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LEGALIZATION

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The Cross-Border Spillover Effects of Recreational Marijuana Legalization
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ABSTRACT

We examine the spillover effects of recreational marijuana legalization (RML) in Colorado and Washington on neighboring states. We find that RML causes a sharp increase in marijuana possession arrests in border counties of neighboring states relative to non-border counties in these states. RML has no impact on juvenile marijuana possession arrests but is rather fully concentrated among adults. We do not find evidence that marijuana sale/manufacture arrests, DUI arrests, or opium/cocaine possession arrests in border counties are affected by RML.

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1. Introduction

Since 2012, eight states and the District of Columbia have legalized personal recreational marijuana use.¹ One often-cited justification for recreational marijuana legalization (RML) in these states concerns its expected positive fiscal impacts.² For example, the state of Washington collected \$186 million in tax revenue from legal sales of recreational marijuana in fiscal year 2016, just its second year with legal sales.³ Other potential impacts include savings to law enforcement and the criminal justice system from no longer investigating and prosecuting some marijuana-related crimes (Miron, 2010).

Though the fiscal impacts of marijuana legalization may be positive in states that pass RML, the effect on surrounding states is more likely to be detrimental. The nature of these laws is that marijuana can be purchased and possessed legally in RML states by those of majority age (21 and older) regardless of state of residency.⁴ This could lead to an increase in marijuana possession and related crimes in areas that neighbor RML states, which would likely contribute to higher burdens on law enforcement and the criminal justice system in those places. In line with this reasoning, in 2014, Nebraska and Oklahoma launched a federal lawsuit against

¹ Legalization of recreational marijuana took effect in Colorado and Washington in December 2012; in Oregon in July 2015; and in Alaska and Washington DC in February 2015. California, Massachusetts, Maine and Nevada passed recreational marijuana legalization in November 2016.

² See, for example, <https://taxfoundation.org/marijuana-tax-legalization-federal-revenue/>. Most recent date of access: May 9, 2017.

³ The fiscal year in Washington state runs from previous July 1 to current June 30. Source: Weekly Marijuana Report, Washington State Liquor and Cannabis Board (<http://lcb.wa.gov/marj/dashboard>). Most recent date of access: February 20, 2017.

⁴ Article XVIII, Section 16: Personal Use and Regulation of Marijuana, Colorado Constitution (<https://www.colorado.gov/pacific/sites/default/files/Section%2016%20-%20%20Retail.pdf>). Most recent date of access: March 17, 2017. Washington Initiative Measure No. 502, Office of Washington Secretary of State (<https://sos.wa.gov/assets/elections/initiatives/i502.pdf>). Most recent date of access: March 17, 2017.

Colorado, arguing that Colorado’s RML has led to an increase in marijuana-related law enforcement costs and other social costs in their states. While the suit was denied by the Supreme Court, the question of how one state’s recreational marijuana legalization affects neighboring states’ outcomes has not been examined.⁵ This is the focus of our paper.

Intuitively, for customers living in neighboring non-RML states, the legal cost of acquiring marijuana is reduced after RML because although possessing marijuana is still illegal in their home states, one is now free from penalty for the acts of buying and possessing marijuana across the border. In addition to this, RML most likely reduces the pecuniary cost of marijuana. Anderson et al. (2013) find that medical marijuana legalization (MML) is associated with sharp decreases in the price of marijuana. Similarly, the average retail price of marijuana in Washington has dropped substantially since the beginning of legalized retail in the state (July 2014) as shown in Table 1. Though an individual can certainly consume the marijuana in the RML state, legal restrictions on where this can occur, as well as simple matters of convenience, may increase individuals’ propensity to possess and consume marijuana illegally in their home (non-RML) state.⁶ We expect this to occur most especially for individuals living near the border of RML states, since for these individuals the reduction of the legal and pecuniary costs of

⁵ Nebraska and Oklahoma v. Colorado, Supreme Court of the United States Blog (<http://www.scotusblog.com/case-files/cases/nebraska-and-oklahoma-v-colorado/>). Most recent date of access: February 21, 2017. For more information on this case, see: Lyle Denniston, U.S. opposes marijuana challenge by Colorado’s neighbors, Supreme Court of the United States Blog (Dec. 17, 2015), (<http://www.scotusblog.com/2015/12/u-s-opposes-marijuana-challenge-by-colorados-neighbors/>). Most recent date of access: March 17, 2017. See also Justice Clarence Thomas’ dissent in this case (https://www.supremecourt.gov/opinions/15pdf/144orig_6479.pdf). Most recent date of access: March 17, 2017.

⁶ In Washington state, it is illegal to consume “in view of the general public” (Initiative 502), and in Colorado, a person may not consume “openly and publicly or in a manner that endangers others” (Article XVIII, Colorado Constitution).

buying and possessing marijuana is most likely to be larger than the travel cost associated with crossing the border to purchase marijuana.

In addition to affecting marijuana possession in neighboring areas, RML may indirectly affect other types of crimes in those areas. For example, the manufacture and sale of marijuana in counties that border RML states may become less attractive after RML because customers can purchase it legally—possibly at a lower price—across the border. This is ambiguous, however, since sellers also have the opportunity to cross the border and purchase cheap marijuana legally (and then return to sell it in the non-RML state). Driving under the influence (DUI) could also theoretically increase or decrease. On the one hand, if marijuana and alcohol are substitutes (as some papers, such as Anderson et al., 2013, have suggested), RML may decrease the frequency of DUI in bordering areas. On the other, if individuals are more likely to drive back and forth across the border, and some of this driving is done under the influence of marijuana or other drugs/alcohol, DUI arrests may increase following RML. Similar reasoning render the relationship between RML and other drug possession arrests theoretically ambiguous.

In this study, we adopt a difference-in-differences (DID) framework to examine whether RML leads to changes in various marijuana-related arrests in border counties of adjacent states relative to non-border counties in the same states. We use Uniform Crime Reports (UCR), a nation-wide arrest record database, from 2009 to 2014, to examine marijuana possession arrests, marijuana sale and manufacture arrests, DUI arrests, and opium/cocaine possession arrests. Since studies have found that drug arrests are generally good indicators of drug use (Rosenfeld and Decker, 1999; Moffatt et al., 2012; Chu, 2015), our study sheds light on how RML affects the drug consumption of neighboring states. However, we recognize that any change in arrests may be driven in part by how law enforcement officials respond to RML in a neighboring state.

Because of the recentness of recreational marijuana legalization in the U.S., we focus on the first two states that passed RML laws, Colorado and Washington (both in 2012). We first examine how RML in Colorado has affected counties in 6 neighboring (border) states: Wyoming, Utah, New Mexico, Oklahoma, Kansas and Nebraska (these six states are collectively defined as the “Colorado region” in this paper). Next, we examine how RML in Washington has affected counties in the border states of Idaho and Oregon (collectively defined as the “Washington region”).

We find that RML causes a sharp increase in marijuana possession arrests of border counties relative to non-border counties in both the Colorado and Washington regions. If a county shares a physical border with an RML state, it experiences an increase in marijuana possession arrests of roughly 30% following RML implementation (relative to non-border counties in the same region). In subgroup analyses, we show that RML has no impact on juvenile marijuana possession arrests, consistent with previous findings that MML does not lead to increased marijuana consumption among teenagers (Anderson et al., 2015). We do not find evidence that marijuana sale/manufacture arrests, DUI arrests, or opium/cocaine possession arrests of border counties are affected on net by RML.

The validity of our DID design is examined using an event study framework, where we allow the effect of RML to vary for every year in our data. We find no evidence that marijuana possession arrests were rising in border counties relative to non-border counties prior to the legalization year (2012), and strong increases in arrests took place in 2013 and 2014 (the latter is the year in which legal sales began in both Colorado and Washington). In addition to the event study, we include a robustness check in which we control for proxies for medical marijuana

activity in Colorado (which experienced a large increase in registered medical marijuana patients prior to 2012) and find that our estimates of the RML effect are largely undisturbed.

Finally, we address the fact that RML border counties tend to have higher per capita arrests than non-border counties in our data. Though our DID design relies on an assumption concerning trends rather than levels—that the marijuana possession arrest trend in non-border counties is a good proxy for the trend in RML border counties if RML had not occurred—the difference in levels between the county types creates concern regarding the validity of this assumption. Thus, we adopt a synthetic control design using as potential “donors” non-RML border counties in each region as well as counties from other western states that did not change their marijuana laws over our sample period. We find that this analysis is also supportive of our baseline DID estimates.

Our results raise concerns about the enforcement of marijuana laws in non-RML states that are neighbors to RML states. Given the nature of current state RML laws and unrestricted movement across states, it appears that neighboring non-RML states experience increases in illegal marijuana activity and accompanying arrests (in particular, in counties near the RML state border). Setting the question of public health consequences of RML aside, this means that the fiscal impacts of marijuana legalization are ambiguous overall, since there may be a larger financial burden on law enforcement or the criminal justice system in border non-RML states.

2. Literature

Since recreational marijuana legalization is new in the U.S., evidence on the effects of relaxing marijuana restrictions comes mainly from studies on medical marijuana legalization (MML) and marijuana decriminalization, which have been occurring in many states over the past several decades. Studies generally find that MML increases the illegal use of marijuana as well

as marijuana-related arrests and hospital treatments among adults (Model, 1993; Pacula et al., 2010; Chu, 2014; Kelly and Rasul, 2014; Wen et al., 2015). In the context of MML, allowing marijuana possession for some individuals (those who qualify to use it medicinally) appears to lead to an increase in illegal use as well.

Regarding adolescents, studies generally find that MML does not increase marijuana use among youths and may even discourage it (Harper et al., 2012; Lynne-Landsman, 2013; Choo et al., 2014; Anderson et al., 2015). This may be because the relative risk of selling marijuana to youth (compared to adults) increases after MML is passed (Anderson and Rees, 2014).⁷

A common theme of these studies is that they assume that a change in marijuana policy in one state or location has no effect on outcomes in other locations, including neighboring ones. One contribution of our study is to test whether this assumption holds in practice. To the extent that relaxed marijuana laws in one state affect outcomes in neighboring states, it implies that results in previous studies could be biased depending on how their control group(s) are constructed.

Though there is a dearth of evidence regarding spillover effects of marijuana law specifically, previous papers have considered spillover effects of region-specific policies on surrounding areas in other contexts. Dube et al. (2013) and Knight (2013) examine potential externalities associated with U.S. gun laws, with both finding that weaker gun law restrictions lead to an outflow of firearms. Figlio (1995) studies differential drinking ages between

⁷ The question of how relaxing legal restrictions on the sale and use of marijuana affects public health is complicated due to its potential impacts on the use of other substances. On this point, the literature is mixed. Model (1993) shows that marijuana decriminalization was accompanied by less emergency room episodes involving drugs other than marijuana. Similarly, Bachhuber et al. (2010) and Chu (2015) find that MML lowers state opioid overdose mortality rates as well as heroin treatments and cocaine/heroin arrests. Anderson et al. (2013) find that MML leads to a reduction in drunk driving fatalities. In contrast, Wen et al. (2015) provide evidence that MML increases the frequency of binge drinking among adults and has no impact on the use of hard drugs.

Wisconsin (which had a low drinking age in his data range) and border states and shows that counties on the border had more alcohol-related crashes than other counties. Lovenheim and Slemrod (2010) similarly find that an increase in a state's minimum legal drinking age actually leads to an increase in fatal accidents for 18-19 year-olds in that state living within 25 miles of a jurisdiction with a lower drinking age. Lovenheim (2008) provides evidence that consumers travel to purchase cigarettes in lower-price jurisdictions. Finally, Jacks et al. (2017) find that the repealing of prohibition in some counties in the 1930's contributed not only to an increase in infant mortality in those counties but in neighboring (dry) counties as well.

The paper most similar to ours in terms of topic is Ellison and Spohn (2015), in which the authors examine the impact of the expansion of the medical marijuana program in Colorado on drug arrests and jail occupancy in counties of Nebraska. They find that Nebraska border counties experienced significant growth in marijuana-related arrests and jail admissions after Colorado's policy change. However, their identification strategy does not make use of a control group. They also use data from 2000-2004 and 2010-2013 but not data from 2005-2009, which further underscores the concern that their results may be partially due to other factors that have changed over time. Our contribution is to use a formal DID framework in which we examine the effects of RML (previously unstudied in terms of spillover effects) on all border counties of neighboring states using non-border counties in those states as a control group.

