to "race to the bottom" (Devereux et al., 2008; Jacobs et al., 2010), these incentives potentially create a "race to legalize." Indeed, several other states have chosen to legalize in part due to expected tax revenues, and news reports indicate that others may choose to follow suit (Chafin, 2019). These incentives may also apply at levels below individual states – communities may also choose to sell legal marijuana in spite of local desire for prohibition due to the revenue cross-border shopping can bring and the inefficacy of bans at keeping marijuana out of the community.

We proceed in Section 2 by providing background on marijuana policy and Washington's marketplace. Section 3 describes our data and the methods we use to estimate the size of cross-border shopping in Washington. The results are detailed in Section 4. We conclude in

Section 5 with a discussion of policy implications at the local and federal levels.

2 Background

The U.S. federal prohibition on marijuana began in 1938 with the passage of the Marijuana Taxation Act, though many states had banned the substance earlier including Washington and Oregon in 1923, and Idaho in 1927 (Sanna, 2014, p. 88). The Controlled Substances Act of 1970 strengthened the prohibition against marijuana by increasing penalties for production, distribution, and possession.

Despite this consistent federal prohibition, public attitudes towards marijuana use have shifted, particularly about use for medical reasons. Policies in many jurisdictions have changed as a result. Washington reduced penalties for marijuana possession in 1971, and in 1973 Oregon became the first state to decriminalize marijuana possession. The first successful medical marijuana legalization effort occurred in 1996 in California via ballot initiative. Oregon and Washington followed in 1998. Currently, 27 states and regions permit medical marijuana in some form, with varying restrictions. Notably, Idaho has neither decriminalized possession nor permitted any use of marijuana in any form.[4]

In the November 2012 election, Washington voters approved Initiative 502, which legalized the production, sale, possession, and consumption of marijuana for recreational purposes for adults over 21. Colorado passed a similar ballot measure, making these two states the first to create legal recreational marijuana markets. Oregon followed suit in the November

[4]In 2015, the Idaho legislature passed a bill allowing the use of cannabidiol oil for treatment of severe epilepsy, mirroring the highly restrictive medical marijuana laws of several other states. The bill was vetoed by the governor and has not been reconsidered (Associated Press, 2015).

2014 election, and several other states have chosen to legalize since, despite no change in federal statutes (Hawken et al., 2013).

Initially, federal prosecutors enforced the Controlled Substances Act in states with medical marijuana laws. These efforts culminated in *Gonzales v. Raich*, a 2005 U.S. Supreme Court case stemming from a 2002 enforcement action that destroyed marijuana plants owned by Californian licensees. Patients sued the government and made a federalism argument by claiming, in part, that because the marijuana had been produced and used entirely within California's borders, interstate commerce was unaffected and therefore Congress had no power to regulate their behavior. In its 6-3 opinion, the Supreme Court sided with the government, in part due to the "difficulties that attend distinguishing between marijuana cultivated locally and marijuana grown elsewhere ... and concerns about diversion into illicit channels."

As the number of states with some form of legal marijuana markets has grown, and public opinion has shifted, federal enforcement policy has adjusted even as federal laws remain unchanged. In August 2013, during the implementation of Initiative 502, the Department of Justice responded to Washington and Colorado's efforts with a memo written by then-Deputy Attorney General James Cole. The "Cole Memo" emphasized the federal prohibition of marijuana but provided guidance to U.S. Attorneys as to specific enforcement priorities.[5] States which complied with those priorities were promised that the federal government would not seek to eliminate recreational marijuana markets wholesale.

One priority was "preventing the diversion of marijuana from states where it is legal under

[5]The Cole Memo was a follow-up to a previous 2009 memo focusing on medical marijuana which specified that "federal resources in [legal] States" should not be focused "on individuals whose actions are in clear and unambiguous compliance with existing state [medical marijuana] laws." (Ogden, 2009, p.2).

state law in some form to other states." Other priorities included preventing consumption by minors, preventing marijuana sales revenue from going to "criminal enterprises, gangs, and cartels," and "preventing drugged driving and the exacerbation of other adverse public health consequences associated with marijuana use." Importantly, the Department established a clear expectation that "states and local governments... will implement strong and effective regulatory and enforcement mechanisms."

Bordering states also expressed concerns. In March 2013, Idaho's legislature passed a resolution in support of the federal prohibition policy after local law enforcement agencies claimed that the changes in Washington and Colorado had led to a rise in trafficking activity in the state (Graf, 2013). Nebraska and Oklahoma sued Colorado claiming that unilateral legalization increased their law enforcement costs, though the suit was eventually dismissed (Ingold, 2014). Indeed, according to FBI arrest statistics, the drug violation arrest rate increased 9.2 percent in Idaho and 8.2 percent in Oregon from 2012 to 2013 even as the national rate decreased 4.0 percent. These increases could have stemmed from an increase in cross-border activity—though an increase in enforcement effort would also explain the change. Rates in Nebraska and Oklahoma remained nearly flat (Puzzanchera & Kang, 2017).

The need for effective enforcement was not lost on Washington policymakers. The ballot measure created a three-tiered supply chain, with separate licenses for cultivators (legally 'producers'), wholesalers (legally 'processors'), and retailers.[6] To comply with the priorities laid out in the Cole Memo, Washington implemented a "traceability" system to track the cultivation, testing, processing, and retail sales of marijuana. At every step, the system

[6]Initiative 502 set up vertical integration and ownership constraints for firms; these constraints do not bear upon this analysis. Additionally, the Initiative specified a tax structure that was later reformed extensively before Oregon's market opened. Hansen et al. (2017) examine these details of Washington's policy.

tracks each gram of marijuana produced and each dollar transferred. The data is verified through random site audits—on average eight per licensed retail location per year—backed by penalties ranging from fines to inventory destruction and loss of license. In this way, Washington's system is designed to ensure that marijuana is not diverted from within the supply chain to black markets. We provide more details on the administrative data gathered from this system in Section 3.

Washington's market opened on July 8, 2014, though the opening was not without some friction. As part of the original Initiative, regulators capped licenses throughout the state based on each local jurisdiction's share of the population. Potential retail entrants could apply for a single license covering up to three sales locations. In places where more potential entrants applied than could be satisfied by the cap, a lottery was held (Thomas, 2018). In other words, although entrepreneurs may have wished to concentrate entry in areas where they expected the highest demand, the regulatory license quota made it difficult to endogenize entry in this way. Though at least some licenses were granted across every jurisdiction before the market opened, the Initiative gave local authorities the power to impose additional zoning restrictions or enact moratoria on retail entry; many did so. As a consequence, only 26 stores opened in July 2014, though 140 locations operated by 139 firms were operating by the time Oregon's market opened. Figure 1 illustrates the locations of each of the retail firms throughout the state at the time Oregon's market opened.

Though the Oregon measure legalized the recreational use of marijuana on July 1, 2015, retail stores were not expected to open until late 2016. However, in late July 2015, Oregon's governor signed a bill allowing the roughly 400 existing medical dispensary locations to sell recreational marijuana starting on October 1, 2015. The governor cited the need to curb

black market usage and hasten the transition to a revenue-producing legal market (Sebens, 2015). This opening of retail sales acts as a demand shock to Washington's market insofar that some of Washington's sales along the border came from Oregon residents. As the market opened many months earlier than expected, we treat the precise date as exogenous variation in demand for Washington's marijuana retailers.[7]

We proceed to use this demand shock to identify the share of sales – measured by the weight of dry marijuana flower ('usable marijuana') sold – due to cross-border shopping. Interpreting the results requires an understanding of marijuana dosage and consumption rates. Relative to other substances such as nicotine or alcohol, establishing a standardized measure of marijuana consumption is difficult, both due to the variety of consumption paths, and variation in potency measured by the concentration of tetrahydracannabinol (THC) and cannabidiol (CBD) (Gray et al., 2009).[8] Indeed, in our data the average potency of marijuana sold in Washington's marketplace has increased substantially since its market opened, from roughly 13 percent THC and CBD content by weight to more than 20 percent and the correlation between prices and THC content is not very high (Hansen et al., 2020). The most relevant estimate of use by Washington's consumers comes from Cuttler & Spradlin (2017), who surveyed over 2,000 marijuana users at a major university in Washington and found that users consumed marijuana on an average of 7.82 days per month and, conditional on use, the average weight consumed per day was 0.99 grams. Other measures of consumption come implicitly from the market: stores generally sell usable marijuana in packages of 1g, 2g,

[7]While Oregon developed a tracking system comparable to Washington's system, it was not available when recreational sales began. Because of this, we cannot observe the details of Oregon's retail market at the time of its opening, as we can with Washington. In any case, any demand change in Washington's market is the key sufficient statistic for identifying the movement of marijuana from Washington to Oregon.

[8]Very roughly speaking, it may be useful to think of 1 to 2 grams of usable marijuana as having an equivalent intoxicating power as a single bottle of wine.

3.5g, 7g, 14g, and 28g (one ounce).[9] Pre-rolled joints are included in the category of 'usable marijuana', often contain smaller amounts of dried flower (e.g. .33g or .5g), and are also commonly sold in packs (e.g. three packs, six packs, or ten packs). We therefore define a "large transaction" as any transaction where the weight of usable marijuana sold was greater than 6g.

Marijuana is also available in other forms, including edibles – processed foods which contain THC or CBD extract – and concentrates – highly purified extracts that are consumed with a vaporizer. The nature of these forms precludes using the weight or number of units sold directly as a measure of quantity, as these measures are not comparable across products. We therefore use revenue instead of weight when analyzing these products.

The extent to which consumers are incentivized to engage in cross-border shopping after legalization depends at least in part on the tax regime in different jurisdictions. Washington initially assessed a 25 percent gross receipts tax at multiple stages in the supply chain (Hansen et al., 2017). On July 1, 2015, Washington changed its tax structure by removing non-retail taxes and increasing the retail tax rate to 37 percent. Due to the nature of Oregon's legalization process, marijuana sales were initially untaxed. Starting in January 2016, Oregon assessed a 20 percent excise tax on marijuana sales.[10] This difference mirrors the states' sales taxes on other goods; Washington assesses a 6.5 percent general sales tax and allows local jurisdictions to assess additional sales taxes, whereas Oregon does not have a general sales tax.

[9]Washington limits purchases to one ounce per transaction, though there is no tracking of purchase behavior across stores.

[10]This consists of a 17 percent state-wide rate and an optional local assessment of up to 3 percent; nearly every jurisdiction has chosen to enact the maximum local rate, including Huntington.

2.1 Population centers, border crossings, and retail locations

To understand the degree to which we could expect cross-border behavior at different locations, it is useful to consider the geography of Washington and Oregon's borders. For example, approximately 75 percent of Washington's border with Oregon is formed by the Columbia River and there are only ten road crossings over the roughly 300 mile length of the river border (Holmes, 1998). In contrast, Washington's borders with Idaho and Canada are defined by longitude and latitude lines, respectively. There are thirteen road crossings between Canada and Washington, with four serving the Seattle-Vancouver region. The Washington-Idaho border is considerably more porous. The Idaho-Oregon border is a hybrid – in the north it is divided by the Snake River and in the south it is divided by longitude lines. As a consequence, it has areas of more and less porousness dictated by the river, mountain ranges, and nearby populations.

We proceed by splitting Washington into four zones by county: the Oregon border, the Idaho border, the Canadian border, and the interior. Figure 1 maps these zones and the location of Washington retailers at the time that Oregon's market opened. Most retailers are located in the interior region within the greater Seattle-Tacoma area, though there are several located in the middle of the state near Wenatchee. The greatest concentration of retailers along the Canadian border are in Bellingham, less than 60 miles from Vancouver, British Columbia, though there is a single retailer less than one mile from the border.

Retailers in the Oregon border region are spread more evenly, with many located along the Columbia River Gorge near river crossings. The greatest number are in the Vancouver, Washington area (near Portland) and along the Interstate 5 (I-5) corridor.[11] Appendix

[11]The I-5 corridor traverses the Willamette valley, home to approximately 70 percent of Oregon's popu-

Table A.1 groups Oregon's counties by the Washington county with the closest retailer and reports county populations and the distance to the closest Washington retailer. Appendix Figure A.1 illustrates this data with a map of Oregon's counties.

Idaho border region retailers are almost all located near Spokane, though one is located in Pullman. Several of Idaho's population centers are within 30 miles of the Washington border, including Coeur d'Alene, which is close to Spokane, and Moscow, which is close to Pullman. The proximity of Moscow and Pullman is particularly relevant, as both host land-grant universities (University of Idaho and Washington State University, respectively). Several of Montana's population centers are also closer in driving distance to Spokane than Colorado, including Missoula, Great Falls, Helena, and Bozeman.

Though Oregon allowed existing medical dispensaries to participate in the recreational market when it opened in October 2015, no dispensaries existed along the Interstate 84 (I-84) corridor between the eastern border with Idaho and the Columbia river to the north at that time.[12] The first cannabis dispensary of any type to open in Oregon along the eastern I-84 corridor was in Huntington, 84 miles from Boise, in March 2016. Despite this distance and Huntington's small size (population 440 at the 2010 census), Huntington's stores have been the most popular in the state, and county-level aggregate data released by the state suggest that the region's per-capita sales are 744 percent greater than per-capita sales in the Portland metro area (Danko, 2019). More recently, additional stores have opened in Ontario, a town of 11,000 people located 55 miles from Boise. Anecdotal reports suggest that the revenue potential overcame local objections to marijuana consumption. The expansion of

lation

[12]Opposition to Oregon's recreational legalization ballot measure was much stronger along the I-84 corridor in the eastern part of the state than along the I-5 corridor in the western part of the state.

the marijuana industry in rural eastern Oregon recently drew headlines and attention to cross-border shopping as Snoop Dog performed at the opening of Hotbox Farms in Ontario to a crowd of 6,000 people largely consisting of visitors from Idaho.[13]

3 Data and Methods

We estimate the extent of cross-border shopping with records from Washington's traceability system. We observe, for each retail transaction, the types (i.e. usable marijuana, edibles, or concentrates) and quantities of products sold, the prices paid by consumers, and the wholesale prices paid by retailers. Though the data are generally reported in real time, we aggregate our data to the weekly level to avoid cyclical day-to-day variation in sales.