3. Data

Our main dataset is compiled from Uniform Crime Reporting (UCR) Program Data: County-Level Detailed Arrest and Offense Data from 2009 to 2014.⁸ These datasets report

⁸ Source: United States Department of Justice. Federal Bureau of Investigation. Uniform Crime Reporting Program Data: County-Level Detailed Arrest and Offense Data, 2009-2014. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor].

county-level arrests for different offenses including marijuana possession, marijuana sale and manufacture, driving under the influence of drugs/alcohol (DUI), and other drug possession like opium/cocaine possession.⁹ UCR also reports adult and juvenile sub-group arrests data, allowing us to examine the potential heterogeneous effects of RML along this dimension.¹⁰

We use the County Distance Database from the National Bureau of Economic Research to construct distances between counties in non-RML states to RML state borders. The County Distance Database provides great-circle distances using the Haversine formula based on internal points in the geographic area.¹¹

As stated in the introduction, we define the Colorado region as all counties in Wyoming, Utah, New Mexico, Oklahoma, Kansas and Nebraska. There are 360 counties in this region and 29 of them share a physical border with Colorado.¹² Similarly, the Washington region is defined as all counties in Oregon and Idaho. There are substantially fewer counties (80) in the Washington region, with 16 physically bordering Washington state.

Among these two case studies, we place more emphasis on Colorado and its adjacent states for the following reasons. First, Colorado has substantially more bordering states/counties than

⁹ Apart from marijuana possession arrests, UCR provides 3 categories on drug possession arrests: 1) opium/cocaine possession, 2) synthetic narcotics possession, and 3) other drug possession. Opium/cocaine possession includes possession of opium or cocaine and their derivatives (morphine, heroin, codeine). The UCR database does not distinguish cocaine possession from opium possession or other derivatives possession.

¹⁰ The UCR Program considers a juvenile to be an individual under 18 years of age.

¹¹ Source: County Distance Database, the National Bureau of Economic Research (<http://www.nber.org/data/county-distance-database.html>). Most recent date of access: February 22, 2017.

¹² Arizona technically borders Colorado at a single point but is excluded from the analysis because of a marijuana policy change in California. In 2010, California decriminalized possession of small amounts of marijuana. In Appendices 1a to 1c, we can see that it is very likely that marijuana decriminalization strikingly lowered California marijuana possession arrests from 2010 to 2014. Since Arizona shares a border with California, we exclude Arizona in our main regressions due to possible contamination resulting from California's policy change. However, the results with Arizona included in the region are similar to our main results and are available upon request.

Washington does, giving us more observations for the analysis. Second, no states adjacent to Colorado had major changes in terms of their marijuana laws over our study period. In contrast, RML was passed in 2014 in Oregon (Ballot Measure 91). Although Oregon's RML only took effect in 2015, the anticipation of legalization might have affected the behaviors of individual Oregonians and Oregon law enforcement officials in 2014. Finally, Colorado opened its first recreational marijuana retail store in January 2014, while Washington opened its first in July 2014. Since the UCR data is currently only available through 2014, the Colorado region results might give us more insight into the impact of a fully operational RML policy on neighboring states.¹³

For each of the Colorado and Washington regions, Table 2a shows the descriptive statistics for the full sample, counties that physically border the RML state, and non-border counties in the region. Tables 2b and Table 2c repeat the analysis for the adult and juvenile subgroups separately.

From Panel 1 of Table 2a, the average number of marijuana possession arrests per 10,000 people is 18.4 for the whole period (2009-2014) in the Colorado region, with an average of 18.9 before RML (2009-2012) and 17.6 after RML (2013-2014). Comparing border counties with non-border counties, marijuana possession arrests are higher in border counties even before RML (28.3 arrests per 10,000 people in border counties compared with 18.1 arrests in non-border counties). After the implementation of RML, we see a big rise in marijuana possession arrests in border counties but a drop in non-border counties. Marijuana sale/manufacture arrests are also generally a bit higher in border counties, but both border and non-border counties

¹³ Colorado also has an arguably more permissible RML law than Washington, allowing for growing one's own recreational marijuana at home, which Washington prohibits. See footnote 3 for details. See also: Philip Wallach and John Hudak, 2013, Comparing Legal Marijuana Systems in Colorado and Washington, Brookings Institution (<https://www.brookings.edu/wp-content/uploads/2016/06/Comparing-Legal-Marijuana-Table.pdf>). Most recent date of access: March 17, 2017.

experience a small increase in these arrests after RML. DUI arrests decrease markedly for both border counties and non-border counties after RML. Opium/cocaine possession arrests increase after RML for border counties but fall slightly for non-border counties.

Panel 2 of Table 2a reports the descriptive statistics for the Washington region. This region has a significantly higher marijuana possession arrest rate than the Colorado region. After RML in Washington, average marijuana possession arrests went up from 68.3 to 93.2 for border counties. There was only a slight increase in marijuana possession arrests in non-border counties over the same time period. We also see slight decreases in marijuana sale/manufacture arrests and increases in opium/cocaine possession arrests in both border and non-border counties in the Washington region following RML (in the case of opium/cocaine possession arrests, the increase in border counties is large). Finally, border counties saw slightly higher DUI arrests after RML while non-border counties had lower DUI arrests after RML.

In Tables 2b and 2c, we can see that adult arrests generally follow the same pattern as the total sample. However, marijuana possession arrests of juvenile groups in both the Colorado and Washington regions fell slightly after RML for both county types. Other arrest type averages for juveniles are quite small in magnitude and generally either fall or stay roughly constant over time.

In the analysis below, in addition to defining a “border” county based on sharing a physical border with the RML state in question, we use an alternative (looser) definition based on whether a county is within 100 miles from the RML state border. Lastly, we are interested in whether border counties that are near an interstate highway are especially affected by RML, since the travel cost of crossing the border and purchasing marijuana is especially low in these counties. Figures 1a and 1b show the routes of all interstate highways across Colorado and Washington, respectively. There are 3 major interstate highways with 5 border crossings in Colorado and 3

major interstate highways with 3 border crossings (to other U.S. states) in Washington.¹⁴ Thus, we employ a third treatment, which takes a value of one if a (non-RML) county is within 100 miles of the RML border county containing an interstate highway (and zero otherwise).

Figures 2a and 2b display the trends in marijuana possession arrests of counties in the Colorado and Washington regions under the three treatment definitions discussed above. In each panel of these figures, treatment (border) counties are compared to control (non-border) counties as well as the entire region and the national average. In the upper-left panel of each figure, the border definition is based on sharing the physical border; in the upper-right panel, it is based on being within 100 miles of the border; and in the lower-left panel, it is based on being within 100 miles of an interstate highway border crossing. For the Colorado region, there are 29 counties that physically border Colorado, 57 counties that are within 100 miles of the Colorado border, and 34 counties that are within 100 miles of an interstate border crossing. The corresponding numbers for the Washington region are 16, 33, and 25, respectively.

Two immediate observations from Figures 2a and 2b are that marijuana possession arrests are decreasing nationally for these years and that marijuana possession arrests are always higher in border counties than non-border counties, even before RML. Looking at the Colorado region (Figure 2a), non-border counties generally follow the same trend as the national average. However, in border counties, there is a sharp jump in marijuana possession arrests starting in

¹⁴ The interstate highways, exit counties, and corresponding FIPS county codes of Colorado region are: 1. interstate 25 north exit, Larimer County, 8069; 2. interstate 25 south exit, Las Animas County, 8071; 3. interstate 70 east exit, Kit Carson County, 8063; 4. interstate 70 west exit, Mesa County, 8077; and interstate 76 exit, Sedgwick County, 8115. Similarly, the 3 major interstate highways in Washington state are: Interstate 90, which exits Washington from Spokane County (FIPS 53063); Interstate 82, which exits Washington from Benton County (FIPS 53005); and Interstate 5, which exits Washington from Clark County (FIPS 53011). Interstate 205, which is a small branch deviating from Interstate 5, also exits from Clark County.

2012, with arrests reaching a peak in 2014 (this pattern is most pronounced for counties on the physical border, but it is similar based on the other two treatment definitions).

An important question stemming from Figure 2a is why marijuana possession arrests in border counties rose in 2012 (since recreational legalization in Colorado only took place at the end of 2012). A possibility is the relaxation of medical marijuana restrictions between 2009 and 2011, when the number of medical marijuana enrollees in Colorado soared.¹⁵ This perhaps made it easier to cross the border and obtain marijuana in Colorado during this time period as well. Because our focus in this paper is on the spillover effects of RML, in the econometric analyses described below, we classify 2012 as a “control” year (or, as a robustness check, leave it out of the data altogether) so only increases occurring after 2012 contribute to a positive RML effect. In another robustness check, we control for the interaction between “border county” and the total number of registered medical marijuana enrollees in Colorado and find that our results change very little. Finally, in the synthetic control analysis, we construct a control weighted explicitly toward counties that match the pre-RML trend in marijuana possession arrests in border counties.

Moving to the Washington region in Figure 2b, we also notice that border counties see a jump in marijuana possession arrests, but in this case it is in 2013. Arrest numbers also increase after 2012 for non-border counties, although not nearly to the same degree as in border counties.

Overall, the differential marijuana possession arrest trends between border and non-border counties after 2012 hint that RML in Colorado and Washington has affected arrests in nearby counties of non-RML states. In the next section, we examine this hypothesis more rigorously using a regression-based DID framework.

¹⁵ Events taking place starting in 2007 that led to an enormous increase in medical marijuana patients in Colorado from 2009 to 2010 are detailed in: <http://www.westword.com/news/the-history-of-cannabis-in-colorado-how-the-state-went-to-pot-5118475> (most recent date of access: May 9, 2017).

4. Empirical Methodology

We specify our main set of difference-in-difference (DID) models as

$$y_{ist} = \alpha * \textit{Physical Border}_i * RML_t + X_{ist}\beta + \theta_i + \tau_t + \epsilon_{ist}, \quad (1)$$

$$y_{ist} = \alpha * \textit{Border 100 Miles}_i * RML_t + X_{ist}\beta + \theta_i + \tau_t + \epsilon_{ist}, \quad (2)$$

$$\text{and } y_{ist} = \alpha * \textit{Interstate 100 Miles}_i * RML_t + X_{ist}\beta + \theta_i + \tau_t + \epsilon_{ist}. \quad (3)$$

y_{ist} represents the dependent variable of interest in county i of state s in year t including: marijuana possession arrests per 10,000 people, marijuana sale/manufacture arrests per 10,000 people, DUI arrests per 10,000 people, and opium/cocaine possession arrests per 10,000 people.

Our key independent variables are $\textit{Physical Border}_i * RML_t$ in Equation (1), $\textit{Border 100 Miles}_i * RML_t$ in Equation (2) and $\textit{Interstate 100 Miles}_i * RML_t$ in Equation (3), which are interactions between RML_t (equal to zero for the years 2009-2012 and one for the years 2013-2014, since RML took effect in December 2012 in both Colorado and Washington) and different measures of treatment (border) as described in the last section.¹⁶ County level control variables (contained in the vector X_{ist}) include county population, county median household income, and the county unemployment rate.¹⁷ Other independent variables include year fixed effects τ_t and county fixed effects θ_i . This model (i.e., two-way fixed effects)

¹⁶ Ideally, the RML variable would take a value of one for the last month of 2012, but this is not feasible since we only have annual data. Since it is not clear whether 2012 should be a treatment or control year, we have also performed our analyses with the year 2012 excluded. The results are similar to our main results (with 2012 included as a control year) as shown in Appendix 2.

¹⁷ Data on county median household income comes from Small Area Income and Poverty Estimates, U.S. Census Bureau, Small Area Estimates Branch (<https://www.census.gov/did/www/saipe/data/statecounty/data/index.html>). Most recent date of access: March 1, 2017. Median income is deflated using annual CPI from 2009 to 2014 with 1982-1984 CPI =100. CPI data is from Consumer Price Index - All Urban Consumers, Bureau of Labor Statistics (<https://data.bls.gov/pdq/SurveyOutputServlet>). Most recent date of access: March 1, 2017. Data on the county unemployment rate is from Local Area Unemployment Statistics, Bureau of Labor Statistics (<https://www.bls.gov/lau/#tables>). Most recent date of access: March 1, 2017.

generalizes a model including a single “border county” dummy as well as a single “post-RML” dummy. We also include state specific linear time trends in some models presented in the results.