We apply some cleaning steps to our data. In particular, systematic changes in the state's reporting system and third-party tools used by many firms must be accounted for. Hansen et al. (2018) detail the steps needed to transform the raw traceability database into a usable form for research, and we follow their procedure. Most of the details in that paper are focused on the technical features of this administrative data set and are not directly relevant to this analysis. For the purposes of examining sales in the period immediately surrounding Oregon's market opening, we drop firms in their first 14 days of operation and firms which have inconsistent reporting behavior (e.g. firms which report sales one day per week) in the month of Oregon's market opening. After applying these restrictions, we drop 11 percent of the data as measured by the total weight sold in the raw data versus the cleaned data.[14]

[13]https://www.oregonlive.com/news/2019/10/surprise-its-snoop-rappers-last-minute-performance-draws-thousands-to-ontario.html

[14]The largest single contribution to this percentage comes from firms which initially reported irregularly and then switched a more regular reporting scheme. We choose to eliminate these firms to ensure that our results are not driven by changes in the composition of firm reporting behavior which are not likely to be

Table 1 reports aggregates of our data at the region level over three periods surrounding Oregon's market opening. The first column aggregates data over the two months before Oregon's law took effect (May and June 2015). The second column reports aggregates for the two months before Oregon's market opened (August and September 2015), and the third column details our data for the two months after Oregon's market opened (October and November 2015). The first three rows within each region report the total weight, average tax-inclusive price, and share of the total weight sold in the state for the relevant time period. The remaining rows report the region's population share, population of men from age 20 to 24 (as a share of the total in the state), and the fraction of the population reporting using marijuana in the last 30 days based on the National Survey of Drug Use and Health.

The top panel reports statistics for the interior region. Though the interior has 75.4 percent of Washington's population, its market share was only 66.5 percent before Oregon's market opened. Its market share increased to 70.4 percent afterwards. In contrast, the Idaho border region has only 8.1 percent of Washington's population, but captures roughly 19 percent of its market share. Though there were small changes in the distribution of the market share across the Idaho and Canadian border regions, the largest change over the period came from the Oregon border region, where the market share fell from 9.9 percent in the two months before Oregon's market opened to 6.7 percent in the two months afterward. Similar patterns exist when comparing the market shares to shares of men from age 20 to 24 or adjusting directly for marijuana usage rates.

Figure 2 illustrates the time-series nature of our data by plotting the total revenue from usable marijuana, concentrates, and edibles, as well as the total weight of usable marijuana

caused by Oregon's market opening.

sold in each of the four regions by week during the period we study around Oregon's market opening. The outcomes are indexed to the week before Oregon's market opened. In the Oregon border region, all four outcomes drop in the weeks after legalization, though the drop in sales of concentrates and edibles is smaller than the drop in usable marijuana sales.

Transactions are heterogeneous in the weight of usable marijuana sold. Table 2 details the distribution of transaction sizes across regions for the two-month period before Oregon's market opened. The plurality of transactions—33.8 percent statewide—are of a single gram of marijuana. Transactions between one and two grams make up the next largest category, at 25.6 percent. Transactions of greater than six grams, which we refer to as "large," comprise 6.4 percent of sales in the state. Roughly 5 percent of transactions in the interior and Canadian border regions are large. However, 9.3 percent of sales in the Oregon border region and 11.8 percent of sales in the Idaho border region are large. By weight, large transactions comprised roughly 31 percent of the weight sold statewide, 37 percent of the weight along the Oregon border, and nearly 44 percent of the weight sold along the Idaho border.

3.1 Regression Discontinuity Design

To estimate the causal impact of Oregon's market opening on Washington's sales, we use a regression discontinuity (RD) design with time as the running variable and treatment determined by the date Oregon legalized – a regression discontinuity in time (RDIT). We model some outcome variable y_t as a function of time with

$$y_t = \beta_0 + \beta_1 * ORLegal_t + f(t) + u_t. \tag{1}$$

In this equation, $f(t)$ is a function of the running variable – we use a first-degree polynomial and allow the slope to vary across the discontinuity. $ORLegal_t$ is an indicator which is one if the date is October 1st 2015 or later. β_1 is the parameter of interest.

This approach relies on the key identifying assumption that there are no changes in the outcome variable other than those caused by Oregon's market opening. RDIT is a somewhat unique application of the RD approach. As discussed by Hausman & Rapson (2017), tests of covariate balance or sorting are not possible when time is the running variable. However, the analogous requirement, which comes from the interrupted time-series literature, is to have a balanced or semi-balanced panel of firms across time, which we obtain by only including firms in our analysis that have been open for at least one month before and after the event we are studying. Other concerns about identification generally stem from seasonality, as cyclical or non-linear variation in the response variable over time can lead to bias in the estimate of β_1. We choose bandwidths following Calonico et al. (2014)[15] and address these concerns by exploring the sensitivity of our estimates to a variety of bandwidths—thus changing the level of non-linear variation in the response variable—and polynomial orders (Gelman & Imbens, 2017)—thus affecting our ability to capture non-linear variation.

Motivated by pronounced day-of-week effects which reflect the stylized fact that many consumers buy marijuana once per week, we aggregate to the region-week level. Calonico et al. (2018) show that including additional covariates in a RD design can also affect consistency and precision. We avoid this concern because, after aggregating to the region level, the only covariate remaining is the week relative to Oregon's legalization, our running variable.

[15]We estimated our regression discontinuity models with the statistical packages `rdrobust` and `rdplot` described in Calonico et al. (2017).

3.2 Differences-in-Discontinuities

The RD design cannot account for all potential threats to identification. If an external shock occurs coincident in time with the treatment, RD models will be biased as they will attribute all of the observed change to the treatment, when in reality multiple factors changed at the threshold. This is particularly concerning in our application, as regulatory changes in Washington generally occur at the state level; if some change occurred around the time of Oregon's market opening that affected the weight sold, our RD estimates will not successfully capture the impact of Oregon's policy change.

This concern can be addressed if there is another group which does not experience a coincident change in treatment, but which does experience any external shock. In such a case, one can estimate the reduced-form effect of the external shock for this control group, which provides an estimate of the bias present in the RD estimate of the treatment effect. Grembi et al. (2016) first implemented this "differences-in-discontinuities" approach in studying the impacts of regional fiscal rules. We use the interior of Washington as such a control group, and also use the Idaho and Canadian Border regions as placebo tests. The treatment effect of Oregon's market opening is recovered by subtracting the RD estimate of the effect for the control group from the RD estimate for the treatment group.[16]

We perform differences-in-discontinuities analysis with a single regression. For a region

[16]Visualizing the fitted models is a common practice for regression discontinuity approaches. For differences-in-discontinuities, one approach is to show the fitted models for both the treated and placebo regions, which we follow. Another approach is to graph the difference between the outcome for the Oregon-Washington border and the Washington interior regions across the running variable, which Gottlieb et al. (2016) use. Both yield similar visual evidence near the cutoff in our setting because there is essentially no response in the interior of Washington.

r, we model the region-time level outcome variable y_{rt} with

$$y_{rt} = \beta_0 + \beta_1 * ORLegal_t + \beta_2 * ORBorder_r + \beta_3 * ORBorder_r * ORLegal_t + f(t) * (ORBorder_r) + g(t) * (1 - ORBorder_r) + u_{rt}. \quad (2)$$

In this equation, $ORLegal_t$ is an indicator variable which is one if the date is October 1st 2015 or greater, while $ORBorder_r$ is an indicator variable which is one if r is the Oregon border region. β_3 is the parameter of interest. The function $f(t)$ is a first-order polynomial in the running variable which is interacted with the Oregon border indicator, while $g(t)$ is a separate first-order polynomial for the Washington interior region. We allow $f(t)$ and $g(t)$ to vary across the $ORLegal_t$ discontinuity.

This approach accounts for any coincident changes in policy or seasonal changes in the response variable that are common across the interior and border regions. Our standard errors are calculated allowing clustering at the level of the running variable (Lee & Lemieux, 2010). However, because we aggregate to the region by week level, this is mathematically equivalent to standard heteroskedastic-robust standard errors, as there are no repeated observations. Similarly, our aggregation to regions addresses potential concerns about autocorrelation at the county or sub-county (e.g. store) level. We choose a bandwidth following Calonico et al. (2014) and explore the sensitivity of our estimates to the bandwidth selection criteria suggested by Ludwig & Miller (2007) and Imbens & Kalyanaraman (2012).

3.3 External Validity and Google Review Data

The Washington-Oregon border natural experiment is a particularly useful way to estimate the effect of one state legalizing on border shopping by neighbors for two main reasons: (1) we are able to estimate how much the share of sales due to cross-border shopping *changes* when a neighboring state legalizes – not just the share itself, some of which may remain even after neighbors legalize due to price or tax differentials, work-life and travel patterns, and so forth – and (2) because Oregon's policy allowed existing medical marijuana dispensaries to operate in the recreational market, many stores in Oregon were open on the first day of recreational sales. This more closely approximates the long-run supply response than if we examined a state that built a supply chain "from scratch" (e.g. as discussed in Section 2, Washington's recreational market initially opened with very few dispensaries).

However, there is no guarantee that the share of sales in Washington due to cross-border shopping from Oregon will be similar across all pairs of bordering states where recreational marijuana is legal in one and illegal in the other. In general, we expect the share of sales due to cross-border shopping to vary systematically according to three factors: (1) the relative population sizes of the counties near the border, (2) the distance between the population centers near the border , and (3) the restrictiveness of the marijuana regime in the "illegal" state. On these factors, we expect that the Washington-Oregon natural experiment provides a lower bound estimate of the level of cross-border shopping relative to most state pairs we have observed or will likely observe in the U.S. as (1) the Washington-Oregon border is characterized by a single large city (Portland) near the border – the rest of the border is fairly rural – (2) Oregon's other population centers are far from the border and (3) the

marijuana regime in Oregon was relatively permissive before Oregon's recreational market opened – marijuana possession was decriminalized, limited home growing was legal, medical marijuana was legal and relatively lightly regulated, and the black market for recreational marijuana was thriving. We assume the permissiveness of Oregon's pre-legalization regime decreases Oregon residents' incentive to cross-border shop since due to the relative availability of marijuana in Oregon; however, it is also possible that permissiveness has the opposite effect on cross-border shopping because the decriminalization of marijuana in Oregon makes it less costly to get caught with marijuana relative to to other states, like Idaho where possession remains a criminal offense. Ultimately, this is an empirical question.

We provide some evidence for this lower-bound claim in Section 4.1 by comparing per-capita marijuana sales on the Washington-Oregon border, Washington-Idaho border, and the interior of Washington. In the absence of cross-border shopping, marijuana sales per-capita should be approximately the same in each. We might worry that any observed differences in per-capita sales may be driven by differences in the underlying use rates – for example, Washington State University is along the Washington-Idaho border and college students may have higher use rates than other groups. To address this concern, we consider another specification in which we adjust for differences in use rates in the three regions.

To further support our lower-bound claim, we collect recent Google review data from marijuana retailers in the states where marijuana is legal. We calculate the cross-border shopper share of sales by sampling the recent reviewers, examining their other reviews, and taking their modal review location as their home location. In other words, if we see a user review for a dispensary in Spokane, and that user's other reviews predominantly cover businesses in Boise, we conclude that the user likely lives in Boise and crossed the border

to shop at the dispensary in Spokane.[17] This approach is in the spirit of Davis et al. (2019) and is also related to Merriman's work that looks for physical evidence of cigarette cross-border shopping by noting the location of the cigarette stamps on discarded cigarette packs across Chicago and New York City (Merriman, 2010; Chernick & Merriman, 2013) – here we are looking for online traces of cross-border shopping via Google reviews. Because we collect recent reviews, we cannot replicate the Washington-Oregon analysis at the time of the policy change, but we can analyze the extent of cross-border shopping along other borders including the Washington-Idaho and Massachussetts borders and compare these present-day estimates to the point-in-time estimates from the Washington-Oregon natural experiment. To the extent that our Google review data universally point to larger shares of sales going to cross-border shoppers than the Washington-Oregon results, this supports the claim that our Washington-Oregon estimates are a lower bound.

Our estimates of the cross-border shopping sales share using Google review data may be biased towards zero if those who engage in cross-border shopping are less likely to submit reviews on Google due to fear this evidence could be used against them later. It would also be biased towards zero if cross-border shoppers purchase larger transactions (which we report evidence of in Section 4.3). While this approach provides a measure of the cross-border shopping share, it likely overstates the amount by which cross-border shopping will fall in response to the neighboring state legalizing recreational marijuana because cross-border shopping will likely not fall all the way to zero as noted above.

[17] As Google makes scraping their review data a manually intensive task with no automated solutions, we focus on the most recent 10 reviewers for each location (40 recent reviewers for retailers along the Idaho-Oregon border). To be among the list of the 10 most recent reviewers, the reviewer must have posted at least 5 reviews and there must be a clear modal location.

4 Results

4.1 Regional Marijuana Sales

Summary statistics for the regions in our analyses are in Table 1. The first panel reports statistics for all interior firms. These firms sold 3,544 kilograms of usable marijuana in the two months before Oregon's market opened, at an average price of $12.91 per gram. This translates into 0.34 grams of usable marijuana sold per capita per month. The next panel, Oregon's border region, reports similar per capita marijuana sales. The remaining panels categorize firms by county into firms along the Oregon, Idaho, and Canadian borders. Before Oregon's market opened, sales along the Idaho border amounted to 0.91 grams per capita per month – almost three times as large as sales along the Oregon border. Use rates along the Idaho border are only 20 percent higher than along the Oregon border, suggesting that variations in local demand cannot explain the observed per capita differences. We take this as evidence that cross-border shopping along the Oregon border is lower than along the Idaho border, although it is difficult to rule out all alternative explanations based on this evidence alone.

In the two months after Oregon's market opened, the marijuana sold per capita per month fell along the Oregon border to 0.23 grams, while sales stayed relatively constant elsewhere: firms in the interior sold 0.38 grams per capita per month and firms along the Idaho border sold 0.96 grams per capita per month. We interpret this as an indication that Oregon's market opening led to a drop in sales in Washington counties that border Oregon.

4.2 Oregon's Market Opening

Table 3 reports estimates of the effect of Oregon's legalization on marijuana sales in Washington based on the approaches discussed in Sections 3.1 and 3.2. Each coefficient in the table is the treatment effect of Oregon's legalization estimated via separate regressions. Columns (1) through (4) investigate the effect of legalization on different outcomes: the weight of usable marijuana, total transaction counts, revenue from marijuana concentrates, revenue from edibles, and the average price per gram. Because the outcome in each regression has been transformed by the natural logarithm, the coefficients in the table reflect the percentage changes in the dependent variable due to Oregon's legalization. Figure 3 illustrates the predicted model fits relative to the raw data for each of our outcome variables for both the Oregon border and Washington interior regions.[18] Shifts in marijuana sales in Oregon are evident, while the sales appear essentially unchanged in the Washington interior.