Because the travel cost associated with purchasing marijuana in a nearby RML state is likely not discontinuous at the edge of a border county, we also perform some specifications in which a continuous measure of distance is substituted for the binary “border” treatment variable in Equations (2) and (3) above. In these specifications, $Distance_i$ and $Distance\ to\ Interstate_i$ represent distance to the nearest county of an RML state and distance to the nearest county in an RML state that has an interstate highway border crossing, respectively. Thus, the models are specified as

$$y_{ist} = \alpha * Distance_i * RML_t + X_{ist}\beta + \theta_i + \tau_t + \epsilon_{ist}, \quad (4)$$

$$\text{and } y_{ist} = \alpha * Distance\ to\ Interstate_i * RML_t + X_{ist}\beta + \theta_i + \tau_t + \epsilon_{ist}. \quad (5)$$

All other variables are defined the same way as in Equations (1)-(3).

5. Main Results

5.1 Marijuana possession arrests

The effects of bordering an RML state (or, alternatively, distance to an RML state) following RML implementation (after 2012) on marijuana possession arrests are shown in Table 3. Panel 1 contains results for the Colorado region and Panel 2 shows results for the Washington region.

From Panel 1, column (1), physically bordering Colorado after RML has a statistically significant positive impact on marijuana possession arrests (at the 5% level). On average, counties that physically border Colorado see an increase of 8.1 in marijuana possession arrests relative to non-border counties following RML, or a 29% increase compared with the pre-RML mean. The number decreases to 6.7 if the border definition is relaxed to being within 100 miles

to Colorado (column (3)). When we focus specifically on counties that are within 100 miles of a Colorado interstate border crossing (column (5)), the number jump up to 9.9, suggesting that interstate highways may amplify the spillover effect of RML (to be sure, however, these point estimates are not statistically different from each other at conventional levels). Columns (7) and (9) report the effects of distance to Colorado and distance to a Colorado interstate border crossing on marijuana possession arrests of neighboring states. In these specifications, a 100-mile increase in distance to Colorado and to a Colorado interstate border crossing decrease marijuana possession arrests by 3.2 and 3.5, respectively. Even numbered columns show results of models that include state-specific linear time trends on the right-hand side. All effects are somewhat smaller in magnitude, but the results remain significant at the 10% level.

Panel 2 of Table 3 shows the results of the same models for the Washington region. The results generally follow the same pattern as those of the Colorado region in terms of estimated signs and relative magnitudes between results with and without state-specific linear time trends. Of the 5 sets of results using different treatment (border) definitions, two sets are no longer statistically significant at the 10% level, though the estimated magnitudes are still relatively large. Counties that physically border Washington see an especially striking increase of 22.9 arrests (33%) relative to non-border counties after RML. Results in columns (7) and (9) also indicate that the farther a county is located from Washington state, the smaller the increase in arrests following RML.¹⁸

¹⁸Appendix 2 shows the results of the same models as Table 3 but with the year 2012 excluded from the data. The results in Appendix 2 are generally consistent with Table 3 in terms of estimated signs but generally show larger absolute magnitudes, especially for the Colorado region. This is consistent with Figure 2a. However, some of the results in this table are less precisely estimated than in Table 3, which is possibly a result of losing one year of observations out of six total (2009-2014).

We report separate regressions for adult and juvenile subgroups in Tables 4a and 4b. The results show that the RML effect on marijuana possession arrests in border counties is entirely concentrated among adults. Point estimates for juveniles are small, not consistently signed, and never statistically different from zero. These findings appear to be consistent with Anderson et al. (2015), who find that MML does not increase marijuana use among teenagers.

5.2 Marijuana sale/manufacture arrests, DUI arrests, and opium/cocaine possession arrests

Tables 5 through 7 show DID results using marijuana sale/manufacture arrests, DUI arrests, and opium/cocaine possession arrests as dependent variables, respectively. Looking across the tables at the Colorado region (Panel 1 in each table), there is little evidence that RML has affected these outcomes in border counties relative to non-border ones (columns (1) to (6) in each table). Estimated signs are not consistent, and no result is statistically significant at conventional levels. Looking at the effect of distance to Colorado and distance to a Colorado interstate border crossing, results without state-specific linear time trends (columns (7) and (9)) show some indication that marijuana sale/manufacture, DUI, and opium/cocaine possession arrests might have risen following RML in areas closer to Colorado relative to areas farther away. However, after adding state-specific time trends (columns (8) and (10)), all results are rendered insignificant (typically with a large reduction in magnitude).

In the Washington region (Panel 2 in Tables 5 through 7), results are fairly consistent with those for the Colorado region with the exception of DUI arrests. Without state time trends, it appears that border counties experience more DUI arrests following RML (point estimates are significant at the 10% level). However, once again, these results are not robust to the inclusion of state-specific time trends.

Our view of the body of the results on other arrest types is that the evidence is weak that RML affected these arrests, on net, in neighboring states.¹⁹ However, our estimates using the continuous distance measure leave open the possibility that other arrest types increased following RML, so we believe that with additional data, this is a worthwhile topic for future research.

6. Robustness Checks

6.1 Event Study

In this section, we conduct event studies for our three binary treatment variables (border definitions) with marijuana possession arrests as the dependent variable. This allows us to further examine the validity of our DID assumption, i.e., that the trend in arrests for non-border counties is a good proxy for what would have happened to border counties without RML, controlling for relevant observable characteristics. Though we can obviously not test this directly, if border counties were experiencing a different trend in arrests than non-border counties prior to RML, it would cast doubt on whether RML is in fact responsible for our results. To do this analysis, we simply allow the effect of treatment (border county) to vary for every year in our sample (rather than only for pre- and post-RML periods). The results are contained in Tables 8a and 8b (with 2009 serving as the omitted or reference year).

Table 8a shows our results for all three definitions of “border” in the Colorado region. There is no evidence that trends in marijuana possession arrests between border counties and non-border counties were different before 2012. Starting in 2012, estimated signs jump in magnitude, but it is only in 2014, with another jump in magnitude in all three cases, that we see a statistically significant difference from the border/non-border county difference in 2009.

¹⁹ Results excluding the year 2012 and event studies (detailed in the next section) with these three dependent variables are also not supportive of the notion that RML affects the three dependent variables discussed in this subsection. These results are available upon request.

Event study results for the Washington region are shown in Table 8b. The results are a little different than the Colorado ones. In this case, the big jump in the border/non-border difference comes in 2013 (consistent with Figure 2b), with the coefficients falling somewhat in 2014. The point estimates for the 2013 and 2014 interactions are also not always precisely estimated in these specifications. This may be due in part to the limited sample size in this region. Nevertheless, the much larger coefficients after 2012 compared to earlier years are generally supportive of the notion that RML has affected marijuana possession arrests in counties that neighbor Washington.

6.2 Medical Marijuana

As stated in Section 3 concerning Figure 2a, a question concerning the interpretation of our results for the Colorado region is whether they are due to RML or earlier expansion in the availability of medical marijuana in Colorado. In particular, Colorado experienced growth in the number of registered medical marijuana patients prior to RML passage, likely as a result of the relaxation of requirements to dispense and obtain it. Though we expect the mechanisms by which RML and medical marijuana expansions affect non-RML border states to be similar (but not identical), we would like to know if a divergence between border and non-border counties in these states after 2012 is in fact due to RML. While data limitations make this difficult to address, we can add a proxy for medical marijuana availability to our regressions: the total number of patients enrolled in the Colorado Medical Marijuana Registry program (MMRP) interacted with our border dummies or distance from the border.²⁰ The drawback of this method is that since this

²⁰ Source: Medical Marijuana Registry Program Update, 2009-2014 Medical Marijuana Registry Statistics, Colorado Department of Public Health and Environment (<https://www.colorado.gov/pacific/cdphe/medical-marijuana-statistics-and-data>). Most recent date of access: April 27, 2017. Colorado's county level population data is from Population Totals for Colorado Counties, Colorado Department of Local Affairs (<https://demography.dola.colorado.gov/population/data/profile-county/>). Most recent date of access: April 27, 2017.

number generally increased between 2009 and 2014, some of the variation in marijuana possession arrests that could have been due to RML (after 2012) is now soaked up by these interactions.

The results from regressions with these controls are contained in Table 9. Compared to Table 3, most corresponding point estimates are slightly smaller and those with state-specific time trends are no longer statistically significant at conventional levels (with one exception for interstate border counties). However, even with the loss of variation described above, the results are broadly consistent with the notion that RML itself is responsible for the divergence in marijuana possession arrest trends between counties that are closer to Colorado and those that are further from Colorado.²¹

6.3 Synthetic Control Design

Our last robustness check addresses the question of whether non-border counties serve as a suitable control group for RML border counties in our DID design. Figures 2a and 2b (and Tables 2a-2c) indicate that border counties tend to have higher per capita arrest figures than other counties within their states, on average. To address this issue, we adopt a synthetic control design (Abadie and Gardeazabal, 2003; Abadie et al., 2010) that constructs a control group as a weighted average of non-RML border counties where weights are chosen to match the pre-treatment trend in marijuana possession arrests for RML border counties (in each region). We

The total numbers of patients in Colorado who currently possess valid registry ID cards by the end of each year from 2009 to 2014 are: 41,039 in 2009, 116,198 in 2010, 82,089 in 2011, 108,526 in 2012, 110,979 in 2013, and 115,467 in 2014.

²¹ In Appendix 3, we try adding a different control for medical marijuana availability to the regressions: the number of MMRP patients per capita in the Colorado border county lying closest to the non-RML county in question. The results are very similar to those in Table 3.

use the method in Cavallo et al. (2013), which allows for multiple treatment groups (since we have many “treated” counties on the border).²²

We focus on our first definition of RML border county (sharing a physical border with the RML state) in this section of the paper. The pool of counties that might receive positive weight in the synthetic control (i.e., donor pool) for the Colorado region RML border counties including non-border counties in that region plus all counties in other western states that did not experience a change in marijuana law over our time period: Nevada, Texas, Montana, and North and South Dakota.²³ The donor pool for the Washington region RML border counties is constructed in like manner.

The marijuana possession arrest trends for border (treatment) counties and the synthetic control county are shown in Figures 3a and 3b (for the Colorado and Washington regions, respectively). The trends for RML border counties are exactly the same as the ones shown in Figures 2a and 2b. The synthetic control county better matches the pre-treatment trend for RML border counties, though the fit is apparently somewhat better in the Colorado region than the Washington one.

In both cases, there is a substantial divergence in trends between the treatment and control counties following RML. The hypothesis that arrest rates between treatment and control are the same in 2014 for the Colorado region is rejected at the 5% level, and the same is true in the Washington region for both 2013 and 2014.

²² To implement this, we use the “synth_runner” package in STATA developed by Galiani and Quistorff (2016). Weights (for the synthetic control group) are chosen to best reproduce the marijuana possession arrest per capita trend for RML border counties in the pre-treatment period.

²³ We exclude all counties on the Mexican border from the donor pool due to their persistently high arrest rates and potential to be affected by Colorado’s RML policy directly.

Though our ability to match the pre-treatment trends of RML border counties up until 2012 is not perfect, we believe the results using the synthetic control design cast substantial doubt on the notion that the reason marijuana possession arrests increased relatively in border counties following RML was due to differences in baseline levels of arrests or a different pre-treatment trajectory in those counties.

7. Discussion

An open question concerning the interpretation of our results is how much of the relative increase in border counties of non-RML states is driven by increased possession (which would be closely tied to increased use) and how much is driven by the police response to RML across the border. In particular, police officers might adopt new techniques or use more resources toward cracking down on what they perceive to be more illegal marijuana possession following RML.

Given the limitations of our data, we cannot address this question directly. However, we can examine what happens to one proxy for police presence in a county: the number of police officers employed per capita (or, alternatively, the number of police agency employees per capita). This data also comes from the UCR Program database, which reports the number of employed police officers as well as total employees at the police agency level.²⁴ We match each agency to its county using county identifiers from the Law Enforcement Agency Identifiers Crosswalk, 2012.²⁵ We then aggregate the number of employees within a county and divide by

²⁴ United States Department of Justice. Federal Bureau of Investigation. Uniform Crime Reporting Program Data: Police Employee (LEOKA) Data, 2009-2014. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor].

²⁵ United States Department of Justice. Office of Justice Programs. Bureau of Justice Statistics. Law Enforcement Agency Identifiers Crosswalk, 2012. ICPSR35158-v1. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2015-04-17. <http://doi.org/10.3886/ICPSR35158.v1>

county population to obtain total police officers per 10,000 county residents and total police agency employees per 10,000 county residents.

Figure 4 shows that counties that physically border the RML state typically employ more police officers than non-border counties in both regions, though the relative trends are different: in the Colorado region, police presence in RML border counties looks to be diverging somewhat from the rest of the state, while in Washington it is the opposite (at least until 2014).²⁶ The regression analysis in Tables 10a and 10b confirm that after adding controls, the interaction between “border” and the post-RML time period is generally positive in the Colorado region, though most results are not statistically significant at conventional levels. This is in contrast to the Washington region, where the interactions tend to be negative in sign, though again they are not generally precisely estimated.

Overall, we do not observe that police employment has responded strongly to RML in RML border counties relative to non-border counties. However, we have noted that even with existing resources, police departments may be directing increased attention to marijuana possession in areas near newly legal jurisdictions. Sorting out how much of the response we observe is due to possession and how much is due to a change in the probability of arrest conditional on possession is a subject for future work.

8. Conclusion

In this paper, we examine the impact of recreational marijuana legalization (RML) in Colorado and Washington on their neighboring states in terms of marijuana-related arrests. We

²⁶ We drop Marion County of Oregon (FIPS code: 41047) in this analysis and in subsequent regressions due to an apparent error in the data. While all other counties in the Washington region have no more than 60 employed officers per 10,000 people in any year, Marion County is recorded as having employed more than 500 officers per 10,000 people in 2011 (in other years, the number for this county is always lower than 40).

find that RML causes a sharp increase in marijuana possession arrests in border counties near both Colorado and Washington relative to non-border counties, suggesting strong spillover effects of marijuana legalization. These results suggest that individuals with the lowest travel costs (those near the border and possibly an interstate border crossing) take advantage of RML by acquiring marijuana in RML states and bringing it back across the border. Finally, we find little evidence that marijuana sale/manufacture arrests, DUI arrests, or opium/cocaine possession arrests of either region are affected by RML.

Our paper suggests that law enforcement efforts to penalize marijuana use in non-RML states are complicated by neighbors' choices to adopt RML. Since 2012, eight states (plus the District of Columbia) have passed RML. As additional states consider legalizing recreational marijuana, the costs and benefits of these decisions from a national perspective should include the spillover effects on non-adopting states, which our paper shows is likely to include law enforcement and criminal justice costs in addition to any public health consequences of increased marijuana use in these states.

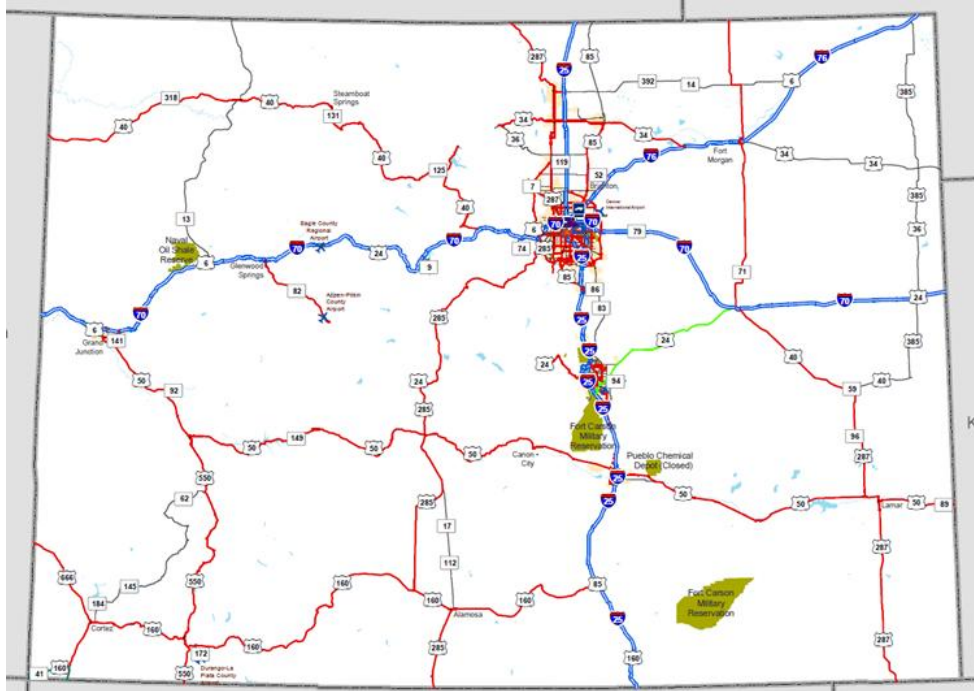
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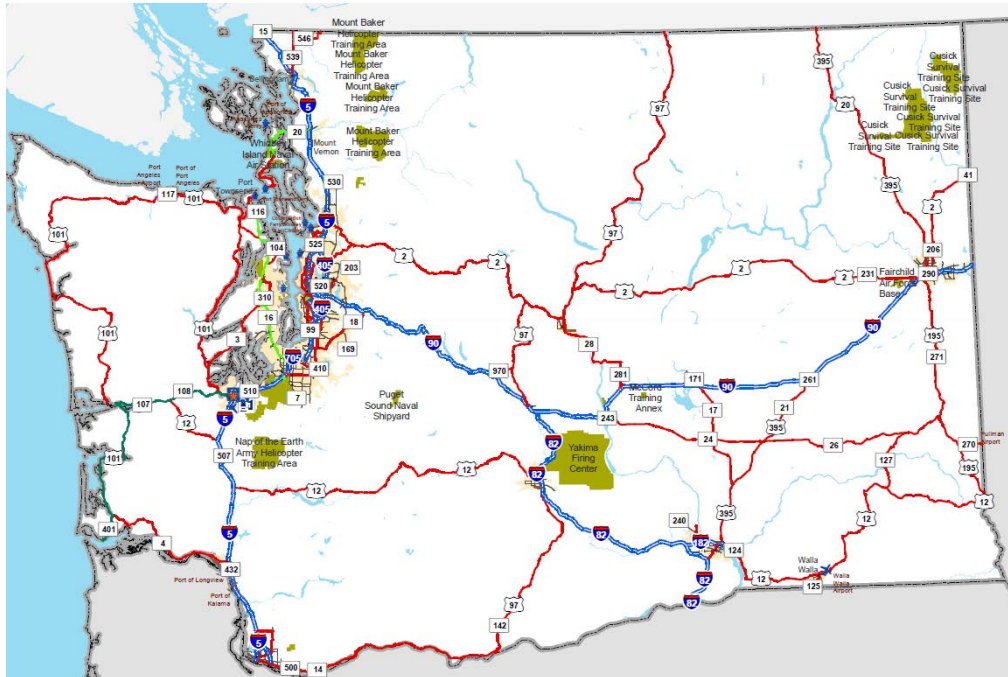
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Figure 1a: Colorado interstate highway system



Source: U.S. Department of Transportation, Federal Highway Administration (https://www.fhwa.dot.gov/planning/national_highway_system/nhs_maps/). Most recent data of access: March 7, 2017.

Figure 1b: Washington interstate highway system



Source: Same as Figure 1a.

Figure 2a: Marijuana possession arrests (per 10,000 people) trends, Colorado region

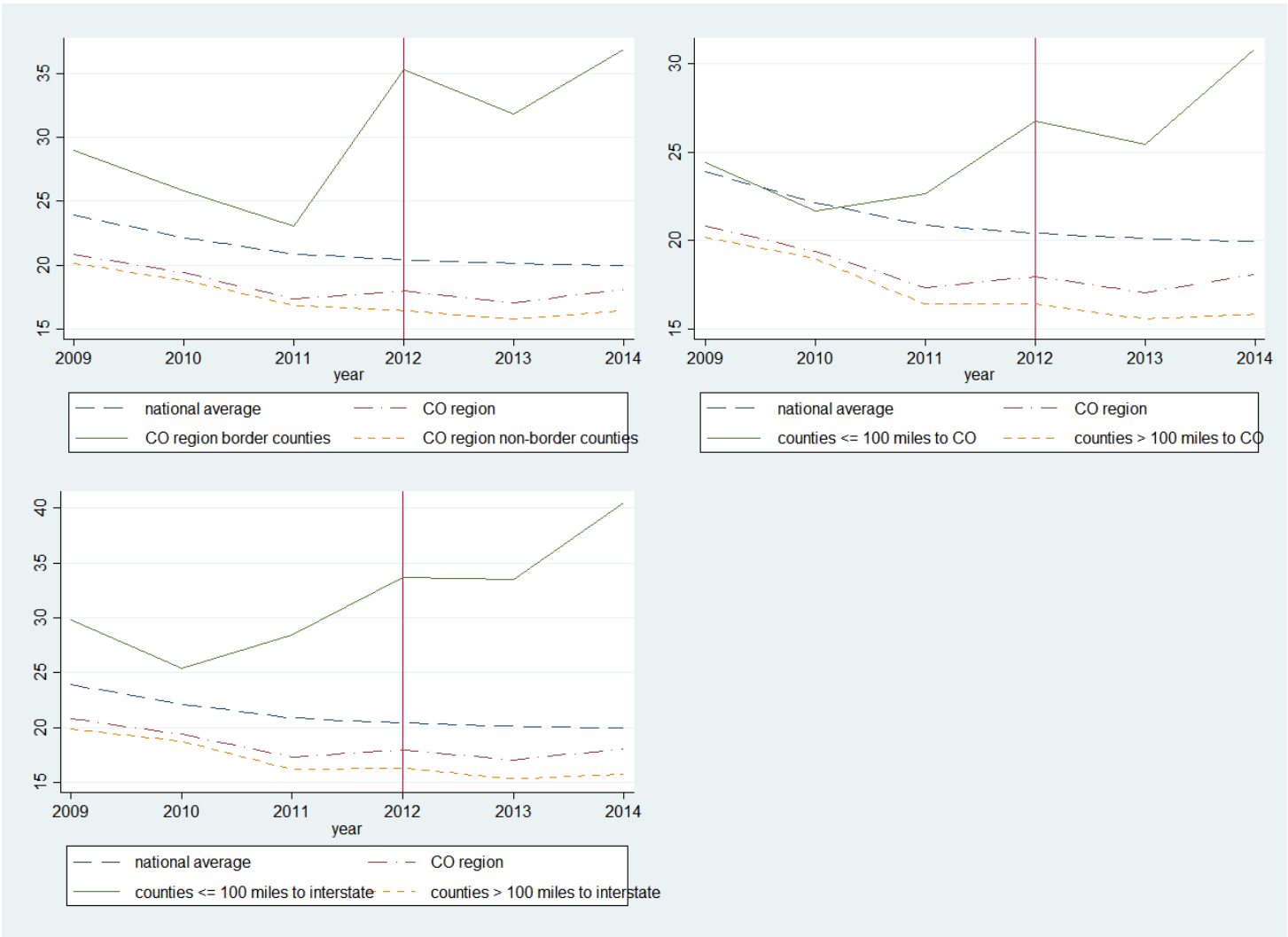


Figure 2b: Marijuana possession arrests (per 10,000 people) trends, Washington region