The rows of Table 3 Panel A report our regression discontinuity estimates (with week as the running variable) for each region of the state. Across the four regions, only the Oregon border shows a consistently significant drop in sales following the opening of recreational stores in Oregon. The optimal bandwidth is 8 weeks, providing a total of 17 observations – the extra observation comes from the week of legalization where the running variable is equal to zero. The point estimates suggest that the weight of usable marijuana sold in the Oregon border region fell by 38 percent after Oregon's market opened, while the count of sales fell by 32 percent. Revenues from concentrates and edibles fell by 18 percent and 12 percent

[18] We follow the approach recommended by Calonico et al. (2015) and fit a 4th order polynomial on each side of the discontinuity. While this does not perfectly mirror the results in the tables, they suggest this provides a more global view of the potential shift relative to the entire data series. Appendix Figure A.2 illustrates outcomes in the Idaho and Canadian border regions.

respectively. Notably, edibles and concentrates were not available in Oregon in October 2015 (though they are today), which could in part explain why sales of those products fell by a smaller margin than usable marijuana. In other regions of the state, the estimated decreases are small and largely imprecise. Only one of the estimates approaches significance, which we would expect when testing 12 coefficients even when the null is true.

Panel B reports estimates based upon our differences-in-discontinuities approach – these are our baseline estimates. These are formed by including observations from the Washington interior region in the same regression with the different border regions – one could also construct the point estimates by subtracting the estimates from the Washington interior from the estimates from the other regions of the state. The point estimates from this approach suggest that the weight of usable marijuana sold fell by 36 percent in the Oregon border region, and the count of sales declined by 28 percent, and revenues from concentrates and edibles fell by 16 percent and 10 percent, respectively. In the other border regions of the state, the estimated declines are small, and mostly indistinguishable from zero. We do find a marginally significant 8 percent decline in revenues from edibles along the Canadian border, but again this result may be spurious given the number of hypotheses we test.

To summarize, Oregon's market opening provides quasi-experimental evidence of the prevalence of cross-border sales. Our estimates suggest that weight of usable marijuana sold in stores near the border fell by 36 percent. The estimates produced using the regression discontinuity in time and the differences-in-discontinuities approaches are nearly identical. Our findings also suggest that the decline in usable marijuana sales was larger than the decline in sales of other marijuana products, concentrates and edibles, which were not available when retailers first began recreational sales.

Column (5) of Table 3 estimates the effect of Oregon's market opening on the price of marijuana sold.[19] The point estimates are generally small across all regions in Washington, suggesting the Oregon border did not experience sizable changes in its market other than the amount of marijuana sold. The quantity reductions we observe in Columns (1)-(4) plausibly stem from a demand shock. Furthermore, it is plausible that the policy change did not affect the costs of marijuana production. Under the assumptions that the price elasticity of demand does not change across retailers (i.e. that the demand shock is a constant level shift) and marijuana is supplied through a competitive market, these estimates may be combined with the price estimate to infer a supply elasticity of 10.

In practice, however, it is likely that the supply chain of marijuana involves a number of frictions: in the short run, individual producers and processors are limited in capacity due to their installed capital (i.e. greenhouses, drying rooms, extraction machines) and the market as a whole may be capacity constrained due to regulatory caps on the number of licenses and congestion in potency testing. These constraints may bind during a positive demand shock, which would lead to an asymmetric supply response. Furthermore, if retail competition is imperfect and firms are engaged in strategic interactions, policy changes have ambiguous price effects – it is difficult to interpret price responses as movements along a supply curve. Finally, it is possible that the remaining shoppers have different price elasticities of demand – for instance, local purchasers may be willing to pay more to avoid travel costs, while cross-border shoppers may be willing to purchase from any retailer that offers considerable discounts for purchasing in bulk.[20] We thus interpret this elasticity at best as suggestive

[19] Appendix Table A.3 contains estimates for other outcomes including measures of marijuana potency and inventory levels.

[20] We have also estimated models examining the effects on prices at the product level, which hold constant unobserved product attributes such as quality, and find essentially identical estimates to those we report in

evidence that the supply of marijuana is elastic in the short-term in response to a negative demand shock.

4.3 Robustness, heterogeneity, and other outcomes

Our identification strategy and estimates may be subject to a variety of concerns, including the possibility of treatment phase-in, our choices of polynomial order and bandwidth, and treatment effect heterogeneity. In this section, we explore the robustness of our estimates to these concerns by modifying our specifications and find that our estimates are highly robust.

If treatment effects phase in over time—if the effects are smaller the week Oregon's market opens and larger in subsequent weeks—then RD estimates are biased downwards. We investigate if this substantially affects both our RD and differences-in-discontinuities approaches by implementing 'donut' regressions (Barreca et al., 2011), in which the first week of treatment is removed.[21] The results are reported in Table 4, which reproduces the structure of Table 3. In general, the estimated effects are slightly larger. The point estimates from the RD approach (Panel A) suggest that along the Oregon border, the weight of usable marijuana sold fell by 45 percent, the count of sales declined by 36 percent, and revenues from concentrates (edibles) fell by 25 percent (15 percent). The point estimates from the differences-in-discontinuities design are also slightly larger. Those estimates suggest that the weight of usable marijuana sold fell by 41 percent, the count of sales declined by 31 percent, and revenues from concentrates (edibles) fell by 25 percent (15 percent). Once

Table 3.

[21] This approach is related to an interrupted time series (ITS) approach which, rather than estimating the level shift near legalization, estimates the deviation observed from the pre-period trend over a longer time horizon. The estimated distributed lag coefficients and confidence intervals based on the ITS approach are provided in Figure A.7. They suggest a drop in sales of up to 55% in the first weeks following legalization. This effect shrinks slightly over time.

again, the point estimates for either approach suggest that other regions of the state were largely unaffected by Oregon's legalization. While these results suggest that there was a small phase-in period, the estimates of Table 3 and Table 4 are not significantly different from each other.

In Figure 4 we explore the robustness of our estimates to local polynomial choice and the bandwidth selection criterion. We focus on estimates of the change in the log weight of usable marijuana sold in the Oregon border region. Panel A reports RD estimates, while Panel B presents results from differences-in-discontinuities models. Increasing the order of the polynomial results in slightly smaller point estimates, although they remain statistically different from zero and overlap with each other. Using the bandwidth selection criterion of Ludwig & Miller (2007) and Imbens & Kalyanaraman (2012) results in slightly larger bandwidths – 20 and 25 weeks, respectively – and larger point estimates. Again, the estimates using all three approaches are not significantly different from each other. In short, our results are both qualitatively and quantitatively similar over polynomial choices and bandwidths. Moreover, our preferred estimates from the previous section tend to be in the middle of the range of values generated by these alternative specifications.

We explore the heterogeneity of the effect across transaction sizes in Figure 5. We focus on the Washington interior and Oregon border regions. In addition to testing the robustness of our results, this can help to identify potential mechanisms. If our results were driven by marijuana tourism – i.e. individuals coming to Washington, consuming marijuana there, and then returning home – we would expect to see the largest declines in the number of small transactions, such as those involving 1 gram or less of marijuana. On the other hand, if individuals are purchasing marijuana in Washington and bringing it back to other places

where it is illegal for longer-term consumption or distribution, then we would expect to see large effects for large transactions. Along the Oregon border, we find the estimated decreases in marijuana sales are close to zero for smaller transactions, and grow in the transaction size. The estimate is 46 percent for sales ranging from 3.5 grams to 6 grams and 58 percent for sales larger than 6 grams. This is consistent with individuals stockpiling for later consumption.

We explore heterogeneity by retailer by estimating retailer-specific models using a RD design. We fix the bandwidth to facilitate the comparison across stores. Figure 6 plots the estimated retailer-level responses separately along with the 95 percent confidence interval for firms within 100 miles of the nearest border crossing. We also plot a quadratic curve fitted to these estimates to illustrate the distance gradient. The estimated effect of Oregon's legalization becomes negligible at distances beyond 20 miles.[22] Note however, the firm level estimates do not necessarily imply that those engaging in cross-border shopping were only coming from nearby regions – it only implies that that upon arriving in Washington they shopped near the Washington-Oregon border. The analyses in the following section provide additional insights into how far cross-border shoppers may be willing travel to purchase recreational marijuana.

4.4 Google Review Analysis

Figure 7 reports the percentage of Google reviews for stores in border counties coming from reviewers residing in neighboring states following the approach detailed in Section 3.3. Each

[22]Figure A.3 reports these results on a map of Washington. Darker colors indicate a more negative point estimate (i.e. a larger estimated decline in sales). The largest declines are in the Oregon border region, while the magnitude of coefficients follows a white noise pattern in other parts of the state. Figure A.4 colors locations according to the t-statistic of the point estimate – darker colors indicate a larger t-statistic and therefore greater significance. As with the point estimates, significance is only consistently found near the border.

panel in the figure reports results for different state pairs: Washington-Idaho, Idaho-Oregon, Massachusetts, and Oregon-Washington. Overall, this approach suggests 61.8 percent of recent reviewers for marijuana dispensaries in Washington reside in Washington, 24.0 percent reside in Idaho, 4.9 percent reside in Montana, 1.8 percent reside in Oregon, and 7.6 percent reside in other locations. If reviewers are proportionate to shoppers, these results suggest that 38.2 percent of transactions along the Idaho-Washington border come from cross-border shoppers. This fraction is similar to, but slightly higher than, our Washington-Oregon border estimate.

Idaho borders both Washington and Oregon to the west. We find that 81 percent of Google reviewers for marijuana stores along Oregon's border with Idaho reside in Idaho. This is much larger than the Washington-Idaho border and the difference is likely driven by population differences – eastern Oregon is more rural than eastern Washington, and Boise, Idaho's largest city, is near the Idaho-Oregon border. Another 10 percent of the reviewers reside in Oregon, and 9 percent of the reviewers reside in other locations.

Given Washington is only one of the states with a legal recreational marijuana market, we extend our Google review approach to Massachusetts. Among states with a legal market, Massachusetts is unique due to its relatively small size and numerous neighbors with restrictive marijuana laws. While some neighboring states in the region allow for medical use and/or have decriminalized recreational use, none offer legal sales and the medical regimes are restrictive (typically only allowing prescriptions for terminal conditions.) Given the limited availability of recreational and medical marijuana, and many nearby population centers, we might expect the cross-border shopping incentives to be stronger than those along the Oregon-Washington border. Recent Google reviewers support this hypothesis: 54.5 percent

of recent Google reviewers for marijuana retailers in border regions reside out-of-state. When broken down by region, the modal out of state purchaser is from New York (14.9 percent), followed by Connecticut (10.5 percent), then New Hampshire and Vermont (9.1 percent), Rhode Island (4.7 percent), and the residual residing in other locations. While this breakdown of Google reviews is not quasi-experimental, it offers supporting evidence cross-border shopping is happening in other regions and may be larger than the already sizeable spillovers we find using Oregon's legalization.

4.5 Measuring *de facto* Legalization and Revenue Implications

The magnitude of the cross-border shopping behavior we estimate, across both the quasi-experimental approach in Section 4.2 and the review approach in Section 4.4, suggests that this behavior plays a substantial role in the overall market for marijuana across all jurisdictions, regardless of local legal status. In this section, we focus on two implications of our main results. First, we investigate the extent to which legalizing marijuana in one state creates access for residents of neighboring states where marijuana is illegal – we refer to this access as *de facto* legalization.[23] Second, we measure the tax revenue earned by a legalizing state from cross-border shoppers.

To address the question of *de facto* legalization, we compare the home-state shares of border region Google reviews to their population shares. Given that some major population centers from regions without recreational marijuana are not always a border county (particularly for Portland and its greater metropolitan statistical area), but are within a rea-

[23]The term "*de facto* legalization" has also been used to refer to loosely regulated medical markets (Anderson & Rees, 2014; Fischer et al., 2015).

sonable driving distance, we define neighboring counties as those within 90 minutes driving time from a recreational marijuana retailer. This also corresponds with the driving distance from Boise to Huntington, a region with marijuana retailers whose revenues, anecdotally, are driven entirely by cross-border shopping.

Figure 8 presents these comparisons. Panels A-D respectively illustrate data for the Washington-Idaho, Washington-Oregon, Massachusetts, and Washington-Oregon border regions. Column (i) contains the Google reviewer shares for home and neighboring border regions, and Column (ii) contains population shares for the same regions. If usage and review rates were identical, then this would suggest that locals and those from out of state enjoy equal access to legal marijuana. However, in each case the population share for the region with legal marijuana is smaller than the Google reviewer share. Next we construct a relative visitation parameter by combining these two different shares to compare the cross-border shopping rates relative to their populations across regions.

We estimate the relative visitation rate of those from border regions, and thus the *de facto* legalization rate, by calculating an α such that $\alpha * \frac{Google\_Legal}{Pop\_Legal} = \frac{Google\_Neighbor}{Pop\_Neighbor}$. Assuming Google reviews are a proxy for marijuana purchases, if α=1 then local consumers where marijuana is legal and those across state lines purchase at identical rates. If $\alpha = 0$, then neighbors never purchase marijuana across state boundaries. This approach ignores both the potential for stockpiling and legal incentives (i.e. cross-border shoppers may write reviews at a lower rate than other shoppers out of fear that such reviews may be construed as evidence of an illegal activity), suggesting our estimates should be viewed as lower bounds. For the Washington-Oregon border we want to estimate the relative visitation of Oregonians to Washington prior to Oregon's legalization. To do this, we add our estimate of the decrease

in marijuana sales after Oregon's legalization (36 percent) to Oregon's recent Google review share along the Oregon-Washington border.

Figure 9 provides estimates of the effective legal access across the borders in our study. For Idaho, *de facto* legal access reaches 72.5 percent in the north (Washington-Idaho border), and 52.7 percent in the South (Idaho-Oregon border). Residents in the region around Massachusetts enjoy roughly 43.9 percent of the access local residents have. We estimate the degree of cross-border shopping was much smaller for the Washington-Oregon region, with Oregon residents visiting at only 17.8 percent of the rate of local Washingtonians. This is consistent with the hypothesis that Oregon's medical market at least partially acted as a *de facto* legal marijuana market for many recreational consumers willing to pay a $200 fee to obtain a medical marijuana user license.

We estimate the total revenue Washington has received from cross-border shopping using both our differences-in-discontinuities estimates and the Google review shares. In Table 5 we report Washington marijuana tax revenue in the two months leading up to Oregon's market opening. We report figures statewide, for the Oregon border region, and for the Idaho border region. For the Washington-Oregon border, if we consider only the differences-in-discontinuities estimate from Oregon's legalization, we conclude that Washington collected $947,130 due to cross-border shoppers from Oregon. If we also include the estimated cross-border shopping from the Google review data (i.e. the cross-border shopping that remains today), Washington's cross-border earnings grow to $1,156,551. For the Washington-Idaho border, we use Google reviewer data alone and estimate that Washington collected $1,079,780 from Idaho residents and $639,769 from residents of other locations.