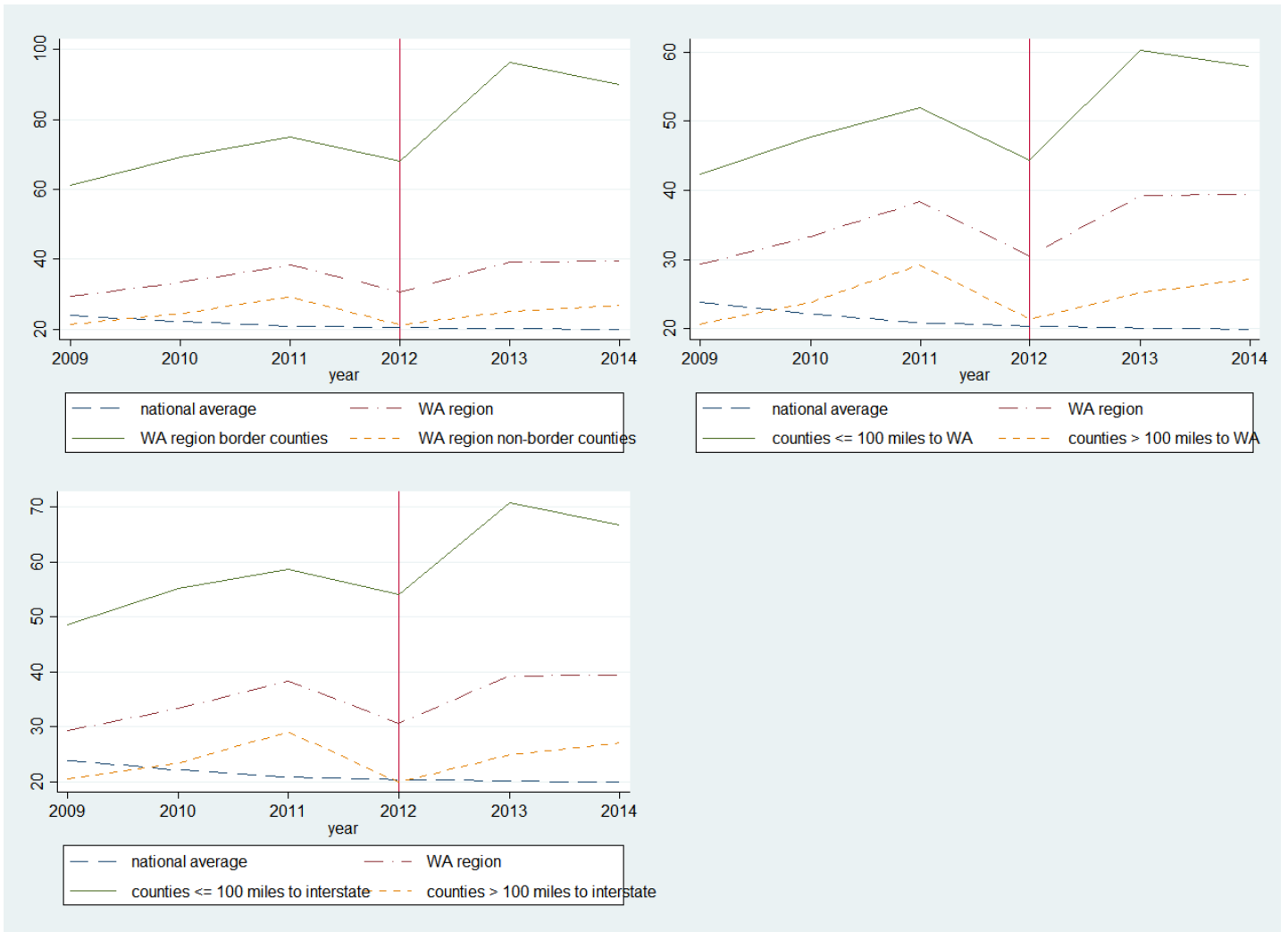
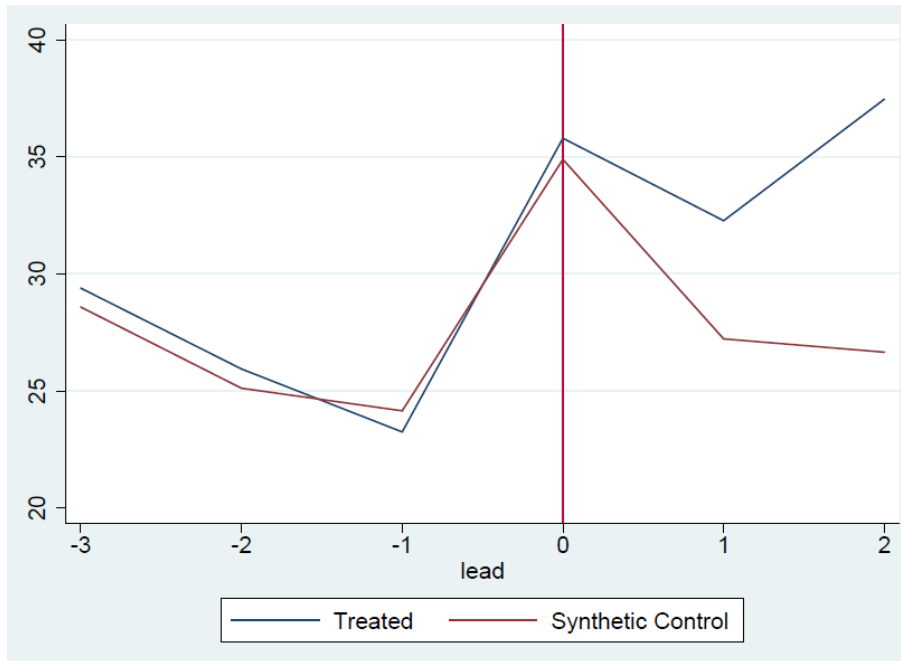
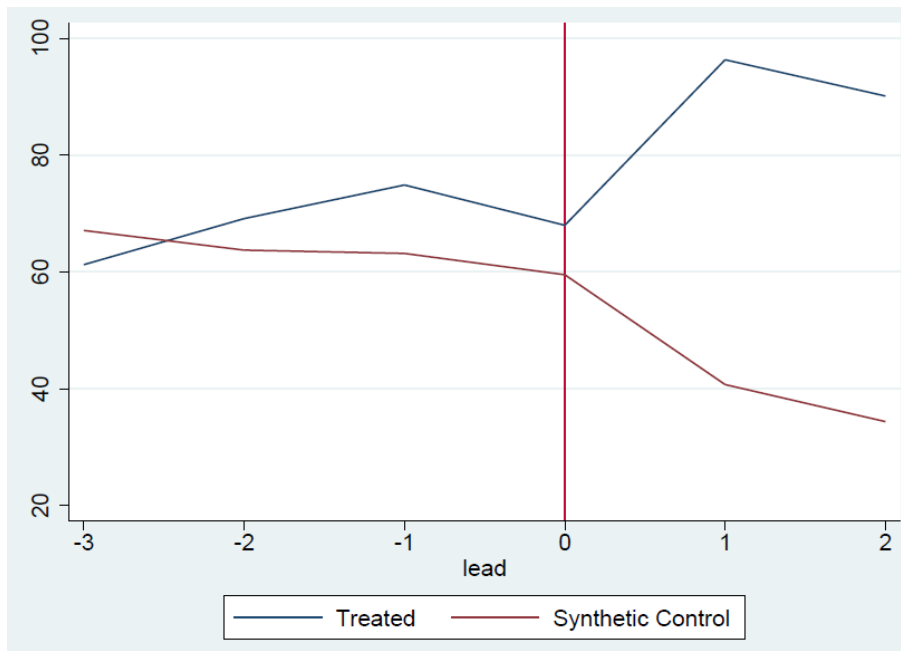


Figure 3a: Colorado region marijuana possession arrests trends vs. synthetic control



Notes: Arrests are measured per 10,000 people. The value “-3” on the X-axis corresponds with 2009, “-2” corresponds with 2010, etc. (“0” is 2012 because that is the last pre-treatment year).

Figure 3b: Washington region marijuana possession arrests trends vs. synthetic control



Notes: Arrests are measured per 10,000 people. The value “-3” on the X-axis corresponds with 2009, “-2” corresponds with 2010, etc. (“0” is 2012 because that is the last pre-treatment year).

Figure 4: Police employment trends, Colorado and Washington regions

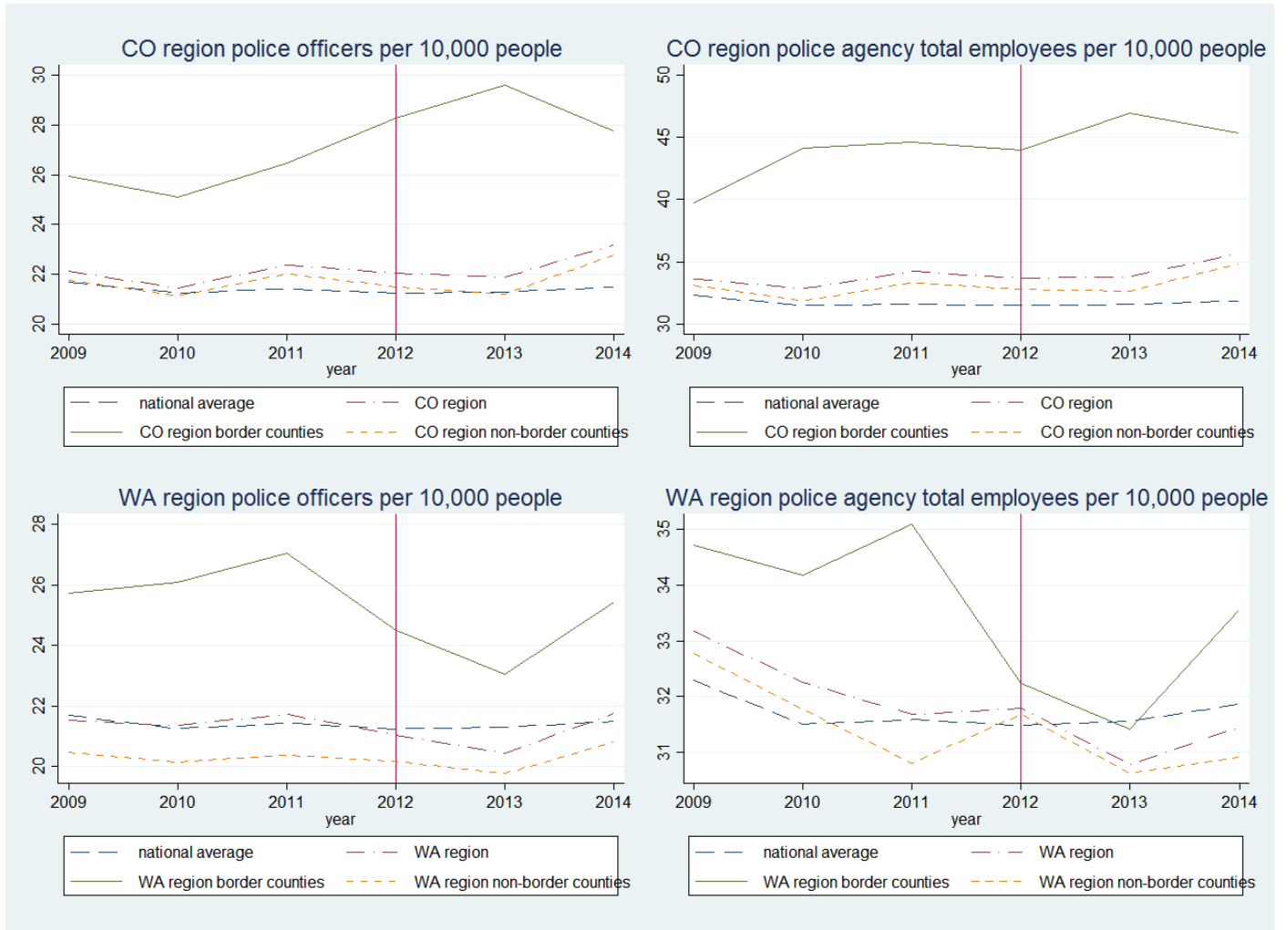


Table 1: Average retail price of marijuana in Washington state over time

Month	Grams Sold	Taxable Retail Sales	Price per Gram
Jul-14	79,160	2,578,241.18	32.57
Aug-14	155,626	4,954,242.75	31.83
Sep-14	232,740	6,208,687.07	26.68
Oct-14	322,402	7,838,338.31	24.31
Nov-14	384,838	9,053,928.85	23.53
Dec-14	537,021	11,560,057.27	21.53
Jan-15	693,564	13,864,328.76	19.99
Feb-15	937,586	15,915,997.39	16.98
Mar-15	1,241,791	20,699,013.49	16.67
Apr-15	1,596,038	23,790,464.42	14.91
May-15	1,926,238	29,210,098.94	15.16
Jun-15	2,168,402	31,931,699.52	14.73
Jul-15	2,756,582	31,822,629.65	11.54
Aug-15	3,126,261	34,976,811.81	11.19
Sep-15	3,518,838	37,443,162.99	10.64
Oct-15	3,613,918	37,533,720.98	10.39
Nov-15	3,486,244	35,178,193.82	10.09
Dec-15	4,018,693	39,657,986.79	9.87
Jan-16	4,111,709	34,316,151.09	8.35
Feb-16	4,417,214	36,490,730.38	8.26
Mar-16	4,932,556	40,156,970.03	8.14
Apr-16	5,373,520	42,666,561.80	7.94
May-16	5,566,192	44,704,503.89	8.03
Jun-16	5,268,603	46,709,764.13	8.87

Notes: Data on marijuana grams sold is from Weekly Marijuana Report, Fiscal Year 2015 and 2016 Data, Washington State Liquor and Cannabis Board (<http://lcb.wa.gov/records/frequently-requested-lists>). Most recent date of access: February 20, 2017. Data on taxable retail sales of marijuana is from Recreational Marijuana Tax Table, Washington State Department of Revenue (http://dor.wa.gov/Content/AboutUs/StatisticsAndReports/stats_RMJTaxes.aspx). Most recent date of access: February 20, 2017.

Table 2a: Summary statistics for full sample, RML border counties, and non-border counties

	Full Sample			Border Counties			Non-Border Counties		
	(1) N	(2) mean	(3) S.D.	(4) N	(5) mean	(6) S.D.	(7) N	(8) mean	(9) S.D.
Panel 1: Colorado Region									
2009-2014									
marijuana possession arrest	2,160	18.44	21.64	174	30.31	46.22	1,986	17.40	17.59
marijuana sale/manufacture arrest	2,160	4.585	6.861	174	5.999	8.494	1,986	4.461	6.687
DUI arrest	2,160	45.17	29.84	174	54.85	36.79	1,986	44.32	29.01
opium/cocaine possession arrest	2,160	1.136	2.406	174	1.637	3.345	1,986	1.092	2.301
2009-2012									
marijuana possession arrest	1,440	18.88	20.99	116	28.28	42.56	1,324	18.05	17.70
marijuana sale/manufacture arrest	1,440	4.505	6.503	116	5.791	8.565	1,324	4.392	6.282
DUI arrest	1,440	49.39	31.25	116	59.03	38.96	1,324	48.54	30.36
opium/cocaine possession arrest	1,440	1.186	2.460	116	1.525	3.404	1,324	1.156	2.358
2013-2014									
marijuana possession arrest	720	17.57	22.86	58	34.37	52.96	662	16.10	17.31
marijuana sale/manufacture arrest	720	4.746	7.526	58	6.416	8.410	662	4.599	7.433
DUI arrest	720	36.72	24.73	58	46.49	30.64	662	35.86	23.98
opium/cocaine possession arrest	720	1.035	2.292	58	1.860	3.241	662	0.963	2.178
distance to Colorado	-	2.324	1.116	-	0.517	0.155	-	2.482	1.020
distance to CO interstate exit county	-	2.604	1.195	-	0.869	0.436	-	2.756	1.118
Panel 2: Washington Region									
2009-2014									
marijuana possession arrest	480	35.06	70.04	96	76.62	145.9	384	24.67	17.83
marijuana sale/manufacture arrest	480	1.781	2.582	96	1.637	2.693	384	1.817	2.556
DUI arrest	480	50.79	21.83	96	55.79	23.73	384	49.54	21.18
opium/cocaine possession arrest	480	2.852	5.711	96	6.787	10.70	384	1.868	2.747
2009-2012									
marijuana possession arrest	320	32.91	63.83	64	68.32	132.6	256	24.06	18.98
marijuana sale/manufacture arrest	320	1.854	2.736	64	1.737	2.880	256	1.883	2.704
DUI arrest	320	52.51	22.93	64	55.18	24.51	256	51.84	22.51
opium/cocaine possession arrest	320	2.363	4.572	64	5.414	8.572	256	1.600	2.254
2013-2014									
marijuana possession arrest	160	39.36	81.10	32	93.22	170.4	128	25.89	15.28
marijuana sale/manufacture arrest	160	1.634	2.245	32	1.436	2.304	128	1.684	2.236
DUI arrest	160	47.34	19.08	32	57.01	22.43	128	44.92	17.42
opium/cocaine possession arrest	160	3.828	7.407	32	9.533	13.78	128	2.402	3.482
distance to Washington	-	1.635	1.097	-	0.371	0.107	-	1.951	1.001
distance to WA interstate exit county	-	2.036	1.313	-	0.628	0.259	-	2.388	1.233

Notes: 1. Colorado region includes all counties in Wyoming, Utah, New Mexico, Oklahoma, Kansas and Nebraska. Washington region includes all counties in Idaho and Oregon. 2. Mean and standard deviation are calculated using county-level observations, which are similar to but different from those calculated using state-level data. 3. Marijuana possession arrest, marijuana sale/manufacture arrest, DUI arrest, and opium/cocaine possession arrest are measured per 10,000 people. 4. Distance to RML state and distance to interstate exit county are the nearest great-circle distance measured in hundreds of miles.

Table 2b: Summary statistics for Colorado region counties: adult and juvenile subgroups

	Full Sample			Border Counties			Non-Border Counties		
	(1) N	(2) mean	(3) S.D.	(4) N	(5) mean	(6) S.D.	(7) N	(8) mean	(9) S.D.
Panel 1: Adult									
2009-2014									
marijuana possession arrest	2,160	16.08	20.09	174	26.86	44.41	1,986	15.14	16.00
marijuana sale/manufacture arrest	2,160	4.175	6.453	174	5.557	8.167	1,986	4.054	6.268
DUI arrest	2,160	44.55	29.43	174	54.02	36.38	1,986	43.72	28.60
opium/cocaine possession arrest	2,160	1.097	2.358	174	1.563	3.286	1,986	1.056	2.256
2009-2012									
marijuana possession arrest	1,440	16.38	19.19	116	24.63	39.60	1,324	15.66	16.05
marijuana sale/manufacture arrest	1,440	4.108	6.162	116	5.397	8.328	1,324	3.995	5.925
DUI arrest	1,440	48.65	30.81	116	58.08	38.59	1,324	47.83	29.91
opium/cocaine possession arrest	1,440	1.140	2.415	116	1.454	3.381	1,324	1.112	2.311
2013-2014									
marijuana possession arrest	720	15.49	21.78	58	31.34	52.82	662	14.10	15.86
marijuana sale/manufacture arrest	720	4.309	7.001	58	5.876	7.896	662	4.172	6.907
DUI arrest	720	36.35	24.49	58	45.89	30.19	662	35.52	23.77
opium/cocaine possession arrest	720	1.011	2.240	58	1.780	3.107	662	0.943	2.138
Panel 2: Juvenile									
2009-2014									
marijuana possession arrest	2,160	2.313	3.303	174	3.373	4.602	1,986	2.220	3.149
marijuana sale/manufacture arrest	2,160	0.371	1.068	174	0.415	1.674	1,986	0.367	0.998
DUI arrest	2,160	0.561	1.089	174	0.796	1.752	1,986	0.541	1.009
opium/cocaine possession arrest	2,160	0.0369	0.192	174	0.0589	0.367	1,986	0.0349	0.169
2009-2012									
marijuana possession arrest	1,440	2.448	3.404	116	3.539	4.965	1,324	2.352	3.217
marijuana sale/manufacture arrest	1,440	0.358	0.960	116	0.353	1.092	1,324	0.359	0.948
DUI arrest	1,440	0.676	1.233	116	0.928	1.963	1,324	0.654	1.146
opium/cocaine possession arrest	1,440	0.0434	0.187	116	0.0482	0.204	1,324	0.0430	0.185
2013-2014									
marijuana possession arrest	720	2.043	3.076	58	3.041	3.792	662	1.956	2.993
marijuana sale/manufacture arrest	720	0.396	1.258	58	0.540	2.464	662	0.384	1.093
DUI arrest	720	0.331	0.662	58	0.533	1.196	662	0.313	0.591
opium/cocaine possession arrest	720	0.0237	0.203	58	0.0805	0.569	662	0.0188	0.129

Notes: Same as Table 2a.

Table 2c: Summary statistics for Washington region counties: adult and juvenile subgroups

	Full Sample			Border Counties			Non-Border Counties		
	(1) N	(2) mean	(3) S.D.	(4) N	(5) mean	(6) S.D.	(7) N	(8) mean	(9) S.D.
Panel 1: Adult									
2009-2014									
marijuana possession arrest	480	30.44	67.69	96	69.91	141.7	384	20.58	16.12
marijuana sale/manufacture arrest	480	1.528	2.421	96	1.409	2.567	384	1.558	2.385
DUI arrest	480	50.20	21.47	96	55.35	23.51	384	48.92	20.76
opium/cocaine possession arrest	480	2.780	5.684	96	6.698	10.70	384	1.801	2.684
2009-2012									
marijuana possession arrest	320	28.13	61.37	64	61.38	128.5	256	19.81	16.92
marijuana sale/manufacture arrest	320	1.597	2.584	64	1.454	2.702	256	1.633	2.558
DUI arrest	320	51.82	22.48	64	54.72	24.32	256	51.09	21.99
opium/cocaine possession arrest	320	2.287	4.531	64	5.318	8.560	256	1.529	2.168
2013-2014									
marijuana possession arrest	160	35.08	78.83	32	86.98	166.0	128	22.11	14.31
marijuana sale/manufacture arrest	160	1.391	2.055	32	1.319	2.312	128	1.409	1.995
DUI arrest	160	46.98	18.93	32	56.61	22.12	128	44.57	17.31
opium/cocaine possession arrest	160	3.767	7.393	32	9.458	13.78	128	2.345	3.442
Panel 2: Juvenile									
2009-2014									
marijuana possession arrest	480	4.572	4.505	96	6.784	6.783	384	4.019	3.526
marijuana sale/manufacture arrest	480	0.253	0.595	96	0.226	0.615	384	0.260	0.591
DUI arrest	480	0.535	0.792	96	0.424	0.660	384	0.563	0.820
opium/cocaine possession arrest	480	0.0635	0.219	96	0.0820	0.216	384	0.0589	0.220
2009-2012									
marijuana possession arrest	320	4.750	4.865	64	7.155	7.458	256	4.149	3.748
marijuana sale/manufacture arrest	320	0.259	0.583	64	0.284	0.730	256	0.253	0.542
DUI arrest	320	0.633	0.864	64	0.453	0.537	256	0.678	0.924
opium/cocaine possession arrest	320	0.0695	0.246	64	0.0854	0.228	256	0.0656	0.250
2013-2014									
marijuana possession arrest	160	4.216	3.670	32	6.042	5.207	128	3.759	3.032
marijuana sale/manufacture arrest	160	0.241	0.621	32	0.111	0.238	128	0.274	0.681
DUI arrest	160	0.338	0.577	32	0.364	0.862	128	0.332	0.486
opium/cocaine possession arrest	160	0.0515	0.154	32	0.0752	0.193	128	0.0455	0.142

Notes: Same as Table 2a.