These results suggests that in the two months prior to Oregon's legalization, as much

as 11.5 percent of Washington's marijuana tax revenue came from cross-border shoppers. If we aggregate these patterns over the lifetime of Washington's legal market from July 2014 through the end of Fiscal Year 2018, we conclude that out of the $923 million in marijuana excise taxes collected by Washington, between $43.6 and $74.8 million were collected from cross-border shoppers.[24]

Framed differently, this revenue earned by Washington represents revenue forgone in the regions where cross-border shoppers reside as a consequence of the decision to maintain the prohibition on recreational marijuana. Indeed, though the cities of rural eastern Oregon originally voted against legalization and initially banned entry, many localities have reversed course after observing the size of the forgone revenue. With this framing in mind, our estimates suggest that residents from Idaho have paid $43.8 million in Washington taxes and $9.2 million in Oregon taxes.[25] This suggests that if Idaho had legalized marijuana at the same time as Washington, the state could have collected at least $53 million in marijuana taxes by the end of June 2018. Given the travel time to the border marijuana retailers, which for some regions was two to three hours round trip, and the potential for additional tax revenue from other regions of the state further from the border, we view this estimate as a lower bound.

[24]The lower bound comes from (1) using only the natural experiment estimates for Oregon and assuming that all Oregon-Washington cross-border behavior stops after Oregon's market opens and (2) using the Google reviewer data for Idaho alone to calculate the Idaho-Washington market opening. The upper bound is calculated using (1) both the natural experiment data and Google review data for the Oregon-Washington border and (2) using all non-Washington Google reviews for the Idaho-Washington border.

[25]The Oregon estimate is based on our Idaho-Oregon Google review data, and data from the Oregon Liquor Control Commission on tax earnings from Baker County.

5 Conclusion

The ability of a federal government to efficiently delegate responsibility depends partly upon the degree to which citizens are able to engage in arbitrage across local borders and the degree to which the government can enforce decisions within those borders. The *de facto* partial prohibition of marijuana in the U.S., despite *de jure* total prohibition, is a prime example of these tensions. Though public opinion has consistently shifted in favor of legalizing marijuana and states began legalizing marijuana for medical use in 1996, arrests for marijuana-related crimes exceeded those for all violent crimes as recently as 2015 (Williams, 2016). Furthermore, the burden of marijuana prohibition has fallen largely on people of color, who are arrested for marijuana-related crimes at much higher rates than whites despite similar consumption rates (Matthews, 2013). Though the federal government has recently taken a more passive approach and effectively allowed individual states to choose policies independently, claims of spillovers have led to state-level conflict (Ingold, 2014).

We show this state-by-state roll-out does indeed come with spillovers in the form of cross-border shopping. The sequential opening of markets in neighboring states provides a natural experiment for measuring the extent of this behavior. We find that sales in Washington along its border with Oregon dropped by 36 percent when Oregon's market opened. Using Google review data to estimate relative visit frequency in other regions, we find people residing in states surrounding Massachusetts enjoy nearly half of the access to legal marijuana that locals have, while residents of Idaho visit at 53 to 73 percent of the frequency that local residents shop at marijuana retailers.

Spillovers may provide strong pro-legalization incentives to states; we find that as much

as 8.1 percent of Washington's marijuana tax revenue to-date has come from cross-border shoppers. Analogous to the oft-cited 'race to the bottom' in tax policy, there may be a 'race to legalize' driven by the ability to collect revenues from one's neighbors (or recover revenues being lost to a neighboring state which has already legalized). Whether all states ultimately act to legalize marijuana on their own depends partly on the market power in the industry (Agrawal & Trandel, 2017) as well as the costs of cross-border shopping. If and when the federal government decides to de-schedule marijuana and collect its own excise tax, that tax will create vertical externalities on the revenue streams of states. For example, Fredriksson & Mamun (2008) find that cigarette taxes in states come down by roughly 48 cents in response to a $1 increase in the federal excise tax rate. Canada, which has legalized marijuana at the federal level, has addressed this concern in part by allocating a portion of federal tax revenue to provinces.

Our findings, particularly with respect to the differences between the Oregon and Washington border and other regions suggest that the western United States may experience less cross-border shopping overall relative to the rest of the country. Although the opening of California's market may have dramatically increased the supply of legal marijuana in the U.S., California is surrounded by states where marijuana is legal – for recreational use on 81 percent of its borders (Oregon and Nevada), and for medical use on the remaining 19 percent (Arizona). We find evidence of plentiful cross-border shopping in Massachusetts, and it might also be common in states like Illinois, Michigan, New Jersey or Pennsylvania, states whose neighbors also have not legalized marijuana for recreational use, and whose medical marijuana regimes are relatively restrictive. Indeed, several media outlets have reported on cross-border shopping between New York and Massachusetts (Cropley, 2019; Fenton &

Golding, 2019; McKay Wilson, 2019). As more states legalize marijuana, the balance of incentives may change. In situations where marijuana is legal both locally and in neighboring jurisdictions, cross-border shopping may drive states to compete on tax rates or regulatory frameworks. In other words, cross-border shopping may be driven by the extent to which the grass is greener (or perhaps cheaper) on the other side.

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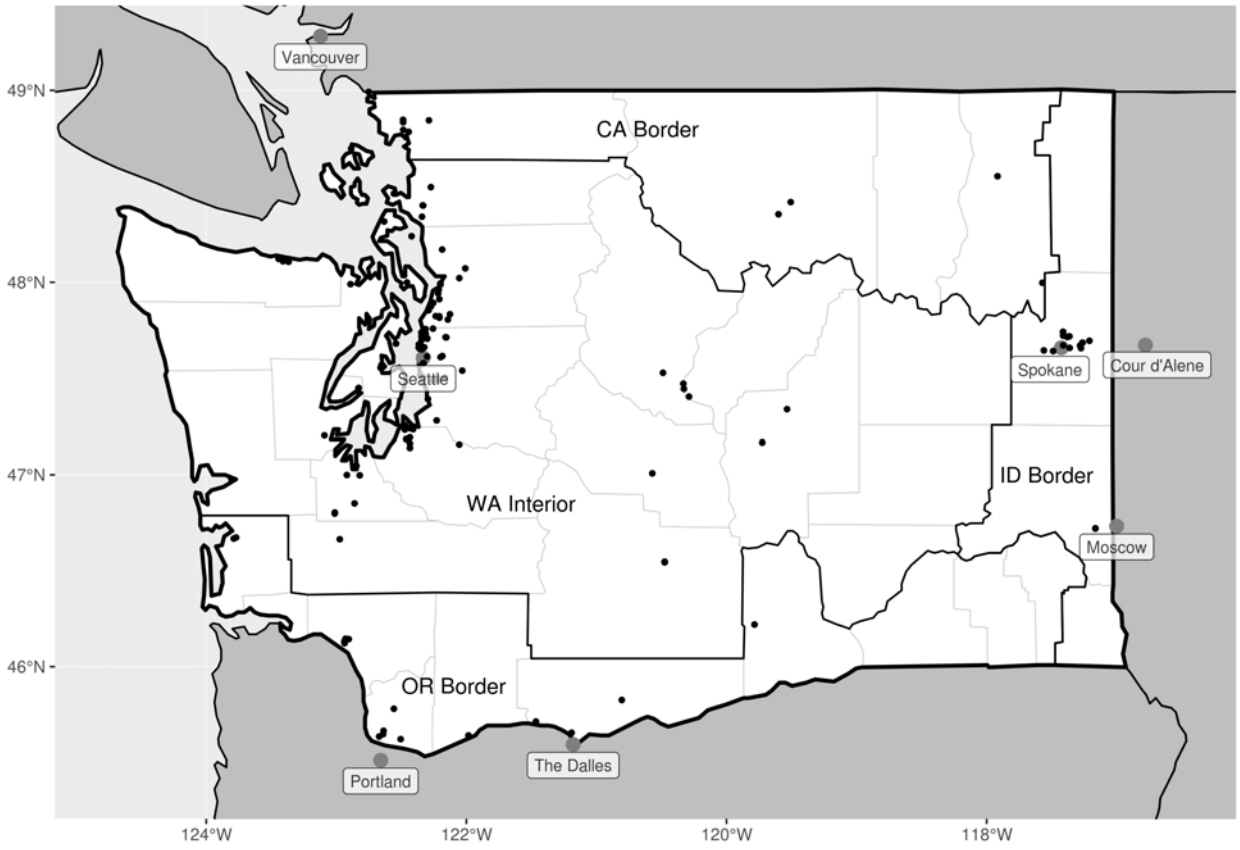
6 Figures and Tables

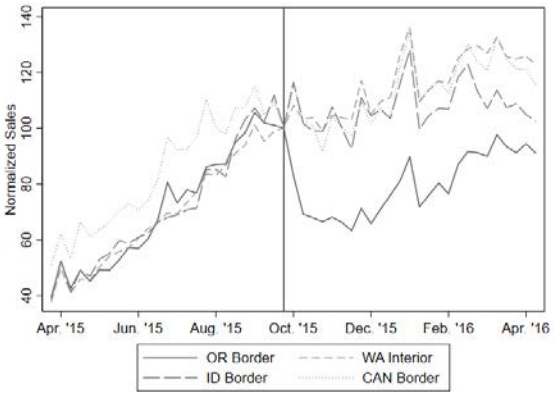
Figure 1: Marijuana retail locations in Washington at the time of Oregon's market opening



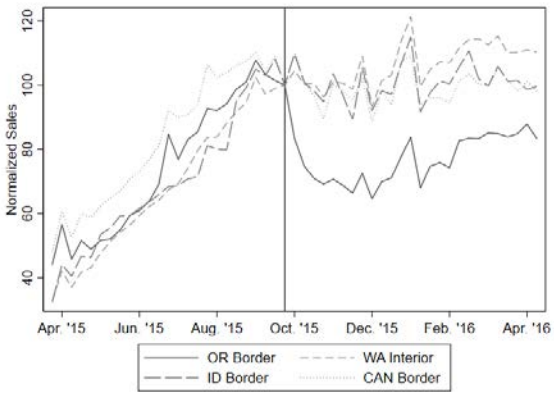
Notes: This map shows the locations of all marijuana retailers included in our analysis. Black lines denote region boundaries.

Figure 2: Marijuana Sales by Washington Region near Oregon's Market Opening

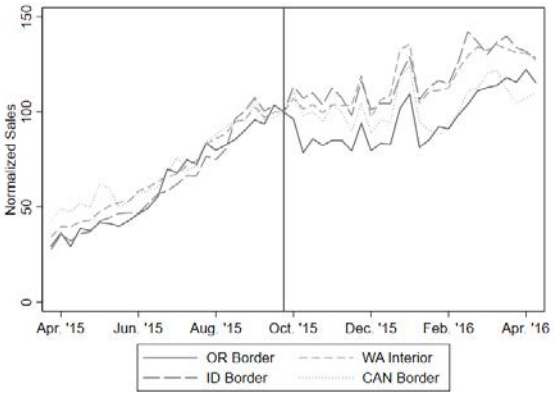
(a) Usable Marijuana (Weight)



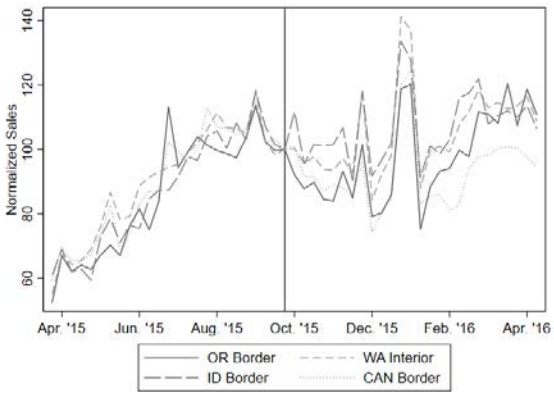
(b) Usable Marijuana (Number of transactions)



(c) Concentrates (Revenue)

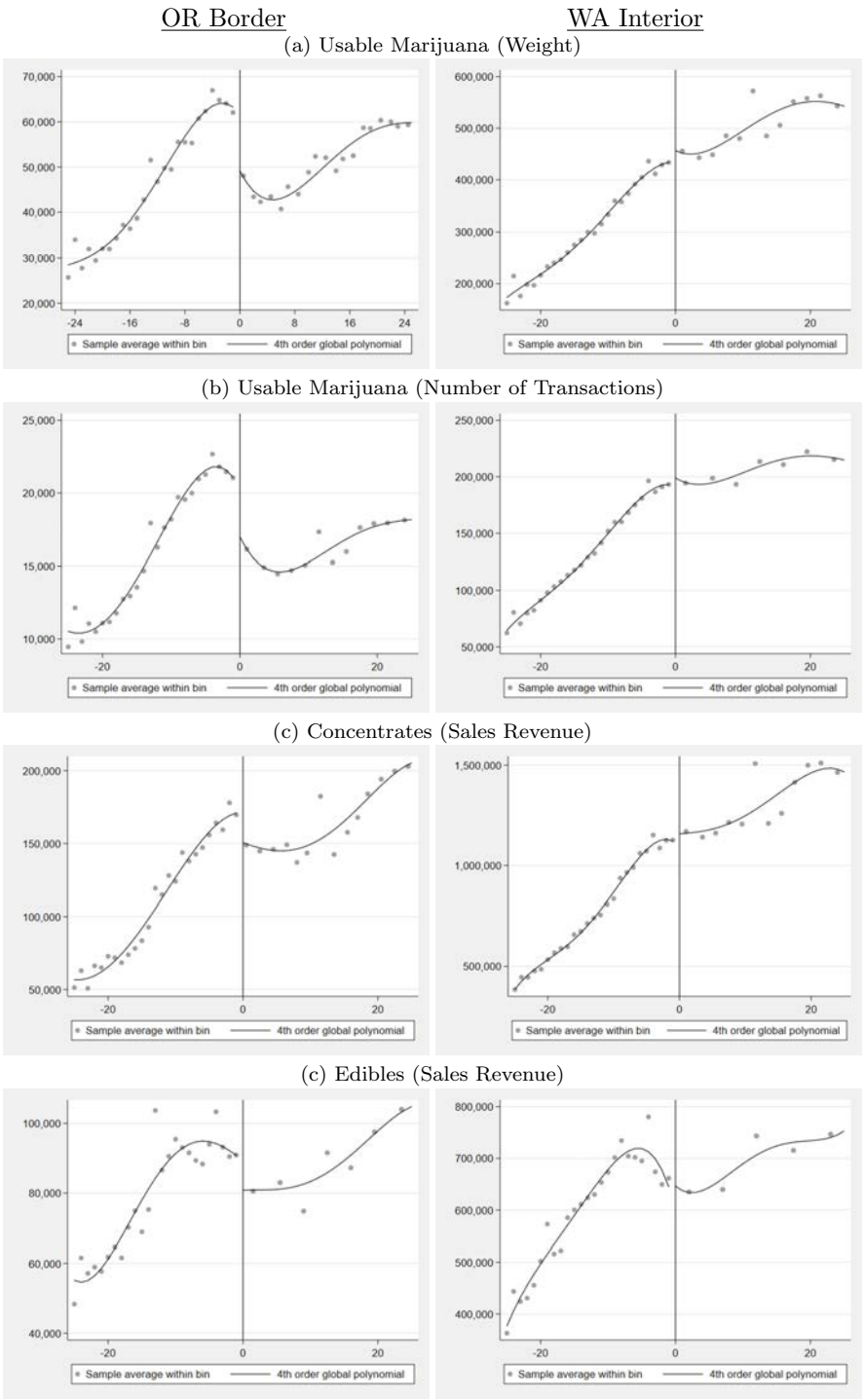


(d) Edibles (Revenue)



Notes: These figures illustrate trends in the marijuana market in four regions of the state: the interior, the Oregon border, the Idaho border, and the Canadian border. The sales in each region are normalized to the week before legalization – sales in that week equal 100 by construction.