Table 3: The effect of RML on marijuana possession arrests by RML border status and distance to RML state

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Colorado Region										
CO Border*RML	8.107**	6.343*								
	(3.993)	(3.822)								
CO Border 100 Miles*RML			6.693**	4.339*						
			(2.756)	(2.619)						
CO Interstate 100 Miles*RML					9.927**	7.172*				
					(4.060)	(3.771)				
Distance to CO*RML							-3.206***	-1.253*		
							(0.713)	(0.667)		
Distance to CO Interstate*RML									-3.480***	-1.139*
									(0.685)	(0.656)
R-squared	0.738	0.756	0.739	0.756	0.740	0.757	0.742	0.755	0.744	0.755
Panel 2: Washington Region										
WA Border*RML	22.859**	21.420**								
	(11.364)	(10.545)								
WA Border 100 Miles*RML			10.535	8.223						
			(6.860)	(5.888)						
WA Interstate 100 Miles*RML					12.659	10.195				
					(8.409)	(7.409)				
Distance to WA*RML							-5.814*	-4.630*		
							(3.053)	(2.547)		
Distance to WA Interstate*RML									-4.400*	-3.176*
									(2.368)	(1.867)
R-squared	0.941	0.941	0.938	0.939	0.938	0.939	0.939	0.939	0.938	0.939
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160 in Panel 1 and 480 in Panel 2. Observations per year are 360 in Panel 1 and 80 in Panel 2. Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

Table 4a: The effect of Colorado RML on marijuana possession arrests, adult and juvenile subgroups

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Adult										
Border*RML	8.330*	6.553								
	(4.236)	(4.086)								
Border 100 Miles*RML			6.922**	4.664*						
			(2.868)	(2.735)						
Interstate 100 Miles*RML					10.144**	7.557*				
					(4.288)	(3.997)				
Distance*RML							-3.198***	-1.312*		
							(0.727)	(0.690)		
Distance to Interstate*RML									-3.445***	-1.214*
									(0.699)	(0.679)
R-squared	0.727	0.746	0.728	0.746	0.729	0.747	0.731	0.745	0.734	0.745
Panel 2: Juvenile										
Border*RML	-0.108	-0.104								
	(0.600)	(0.597)								
Border 100 Miles*RML			-0.155	-0.251						
			(0.460)	(0.458)						
Interstate 100 Miles*RML					-0.232	-0.388				
					(0.597)	(0.593)				
Distance*RML							-0.027	0.037		
							(0.120)	(0.122)		
Distance to Interstate*RML									-0.048	0.052
									(0.113)	(0.124)
R-squared	0.599	0.601	0.599	0.601	0.599	0.601	0.599	0.601	0.599	0.601
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160. Observations per year are 360. Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

Table 4b: The effect of Washington RML on marijuana possession arrests, adult and juvenile subgroups

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Adult										
Border*RML	23.011*	21.427*								
	(11.658)	(10.802)								
Border 100 Miles*RML			10.733	8.193						
			(6.965)	(5.949)						
Interstate 100 Miles*RML					12.740	10.003				
					(8.576)	(7.534)				
Distance*RML							-5.933*	-4.599*		
							(3.083)	(2.555)		
Distance to Interstate *RML									-4.589*	-3.224*
									(2.399)	(1.880)
R-squared	0.941	0.942	0.938	0.939	0.938	0.939	0.939	0.939	0.938	0.939
Panel 2: Juvenile										
Border*RML	-0.650	-0.487								
	(1.044)	(0.994)								
Border 100 Miles*RML			-0.498	-0.246						
			(0.696)	(0.670)						
Interstate 100 Miles*RML					-0.434	-0.138				
					(0.780)	(0.741)				
Distance*RML							0.260	0.102		
							(0.331)	(0.323)		
Distance to Interstate*RML									0.300	0.154
									(0.271)	(0.268)
R-squared	0.679	0.682	0.679	0.681	0.679	0.681	0.680	0.681	0.680	0.682
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 480. Observations per year are 80. Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

Table 5: The effect of RML on marijuana sale and manufacture arrests by RML border status and distance to RML state

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Colorado Region										
CO Border*RML	0.409 (1.378)	0.292 (1.395)								
CO Border 100 Miles*RML			-0.024 (1.046)	-0.332 (1.060)						
CO Interstate 100 Miles*RML					1.474 (1.292)	1.403 (1.310)				
Distance to CO*RML							-0.508* (0.295)	-0.376 (0.334)		
Distance to CO Interstate*RML									-0.575** (0.263)	-0.438 (0.323)
R-squared	0.596	0.602	0.596	0.602	0.597	0.603	0.598	0.603	0.598	0.603
Panel 2: Washington Region										
WA Border*RML	-0.079 (0.350)	-0.076 (0.373)								
WA Border 100 Miles*RML			-0.124 (0.419)	-0.126 (0.469)						
WA Interstate 100 Miles*RML					-0.250 (0.391)	-0.264 (0.426)				
Distance to WA*RML							0.068 (0.193)	0.074 (0.223)		
Distance to WA Interstate*RML									0.065 (0.162)	0.079 (0.191)
R-squared	0.386	0.386	0.386	0.386	0.386	0.386	0.386	0.386	0.386	0.386
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160 in Panel 1 and 480 in Panel 2. Observations per year are 360 in Panel 1 and 80 in Panel 2. Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

Table 6: The effect of RML on DUI arrests by RML border status and distance to RML state

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Colorado Region										
CO Border*RML	0.307 (6.014)	0.033 (5.863)								
CO Border 100 Miles*RML			-0.945 (3.787)	-2.367 (3.649)						
CO Interstate 100 Miles*RML					3.412 (3.729)	1.556 (3.564)				
Distance to CO*RML							-1.045 (1.067)	0.420 (1.060)		
Distance to CO Interstate*RML									-1.750* (0.944)	0.110 (0.958)
R-squared	0.716	0.734	0.716	0.735	0.716	0.734	0.716	0.734	0.717	0.734
Panel 2: Washington Region										
WA Border*RML	9.060* (5.355)	5.118 (4.332)								
WA Border 100 Miles*RML			8.547* (4.636)	2.429 (3.816)						
WA Interstate 100 Miles*RML					7.936* (4.337)	0.849 (4.154)				
Distance to WA*RML							-4.486** (1.915)	-0.503 (1.688)		
Distance to WA Interstate*RML									-4.729*** (1.564)	-0.625 (1.540)
R-squared	0.682	0.737	0.684	0.736	0.682	0.735	0.687	0.735	0.693	0.735
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160 in Panel 1 and 480 in Panel 2. Observations per year are 360 in Panel 1 and 80 in Panel 2. Apart from year, state, and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

Table 7: The effect of RML on opium/cocaine possession arrests by RML border status and distance to RML state

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Colorado Region										
CO Border*RML	0.514 (0.543)	0.270 (0.536)								
CO Border 100 Miles*RML			0.273 (0.334)	0.110 (0.321)						
CO Interstate 100 Miles*RML					-0.019 (0.333)	-0.081 (0.333)				
Distance to CO*RML							-0.208** (0.095)	-0.050 (0.091)		
Distance to CO Interstate*RML									-0.181** (0.088)	-0.023 (0.091)
R-squared	0.580	0.598	0.580	0.598	0.580	0.598	0.582	0.598	0.581	0.598
Panel 2: Washington Region										
WA Border*RML	3.303* (1.922)	2.851 (1.777)								
WA Border 100 Miles*RML			1.494 (1.134)	0.756 (1.010)						
WA Interstate 100 Miles*RML					2.111 (1.381)	1.320 (1.262)				
Distance to WA*RML							-0.799 (0.491)	-0.338 (0.439)		
Distance to WA Interstate*RML									-0.750** (0.369)	-0.280 (0.325)
R-squared	0.723	0.734	0.715	0.726	0.718	0.727	0.716	0.726	0.718	0.726
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160 in Panel 1 and 480 in Panel 2. Observations per year are 360 in Panel 1 and 80 in Panel 2. Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

Table 8a. Event study of RML on marijuana possession arrests, Colorado region

	(1)	(2)	(3)	(4)	(5)	(6)
2010*Border	-1.848 (3.160)	-2.472 (3.273)				
2011*Border	-2.624 (3.759)	-3.782 (3.771)				
2012*Border	10.130 (9.449)	8.364 (9.486)				
2013*Border	7.309 (6.565)	5.008 (6.518)				
2014*Border	11.751** (4.882)	8.887* (4.740)				
2010*Border 100 Miles			-1.526 (2.259)	-2.311 (2.339)		
2011*Border 100 Miles			2.015 (2.893)	0.502 (2.911)		
2012*Border 100 Miles			6.252 (5.422)	3.927 (5.374)		
2013*Border 100 Miles			5.855 (4.187)	2.765 (4.068)		
2014*Border 100 Miles			10.991*** (3.584)	7.151** (3.380)		
2010*Interstate 100 Miles					-3.283 (3.275)	-4.141 (3.390)
2011*Interstate 100 Miles					2.352 (4.288)	0.616 (4.388)
2012*Interstate 100 Miles					7.535 (8.288)	4.879 (8.132)
2013*Interstate 100 Miles					8.329 (6.179)	4.790 (5.930)
2014*Interstate 100 Miles					14.955*** (5.095)	10.529** (4.735)
R-squared	0.741	0.758	0.741	0.757	0.742	0.758
Year Dummies	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. Total number of observations is 2,160 for all specifications.

Table 8b. Event study of RML on marijuana possession arrests, Washington region

	(1)	(2)	(3)	(4)	(5)	(6)
2010*Border	4.655 (8.263)	4.198 (8.184)				
2011*Border	5.505 (13.113)	4.528 (12.805)				
2012*Border	6.422* (3.794)	4.979 (3.632)				
2013*Border	31.124* (16.322)	29.215* (15.258)				
2014*Border	22.979 (15.671)	20.584 (14.535)				
2010*Border 100 Miles			1.912 (4.789)	1.003 (4.651)		
2011*Border 100 Miles			0.916 (7.430)	-0.843 (7.023)		
2012*Border 100 Miles			1.612 (3.700)	-0.905 (3.469)		
2013*Border 100 Miles			13.660 (9.547)	10.331 (8.218)		
2014*Border 100 Miles			9.629 (9.454)	5.532 (8.080)		
2010*Interstate 100 Miles					3.750 (5.775)	2.882 (5.641)
2011*Interstate 100 Miles					1.964 (9.067)	0.259 (8.665)
2012*Interstate 100 Miles					6.515* (3.574)	4.004 (3.282)
2013*Interstate 100 Miles					18.696 (11.823)	15.377 (10.526)
2014*Interstate 100 Miles					12.759 (11.507)	8.638 (10.124)
R-squared	0.941	0.942	0.938	0.939	0.939	0.939
Year Dummies	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. Total number of observations is 480 for all specifications.

Table 9: The effect of RML on marijuana possession arrests in Colorado region controlling for trends in Medical Marijuana Registry Program (MMRP) enrollees

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CO Border*RML	6.687*	5.340								
	(3.579)	(3.399)								
CO Border 100 Miles*RML			5.987**	4.160						
			(2.702)	(2.607)						
CO Interstate 100 Miles*RML					9.392**	7.235*				
					(4.009)	(3.815)				
Distance to CO*RML							-2.477***	-0.983		
							(0.660)	(0.657)		
Distance to CO Interstate*RML									-2.659***	-0.891
									(0.627)	(0.647)
R-squared	0.739	0.756	0.739	0.756	0.740	0.757	0.743	0.756	0.746	0.755
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160. Observations per year are 360. Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles. Total MMRP enrollees are 41,039 in 2009, 116,198 in 2010, 82,089 in 2011, 108,526 in 2012, 110,979 in 2013, and 115,467 in 2014.

Table 10a: The effect of RML on police officer employment in Colorado and Washington regions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Colorado Region										
Border*RML	1.813 (2.055)	1.794 (1.893)								
Border 100 Miles*RML			0.994 (1.176)	0.939 (1.141)						
Interstate 100 Miles*RML					-0.479 (0.653)	-0.789 (0.649)				
Distance*RML							-0.324 (0.248)	-0.247 (0.182)		
Distance to Interstate*RML									-0.324* (0.179)	-0.230 (0.155)
R-squared	0.921	0.921	0.921	0.921	0.920	0.921	0.921	0.921	0.921	0.921
Panel 2: Washington Region										
Border*RML	-1.447 (1.541)	-1.578 (1.481)								
Border 100 Miles*RML			-1.488 (1.110)	-1.747* (1.023)						
Interstate 100 Miles*RML					-0.644 (0.985)	-0.868 (1.160)				
Distance*RML							0.550 (0.426)	0.750* (0.383)		
Distance to Interstate*RML									0.309 (0.300)	0.524* (0.287)
R-squared	0.861	0.861	0.862	0.862	0.860	0.860	0.861	0.862	0.860	0.861
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