Figure 3: Washington Market Outcomes around Oregon's Market Opening

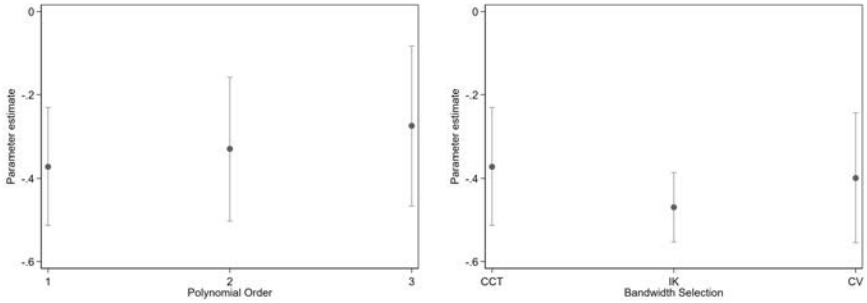


Notes: These figures illustrate trends in the sales of marijuana. The horizontal axis is the week relative to Oregon's market opening. The left-hand side graphs illustrate outcomes in the Oregon border region, and the right-hand side graphs illustrate outcomes in the interior region. Dots illustrate the raw data at the region-week level. The line is a global 4th-order polynomial fit based on the approach of Calonico et al. (2015).

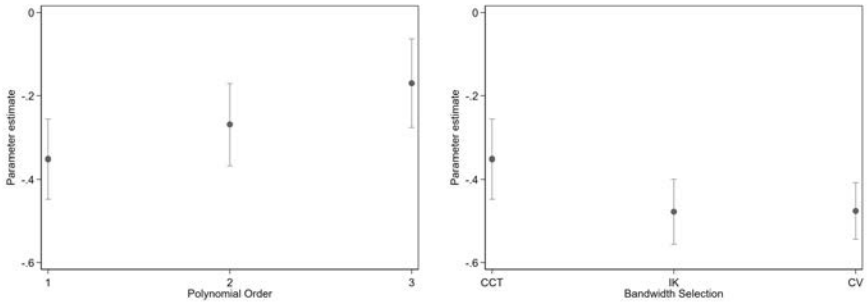
Figure 4: Robustness to Local Polynomial and Bandwidth

Polynomial Choice | Bandwidth Selection

(a) Regression Discontinuity

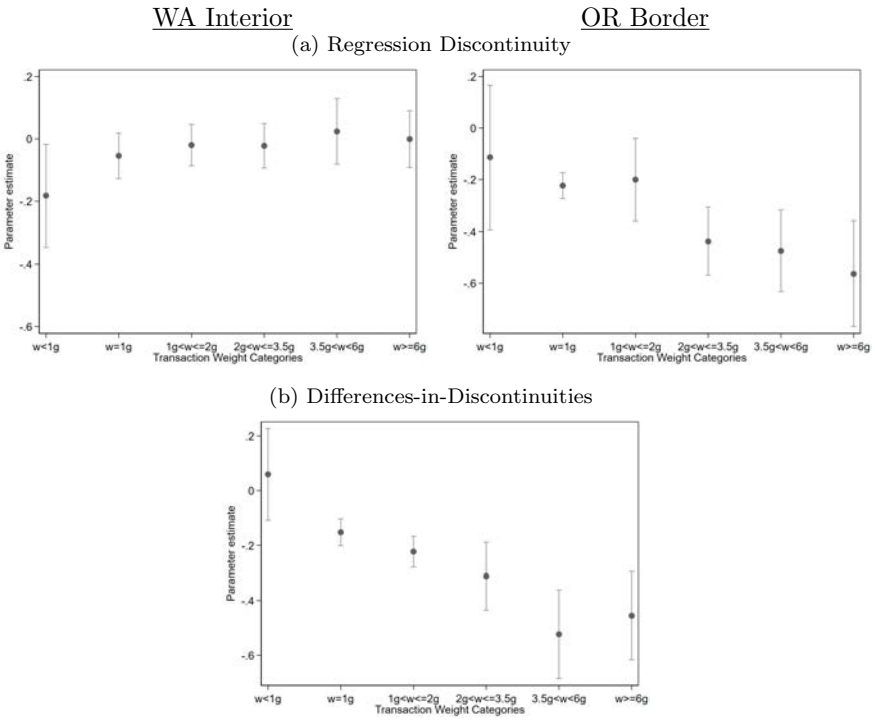


(b) Differences-in-Discontinuities



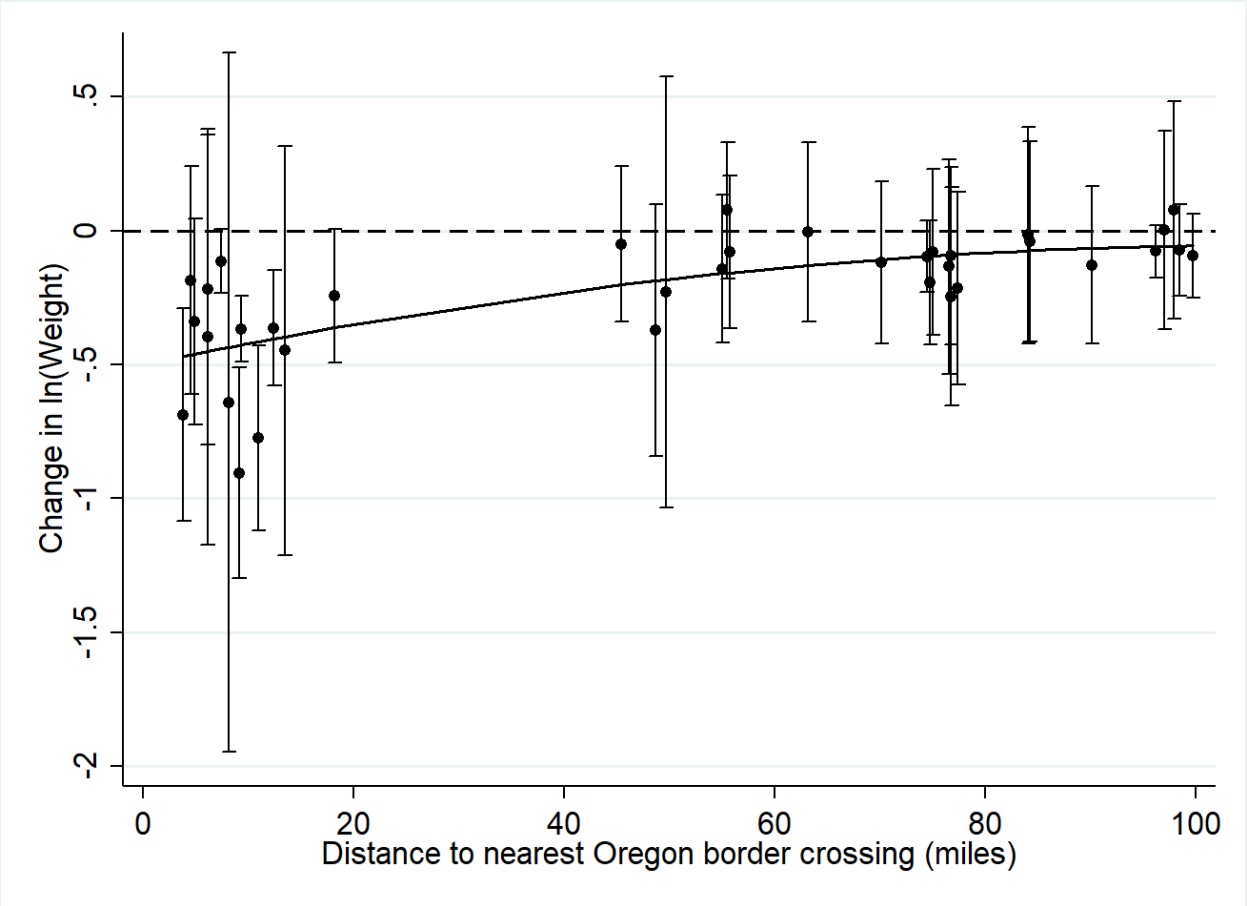
Notes: These figures illustrate the robustness of our regression discontinuity and differences-in-discontinuities estimates of the change in the log weight of usable marijuana sold when Oregon started selling marijuana. The figures report the point estimates and 95% confidence intervals across a variety of polynomial orders and bandwidth selection procedures. When the polynomial is varied, the bandwidth is at 8 weeks. When the bandwidth is varied, the polynomial is fixed at 1st-order. CCT refers to Calonico et al. (2014), IK refers to Imbens & Kalyanaraman (2012), and CV refers to the cross validation procedure suggested by Ludwig & Miller (2007).

Figure 5: Heterogeneity by Transaction Size



Notes: These figures report the point estimates and 95% confidence intervals for regression discontinuity and differences-in-discontinuities models that estimate the change in the weight of usable marijuana sold across six transaction categories: less than 1 gram, 1 gram, 1 to 2 grams, 2 to 3.5 grams, 3.5 to 6 grams, and 6 grams or more. The model estimates seen here follow the bandwidth selection approach of Calonico et al. (2014).

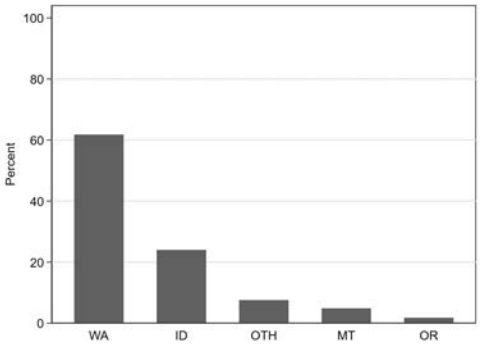
Figure 6: Location-level estimates of change in weight sold



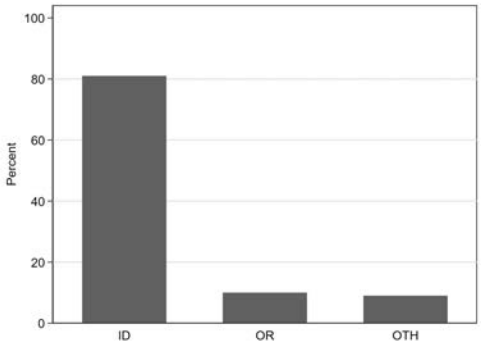
Notes: This figure plots the response (and 95 percent confident interval) to Oregon's market opening for each individual retail location within 100 miles of the Oregon border. The response for each retail location is estimated separately using the estimating equation 1. A quadratic line is fitted through these individual location estimates.

Figure 7: Google Reviewer Shares for Border Regions

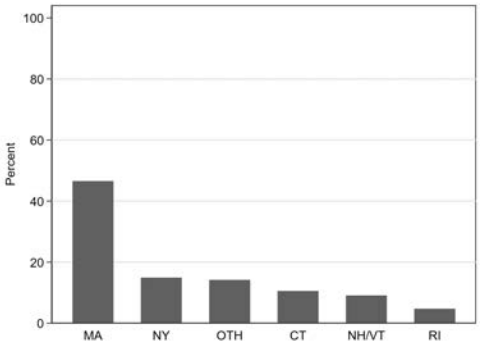
(a) WA-ID Border Region



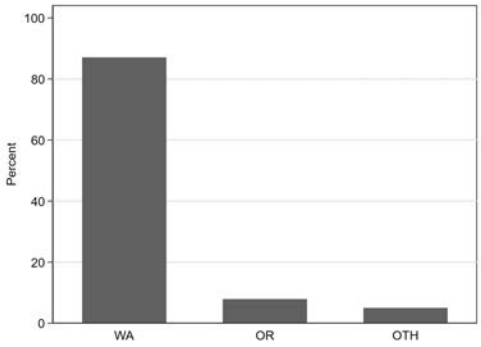
(b) OR-ID Border Region



(c) MA Border Region

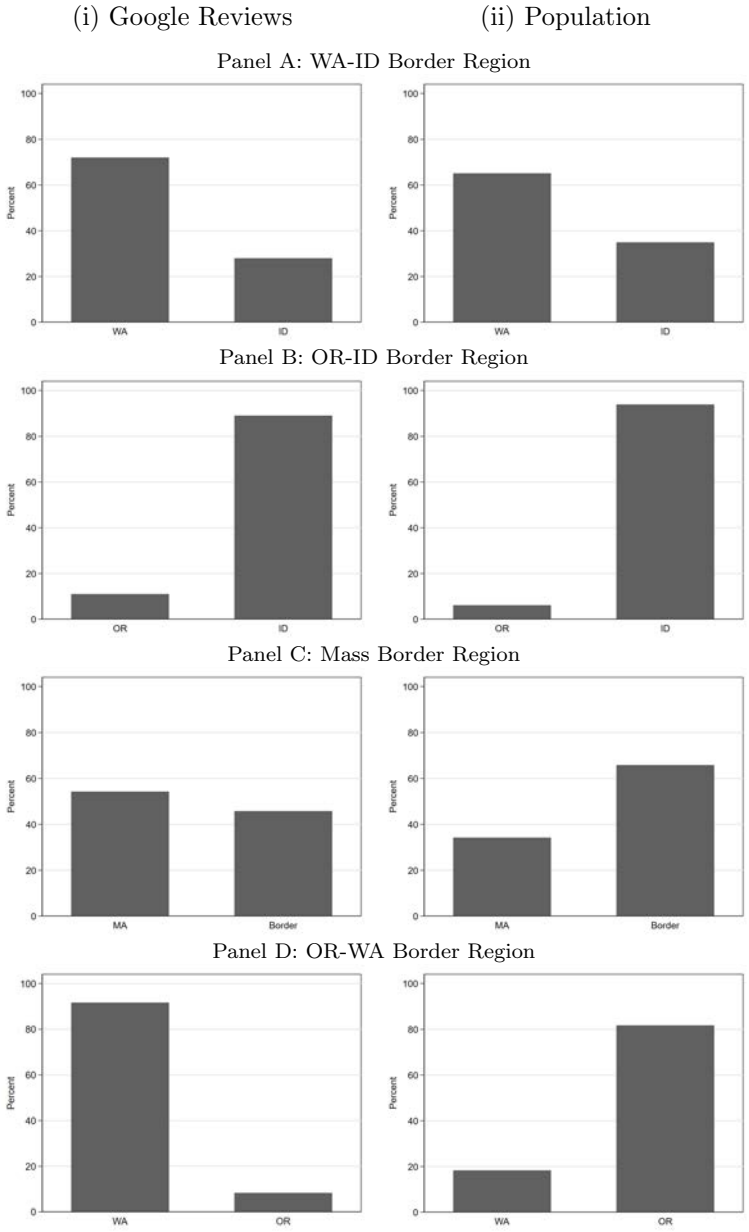


(d) OR-WA Border Region



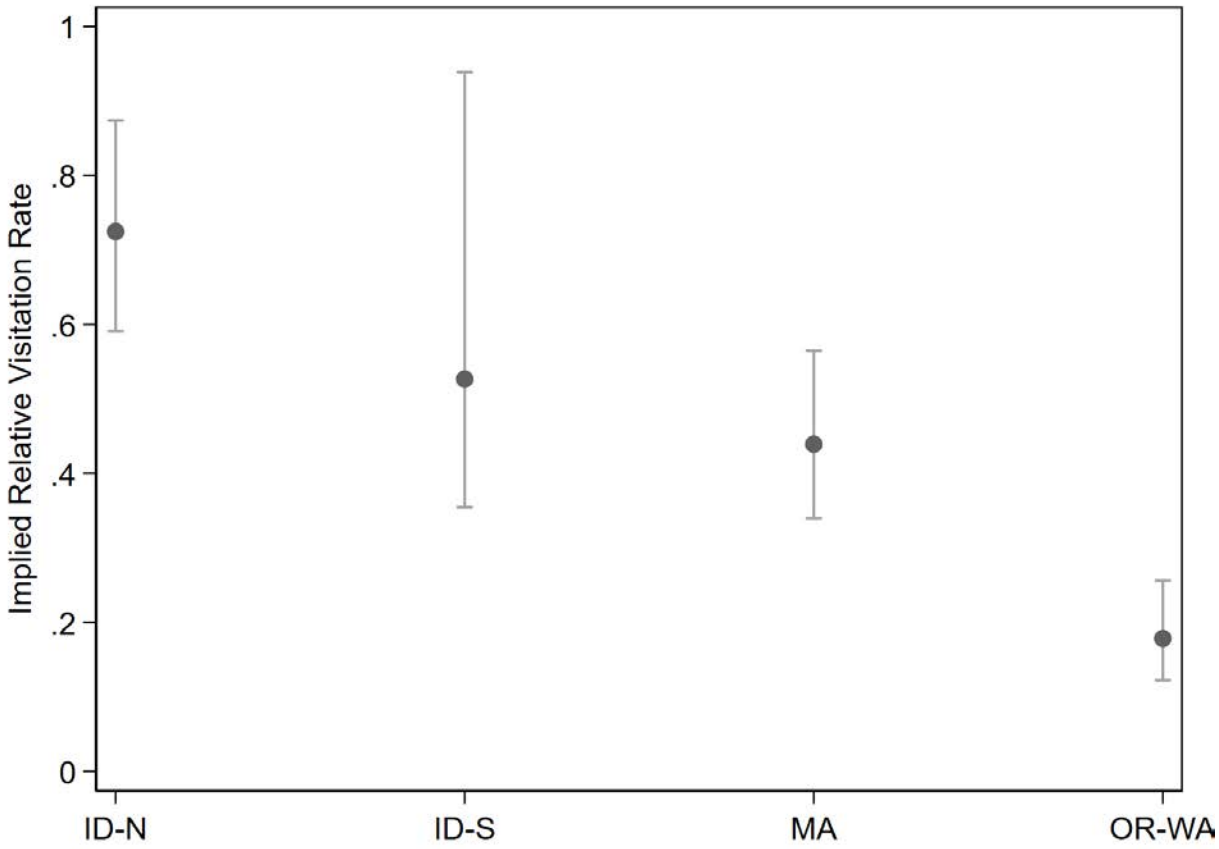
Notes: These figures report the home location for recent reviewers at marijuana retailers in border counties. For each retailer we drew a sample of the 10 most recent reviewers (40 recent reviewers for retailers along the Idaho-Oregon border). For those reviewers, their "home" location is based on their modal review location, provided they have at least 5 reviews shared on Google.

Figure 8: Google Reviewer Shares vs. Population Shares for Border Regions



Notes: These figures compare Google review shares and population shares for neighboring counties. The figures in Column (i) report Google review shares, while the figures in Column (ii) report population shares based recent data from the American Community Survey. The Google review shares are based on the predicted home location for recent reviewers at marijuana retailers in border counties in states where recreational marijuana is legal. For each retailer we drew a sample of the 10 most recent reviewers, except for the eastern Oregon retailers were we drew samples of 40 (as there were only 5 retailers). For those reviewers, their "home" location is based on their modal review location, provided they have at least 5 reviews shared on Google. "Neighboring counties" are defined by all counties within 90 minutes of recreational marijuana retailer.

Figure 9: Implied Relative Visitation Rate for Individuals Residing in Border Regions



Notes: This figure plots the implied visitation rate for individuals in border regions in Idaho, Massachusetts, and Oregon. A value of one would suggest individuals in border regions visit stores in equal rates to those living in those regions. The Idaho North (ID-N), Idaho South (ID-S) and Massachusetts (MA) visitation rates are calculated by scaling the relative Google review share by the border county population share. The Oregon visitation rate is calculated by adding the Google review share to the estimated reduction in sales due to Oregon's legalization based on our differences-in-discontinuities estimates. The dots represent point estimates and the whiskers represent a 95% confidence interval based on Wild bootstrap resampling with 1000 replications.

Table 1: Weight Sold and Population across Washington Regions

	Pre-OR Legal	Pre-OR Mkt. Open	Post-OR Mkt. Open
		Interior	
Total Weight (in grams over two months)	2,128,930	3,543,950	4,054,352
Average Tax-Inclusive Price	$13.67	$12.91	$12.55
Market Share	0.670	0.665	0.704
Total Population	5,268,793	5,268,793	5,268,793
Population Share	0.754	0.754	0.754
Men 20-24 Share	0.736	0.736	0.736
Past Month Marijuana Use	0.126	0.126	0.126
		Oregon Border	
Total Weight (in grams over two months)	302,977	529,850	384,862
Average Tax-Inclusive Price	$14.07	$13.42	$12.45
Market Share	0.095	0.099	0.067
Total Population	854,462	854,462	854,462
Population Share	0.122	0.122	0.122
Men 20-24 Share	0.110	0.110	0.110
Past Month Marijuana Use	0.115	0.115	0.115
		Idaho Border	
Total Weight (in grams over two months)	597,980	1,020,964	1,090,151
Average Tax-Inclusive Price	$11.87	$11.91	$11.47
Market Share	0.187	0.192	0.189
Total Population	562,577	562,577	562,577
Population Share	0.081	0.081	0.081
Men 20-24 Share	0.103	0.103	0.103
Past Month Marijuana Use	0.138	0.138	0.138
		Canadian Border	
Total Weight (in grams over two months)	148,747	235,740	228,208
Average Tax-Inclusive Price	$13.02	$12.13	$11.47
Market Share	0.047	0.044	0.040
Total Population	299,632	299,632	299,632
Population Share	0.043	0.043	0.043
Men 20-24 Share	0.055	0.055	0.055
Past Month Marijuana Use	0.125	0.125	0.125

Border regions consist of those counties along the relevant border; the interior consists of the remaining counties. See Figure 1 for a map. Corner counties (Asotin and Pend Oreille) are assigned to the Idaho border region; no retailers are in those counties. Pre-OR Legal calculates each row over the two months before Oregon legalized marijuana (May and June 2015). Pre-OR Mkt. Open calculates each row over the two months before Oregon opened its recreational marijuana market (August and September 2015). Post-OR Mkt. Open calculates each row over the two months after Oregon opened its recreational marijuana market (October and November 2015). Total weight is the total weight (in grams) of marijuana sold over the relevant two month window for the counties specified. Population share divides the total population in those counties by the total population in the state of Washington. Men 20-24 share divides the total applicable population in those counties by the total relevant population in Washington. Market share divides the total weight in those counties by the total weight in Washington. All population measures are derived from the 2015 American Community Survey. Past-Month Marijuana use comes from the National Survey of Drug Use and Health. The average tax-inclusive price is the average retail location price across the two-month interval.

Table 2: Pre-legalization transaction size distribution

	Avg. weight in bin (g)	Entire state	Borders			
			Interior	OR	ID	CAN
Weight $<$ 1g	.630	5.85	6.73	3.06	4.11	2.70
Weight $=$ 1g	1.00	33.84	35.28	23.74	28.43	44.86
1g $<$ Weight $\leq$ 2g	1.65	25.64	26.32	30.97	18.32	27.82
2g $<$ Weight $\leq$ 3.5g	3.12	19.46	18.09	19.44	28.64	13.29
3.5g $<$ Weight $\leq$ 6g	4.11	8.80	8.46	13.51	8.69	6.33
Weight $>$ 6g	12.25	6.41	5.12	9.28	11.81	4.99
Obs.	2,290,854	2,290,854	1,657,581	191,574	326,896	117,398

Notes: This table reports the distribution of transaction sizes (measured by the weight sold) for the entire state and the regions defined per Table 1. The data illustrated here consists of all transactions in the two months before Oregon's market opened. Transaction size shares are percentages.

Table 3: Regression Discontinuity Estimates of Oregon's Legalization on Washington's Sales

	(1) ln(Weight)	(2) ln(# Trans.)	(3) ln(Concentrates)	(4) ln(Edibles)	(5) ln(Price)
Panel A: Regression Discontinuity Estimates					
Washington Interior					
Treat	-0.020	-0.037	-0.020	-0.019	0.013
	(0.034)	(0.032)	(0.035)	(0.046)	(0.0067)
Oregon Border					
Treat	-0.38***	-0.32***	-0.18*	-0.12*	-0.018
	(0.068)	(0.050)	(0.071)	(0.045)	(0.0098)
Idaho Border					
Treat	-0.083	-0.11	-0.043	-0.016	0.013
	(0.082)	(0.070)	(0.066)	(0.064)	(0.014)
Canadian Border					
Treat	-0.032	-0.024	-0.030	-0.097*	-0.0033
	(0.071)	(0.054)	(0.050)	(0.045)	(0.015)
N	17	17	17	17	17
Panel B: Differences-in-Discontinuities Estimates					
Oregon Border					
Treat*ORBorder	-0.36***	-0.28***	-0.16**	-0.10***	-0.035**
	(0.043)	(0.029)	(0.056)	(0.017)	(0.011)
Idaho Border					
Treat*ID	-0.064	-0.069	-0.023	0.0021	-0.0032
	(0.061)	(0.049)	(0.044)	(0.043)	(0.013)
Canadian Border					
Treat*CAN	-0.012	0.014	-0.0093	-0.078*	-0.0087
	(0.044)	(0.034)	(0.028)	(0.028)	(0.015)
N	34	34	34	34	34

Notes: This table reports point estimates from regression discontinuity and differences-in-discontinuities models. Columns indicate different outcome variables; "Concentrates" and "edibles" refer to the total revenue from those products. Rows indicate estimates for the regions defined by Table 1. Bandwidths are selected following Calonico et al. (2014). *, **, ***, respectively indicate significance at the 5%, 1%, and 0.1% levels.

Table 4: Donut Regression Discontinuity Estimates of Oregon's Legalization on Washington's Sales

	(1) ln(Weight)	(2) ln(# Trans.)	(3) ln(Concentrates)	(4) ln(Edibles)
Panel A: Regression Discontinuity Estimates				
Washington Interior				
Treat	-0.049	-0.054	-0.042	-0.036
	(0.034)	(0.036)	(0.041)	(0.061)
Oregon Border				
Treat	-0.45***	-0.36***	-0.25***	-0.15*
	(0.039)	(0.040)	(0.055)	(0.056)
Idaho Border				
Treat	-0.14	-0.14	-0.060	-0.063
	(0.069)	(0.068)	(0.069)	(0.062)
Canadian Border				
Treat	-0.094	-0.065	-0.069	-0.013*
	(0.062)	(0.054)	(0.047)	(0.050)
N	16	16	16	16
Panel B: Differences-in-Discontinuities Estimates				
Oregon Border				
Treat*ORBorder	-0.41***	-0.31***	-0.21***	-0.11***
	(0.023)	(0.024)	(0.046)	(0.019)
Idaho Border				
Treat*ID	-0.096	-0.087	-0.018	-0.028
	(0.052)	(0.049)	(0.053)	(0.033)
Canadian Border				
Treat*CAN	-0.045	-0.010	-0.027	-0.094
	(0.052)	(0.048)	(0.028)	(0.051)
N	32	32	32	32

Notes: This table reports point estimates from regression discontinuity and differences-in-discontinuities models where the week of treatment has been removed. Columns indicate different outcome variables; "Concentrates" and "edibles" refer to the total revenue from those products. Rows indicate estimates for the regions defined by Table 1. Bandwidths are selected following Calonico et al. (2014). *, **, ***, respectively indicate significance at the 5%, 1%, and 0.1% levels.

Table 5: Estimated weight, market value, and tax revenue from cross-border sales

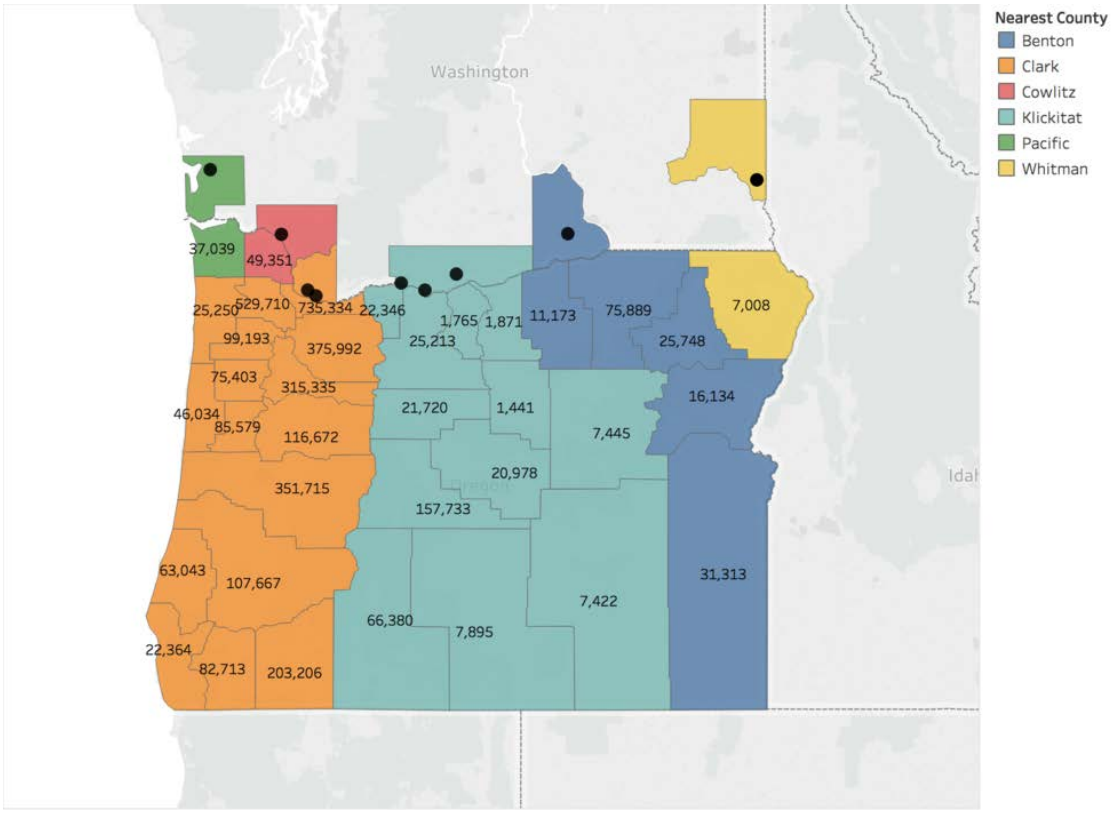
	Weight sold (g)	Market value ($)	Tax revenue ($)
Entire state	5,330,504	67,882,189	25,116,410
OR → WA			
Natural Experiment	190,746	2,259,811	947,130
Natural Experiment & Google Reviews	232,922	3,125,814	1,156,551
ID → WA			
Google Reviews (Only ID)	245,031	2,918,323	1,079,780
Google Reviews (All non-WA)	390,212	4,647,430	1,719,549

Notes: This table reports estimates of the weight, market value, and tax revenue from cross-border sales in the two months leading up to Oregon's market opening under different strategies. The "natural experiment" strategy uses the differences-in-discontinuities estimate for the Oregon border as the fraction of weight sold to cross-border shoppers for Oregon. The "Google Reviews" strategy uses recent Google reviewer home locations to estimate what fraction of reviews are from people normally reviewing outside the state.

Appendices

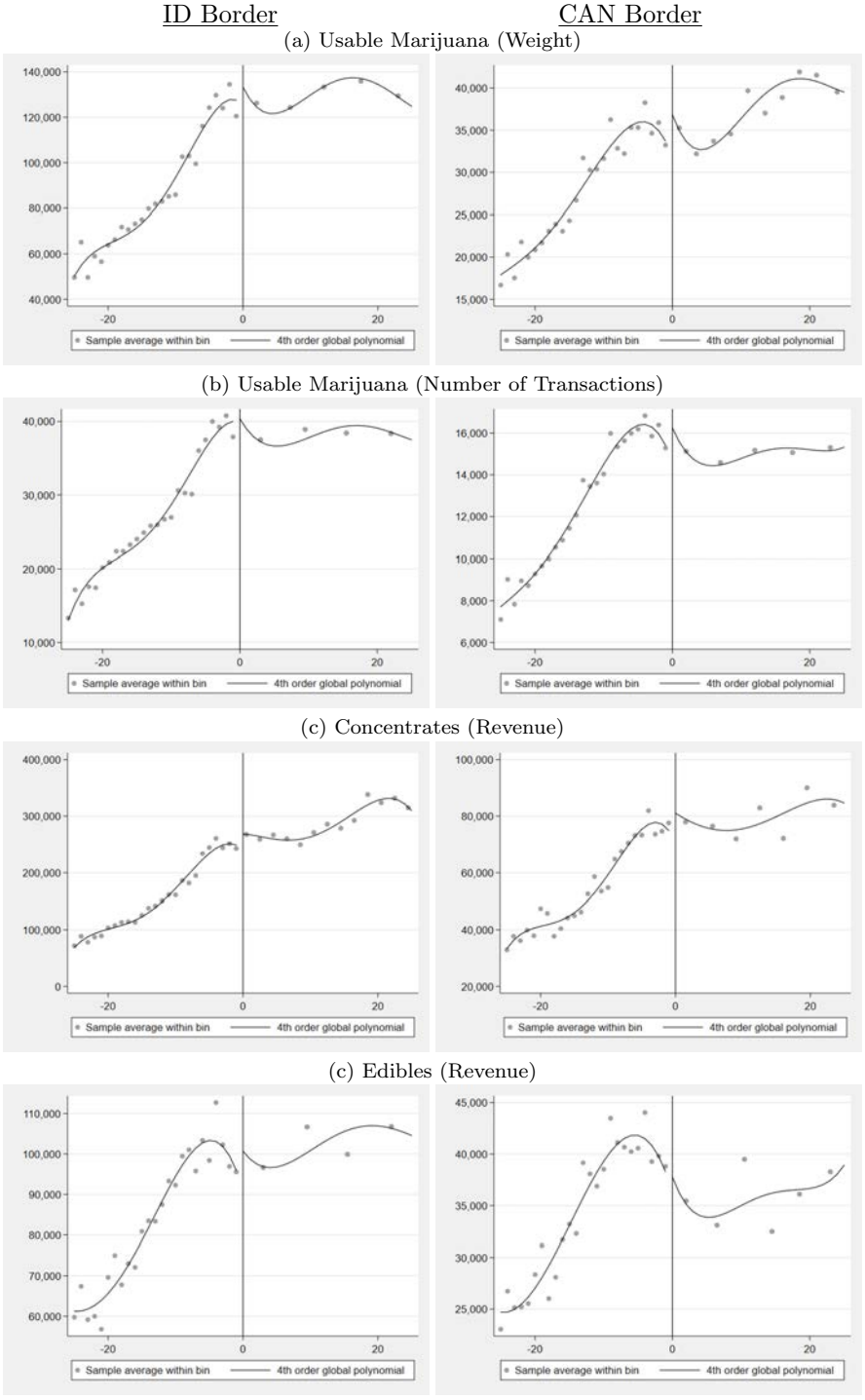
A Additional Tables and Figures for the Oregon Border Analyses

Figure A.1: Washington Border Retailers with Closest Oregon County



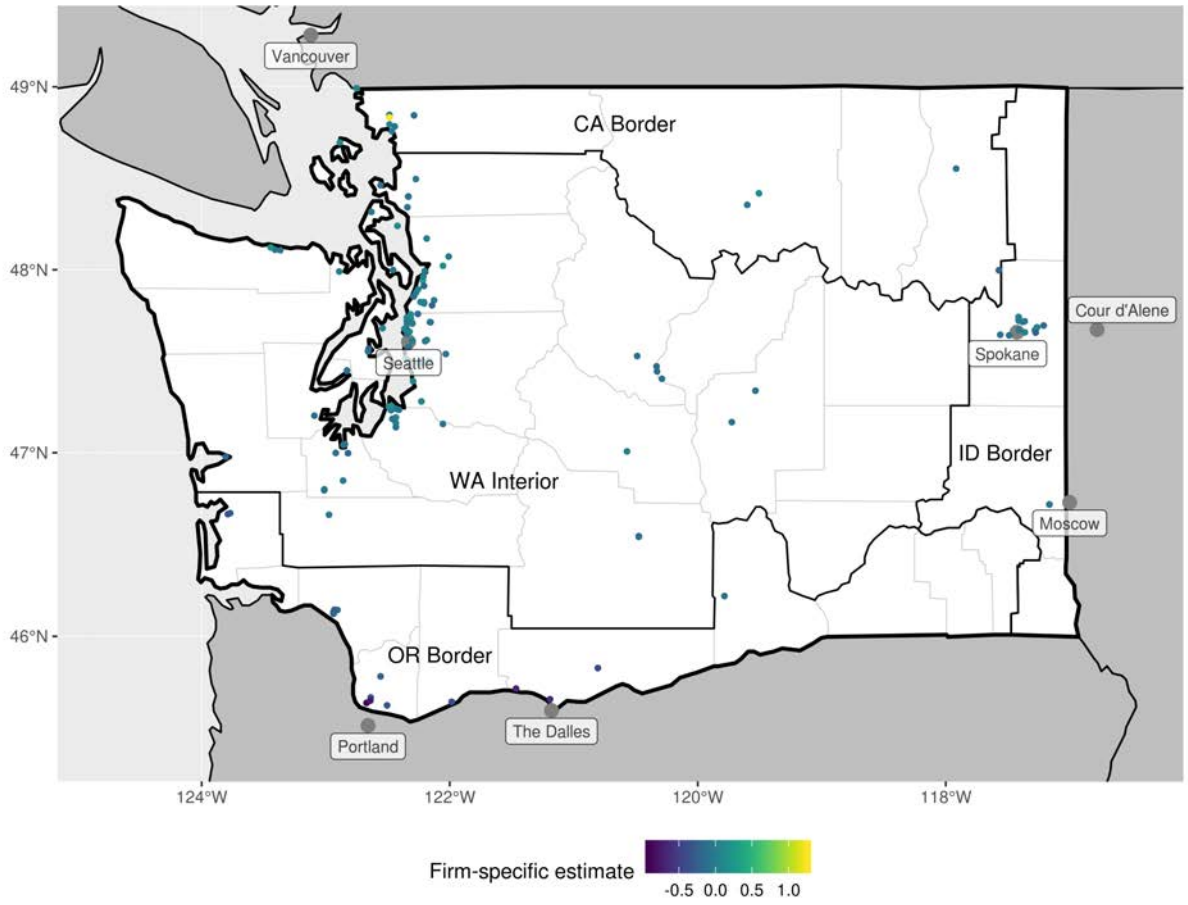
Notes: This map shows the location of the closest Washington retailers for each Oregon county. The numbers inside the Oregon county borders are that county's 2015 population, as estimated by the Census Bureau. Oregon counties are colored to represent the Washington county with the closest retailer based on driving distance.

Figure A.2: Washington Market Outcomes around Oregon's Market Opening, Idaho and Canadian Borders



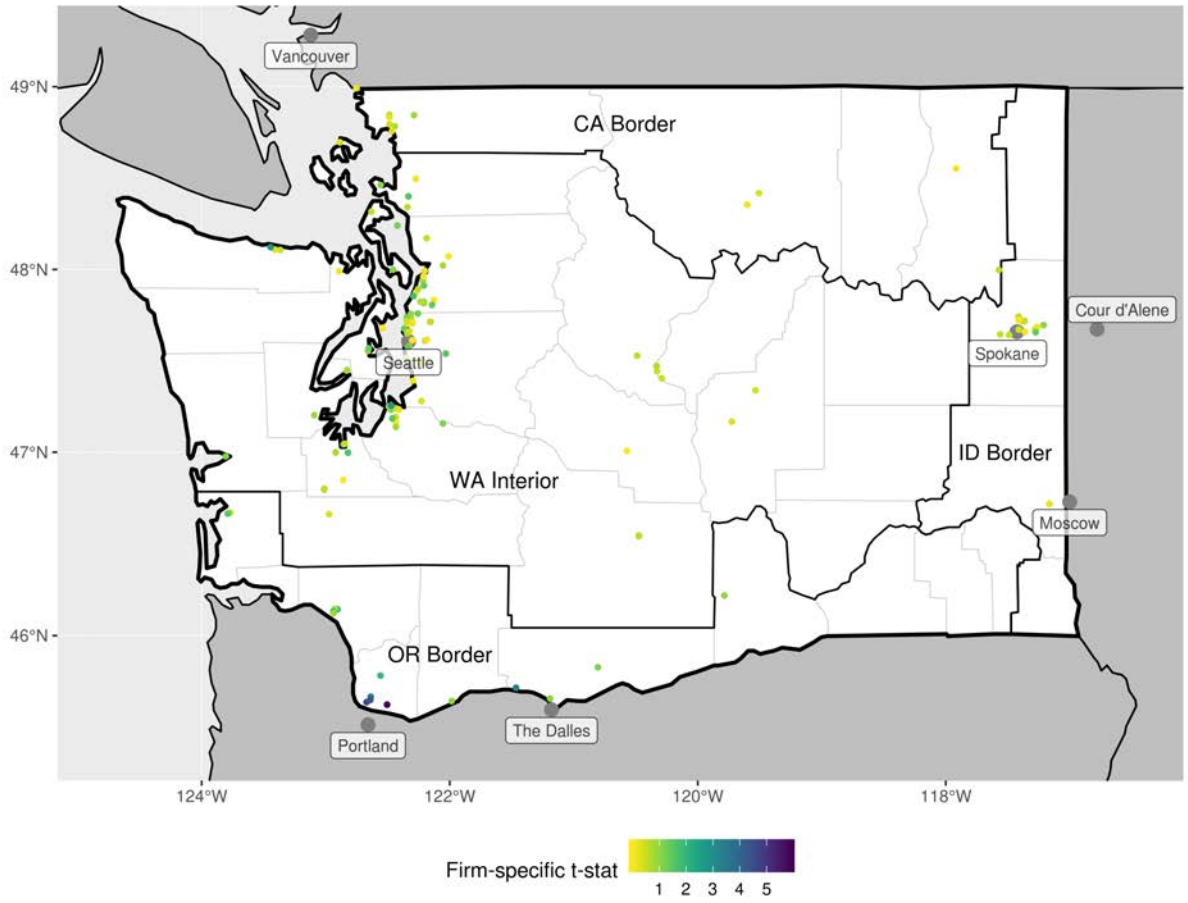
Notes: These figures illustrate trends in the sales of marijuana. The horizontal axis is the week relative to Oregon's market opening. The left-hand graphs illustrate outcomes in the Idaho border region, and the right-hand graphs illustrate outcomes in the Canadian border region. Dots illustrate the raw data at the region-week level. The line is a global 4th-order polynomial fit based on the approach of Calonico et al. (2015).

Figure A.3: Regression Discontinuity Estimates for Retailers by Location



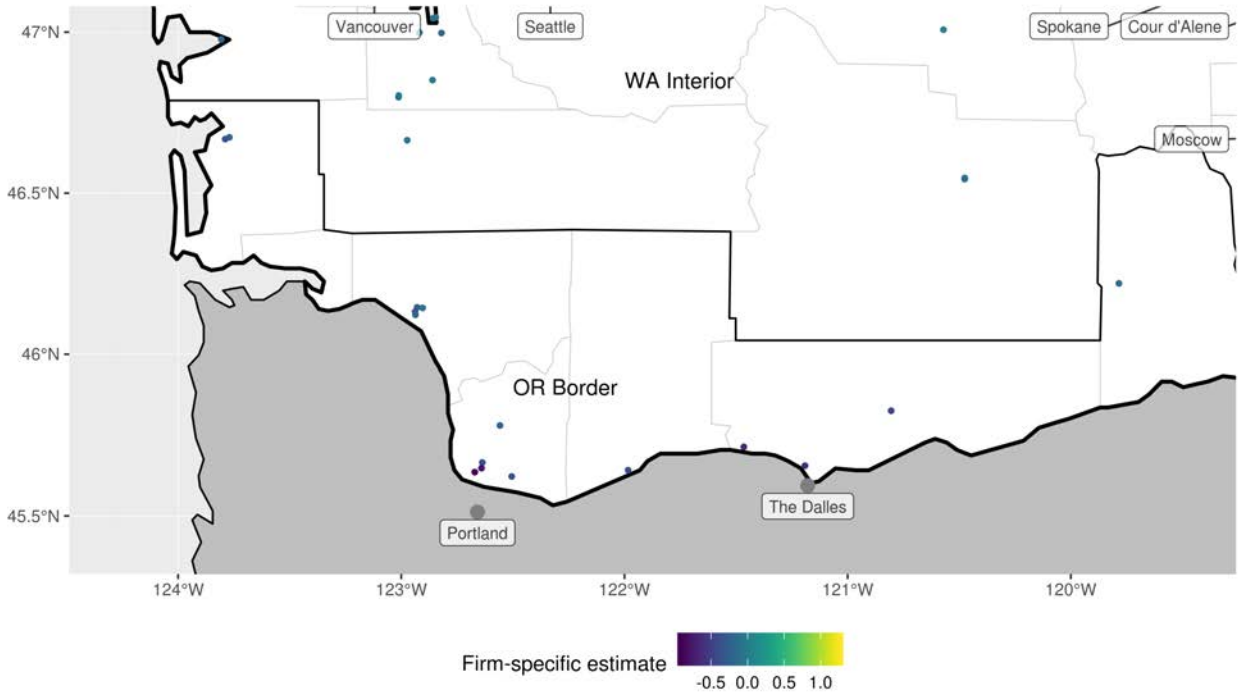
Notes: This figure reports firm-specific point estimates of the change in the log weight of usable marijuana sold formed from regression discontinuity models. Bandwidths are selected following Calonico et al. (2014). Darker dots indicate places where the weight sold fell a greater amount.

Figure A.4: Regression Discontinuity T-Statistics for Retailers by Location



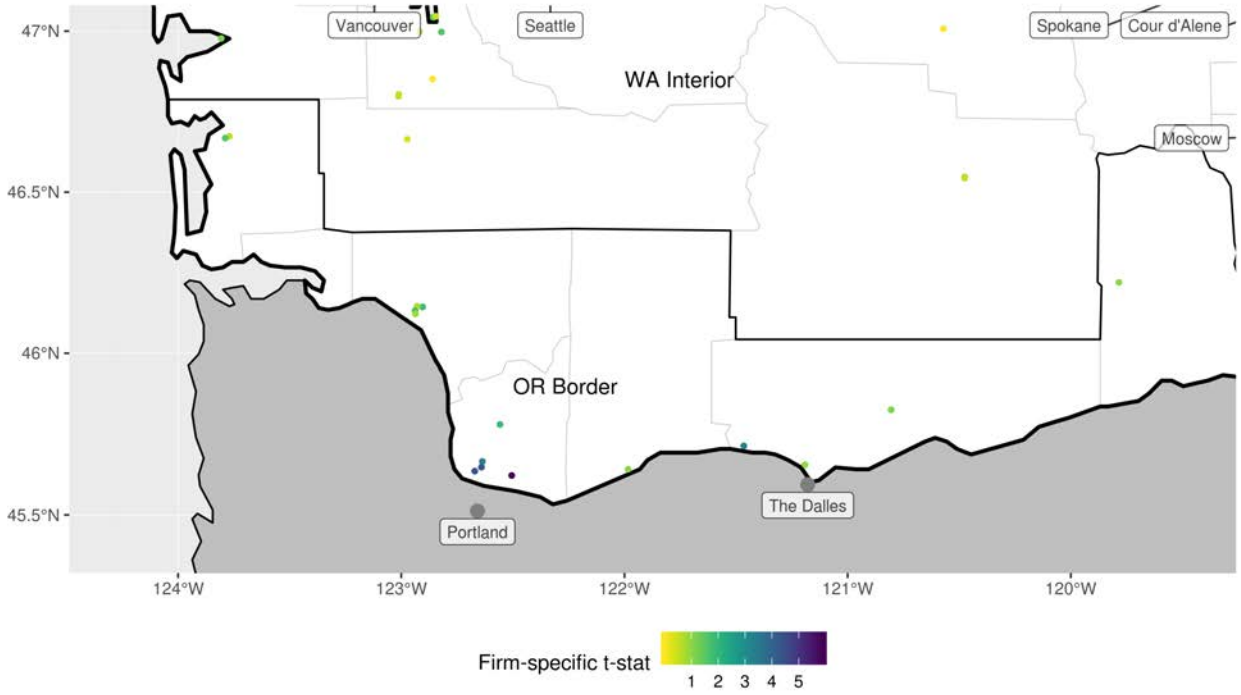
Notes: This figure reports firm-specific test statistics (in absolute value) from estimates of the change in the log weight of usable marijuana sold formed from regression discontinuity models. Bandwidths are selected following Calonico et al. (2014). Darker dots indicate places with a more significant estimated change.

Figure A.5: Regression Discontinuity Estimates by Retailer, Oregon border region



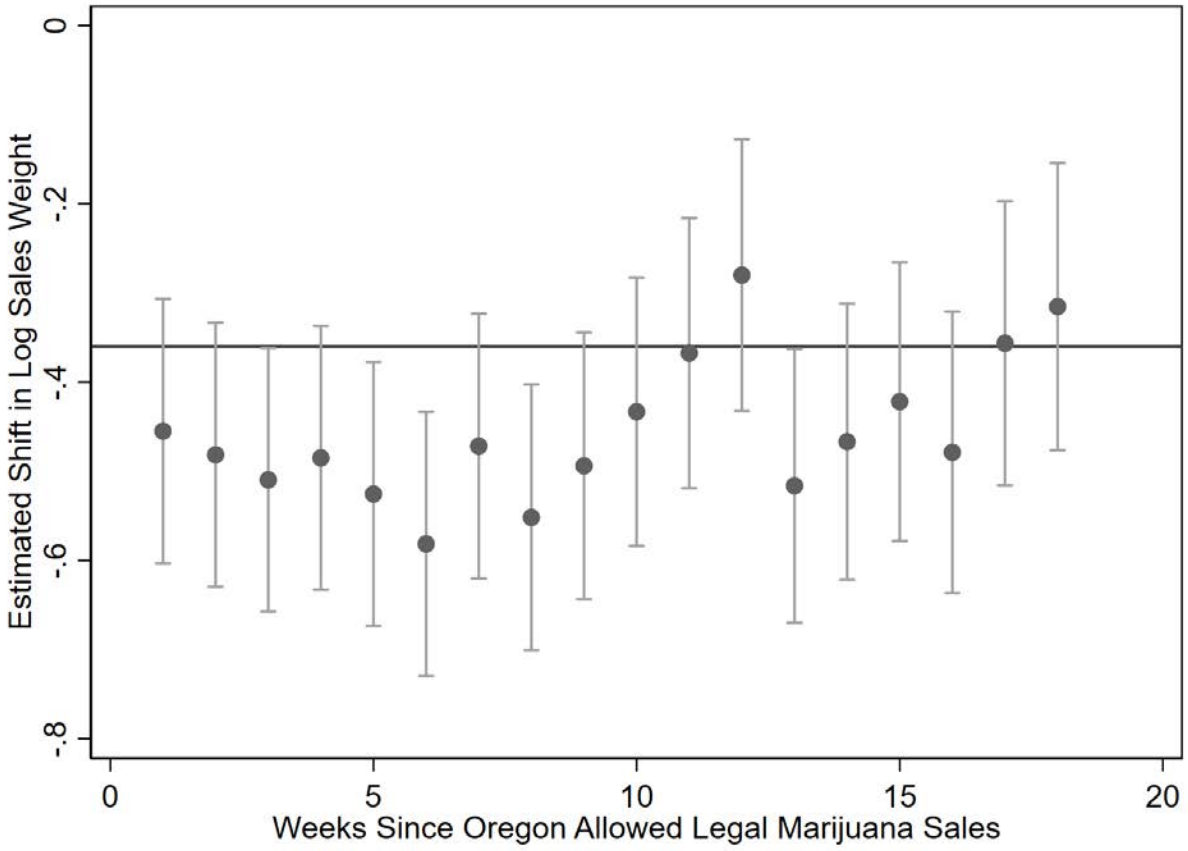
Notes: This figure reports firm-specific point estimates of the change in the log weight of usable marijuana sold formed from regression discontinuity models. Bandwidths are selected following Calonico et al. (2014). Darker dots indicate places where the weight sold fell a greater amount.

Figure A.6: Regression Discontinuity t-Statistics by Retailer, Oregon border region



Notes: This figure reports firm-specific test statistics (in absolute value) from estimates of the change in the log weight of usable marijuana sold formed from regression discontinuity models. Bandwidths are selected following Calonico et al. (2014). Darker dots indicate places with a more significant estimated change.

Figure A.7: Non-Parametric Interrupted Time Series Estimates of the Change in Sales along the Oregon Border Following Oregon's Legalization



Notes: This figure reports point estimates and confidence intervals from a non-parametric interrupted time series estimating the shift in sales along the Oregon border. The horizontal line represents the point estimate from the differences-in-discontinuities approach.

Table A.1: Washington Border Counties and Distance from Closest Retailer to Oregon Counties

WA County	Pop. (2010)	Retail locations	Oregon County	Pop. (2010)	Distance (Miles)
Benton	175,177	2			
			Baker	16,134	189
			Malheur	31,313	267
			Morrow	11,173	82
			Umatilla	75,889	78
			Union	25,748	149
			Total	**160,257**	**147**
Clark	425,363	6			
			Benton	85,579	90
			Clackamas	375,992	23
			Coos	63,043	242
			Curry	22,364	343
			Douglas	107,667	187
			Jackson	203,206	281
			Josephine	82,713	259
			Lane	351,715	122
			Lincoln	46,034	119
			Linn	116,672	88
			Marion	315,335	55
			Multnomah	735,334	12
			Polk	75,403	64
			Tillamook	25,250	82
			Washington	529,710	20
			Yamhill	99,193	43
			Total	**3,235,210**	**72**
Cowlitz	102,410	5			
			Columbia	49,351	29
Klickitat	20,318	3			
			Crook	20,978	120
			Deschutes	157,733	131
			Gilliam	1,871	68
			Grant	7,445	182
			Harney	7,422	267
			Hood River	22,346	10
			Jefferson	21,720	95
			Klamath	66,380	275
			Lake	7,895	280
			Sherman	1,765	29
			Wasco	25,213	13
			Wheeler	1,441	98
			Total	**342,209**	**153**
Pacific	20,920	2			
			Clatsop	37,039	55
Skamania	11,066	1			
			None		
Whitman	44,776	2			
			Wallowa	7,008	121

Notes: Pop. is population from the 2010 Census. Distance for Oregon counties is from the county's center of population, as determined by the Census Bureau for 2010, to the nearest Washington dispensary calculated using the Open Source Routing Machine with Open Street Map data. Oregon counties are listed under the "nearest" Washington county; Skamania County in Washington is along the Columbia River portion of the Washington-Oregon border but its retail location is not the closest location to any of Oregon's counties' centers-of-population. Distance for "Total" is from the author-calculated weighted center-of-population for counties in the panel to the nearest Washington dispensary.

Table A.2: Regression Discontinuity Estimates of Oregon's Legalization on Other Outcomes

	(1) ln(Inventory)	(2) ln(THC)	(3) ln(CBD)
Panel A: Regression Discontinuity Estimates			
Washington Interior			
Treat	0.033	0.0017	0.018
	(0.029)	(0.0028)	(0.035)
Oregon Border			
Treat	0.041	0.016	-0.10
	(0.033)	(0.011)	(0.15)
Idaho Border			
Treat	-0.14*	0.0074	0.076
	(0.058)	(0.0068)	(0.060)
Canadian Border			
Treat	-0.018	0.029*	0.28
	(0.033)	(0.0098)	(0.15)
N	17	17	17
Panel B: Differences-in-Discontinuities Estimates			
Oregon Border			
Treat*ORBorder	0.0089	0.0050	-0.15
	(0.044)	(0.017)	(0.16)
Idaho Border			
Treat*ID	-0.19*	0.0044	0.027
	(0.085)	(0.0083)	(0.059)
Canadian Border			
Treat*CAN	-0.044	0.030**	0.20
	(0.035)	(0.0096)	(0.20)
N	34	34	34

Notes: This table reports point estimates from regression discontinuity and differences-in-discontinuities models. Columns indicate different outcome variables; "Inventory" is the average inventory held by firms measured in grams of usable marijuana, "THC" and "CBD" refer to the average potency of the usable marijuana sold measured by the dry-weight percent content of the relevant chemical. Rows indicate estimates for the regions defined by Table 1. Bandwidths are selected following Calonico et al. (2014). *, **, ***, respectively indicate significance at the 5%, 1%, and 0.1% levels.