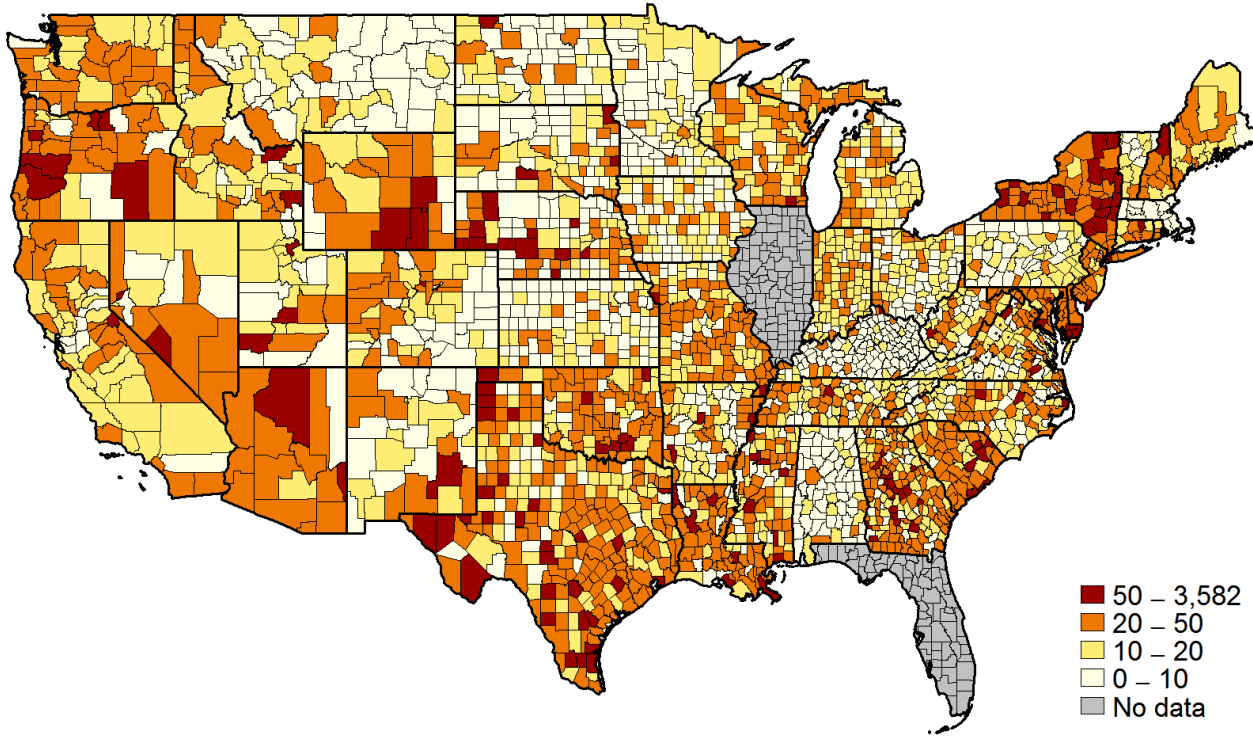
Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160 in Panel 1 and 474 in Panel 2. Observations per year are 360 in Panel 1 and 79 in Panel 2 (Marion County excluded). Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

Table 10b: The effect of RML on total police agency employees in Colorado and Washington regions

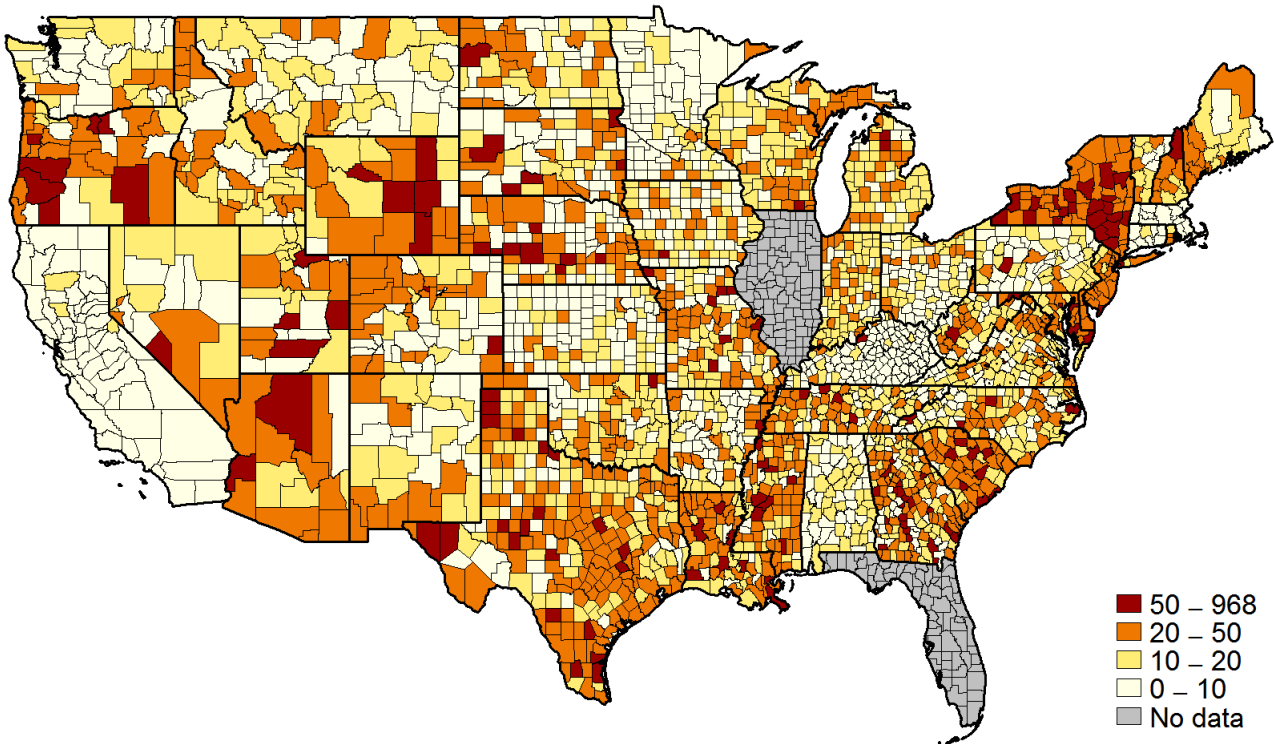
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Colorado Region										
Border*RML	1.991 (1.381)	2.028 (1.305)								
Border 100 Miles*RML			1.106 (0.906)	1.076 (0.901)						
Interstate Exit 100 Miles*RML					1.179 (0.966)	0.892 (1.003)				
Distance*RML							-0.461* (0.250)	-0.466* (0.260)		
Distance to Interstate Exit*RML									-0.474** (0.225)	-0.489* (0.266)
R-squared	0.914	0.914	0.913	0.914	0.913	0.914	0.914	0.914	0.914	0.914
Panel 2: Washington Region										
Border*RML	-0.394 (1.990)	0.099 (2.039)								
Border 100 Miles*RML			-2.173 (2.065)	-1.575 (1.663)						
Interstate 100 Miles*RML					2.026 (1.379)	3.076 (1.900)				
Distance*RML							0.865 (0.708)	0.472 (0.491)		
Distance to Interstate*RML									0.659 (0.577)	0.224 (0.379)
R-squared	0.830	0.832	0.831	0.833	0.831	0.835	0.831	0.833	0.831	0.832
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160 in Panel 1 and 474 in Panel 2. Observations per year are 360 in Panel 1 and 79 in Panel 2 (Marion County excluded). Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

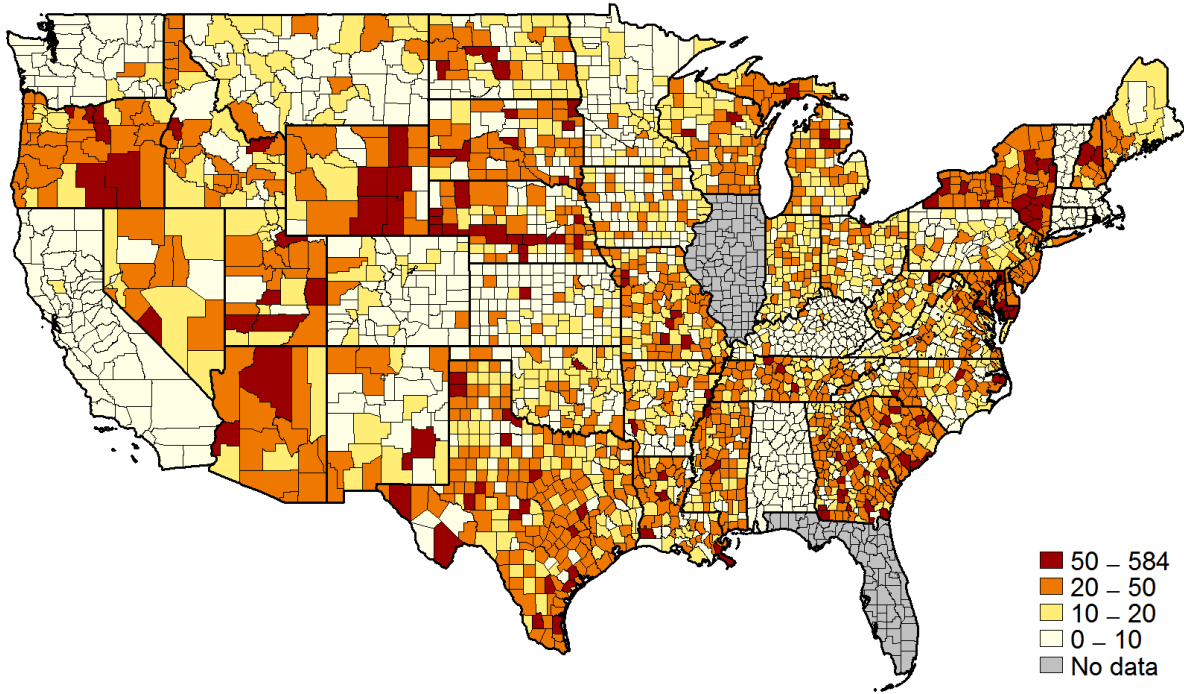
Appendix 1a: County marijuana possession arrests per 10,000 population, 2010



Appendix 1b: County marijuana possession arrests per 10,000 population, 2012



Appendix 1c: County marijuana possession arrests per 10,000 population, 2014



Appendix 2: The effect of RML on marijuana possession arrests by RML border status and distance to RML state (year 2012 excluded)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel 1: Colorado Region										
CO Border*RML	11.049*	9.063								
	(6.273)	(6.190)								
CO Border 100 Miles*RML			8.272**	5.565						
			(3.810)	(3.713)						
CO Interstate 100 Miles*RML					11.817**	8.688				
					(5.703)	(5.486)				
Distance to CO*RML							-3.930***	-1.761*		
							(1.016)	(1.054)		
Distance to CO Interstate*RML									-4.245***	-1.698
									(0.987)	(1.108)
R-squared	0.751	0.773	0.751	0.771	0.753	0.773	0.756	0.771	0.760	0.771
Panel 2: Washington Region										
WA Border*RML	23.253**	21.414**								
	(10.979)	(9.951)								
WA Border 100 Miles*RML			10.698	7.709						
			(6.995)	(5.832)						
WA Interstate 100 Miles*RML					13.728	10.626				
					(8.323)	(7.065)				
Distance to WA*RML							-6.298*	-4.820*		
							(3.235)	(2.675)		
Distance to WA Interstate*RML									-4.856*	-3.337
									(2.560)	(2.069)
R-squared	0.940	0.940	0.937	0.938	0.937	0.938	0.938	0.938	0.937	0.938
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 1,800 in Panel 1 and 400 in Panel 2. Observations per year are 360 in Panel 1 and 80 in Panel 2. Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles.

Appendix 3: The effect of RML on marijuana possession arrests in Colorado region controlling for MMRP enrollees in nearest Colorado county

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
CO Border*RML	8.175** (3.764)	6.381* (3.818)								
CO Border 100 Miles*RML			6.394** (2.663)	4.359* (2.623)						
CO Interstate 100 Miles*RML					9.204** (3.943)	7.178* (3.771)				
Distance to CO*RML							-2.920*** (0.674)	-1.263* (0.670)		
Distance to CO Interstate*RML									-3.104*** (0.648)	-1.143* (0.657)
MMRP enrollees	0.323*** (0.079)	0.031 (0.092)	0.312*** (0.079)	0.027 (0.092)	0.299*** (0.077)	0.023 (0.091)	0.277*** (0.077)	0.029 (0.092)	0.238*** (0.075)	0.024 (0.092)
R-squared	0.742	0.756	0.742	0.756	0.743	0.757	0.745	0.755	0.746	0.755
Year Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
County Dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
State Specific Linear Time Trends	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES

Notes: *** p<0.01, ** p<0.05, * p<0.1. Estimates are obtained using OLS with standard errors (in parentheses) clustered by county. The number of observations for each specification is 2,160. Observations per year are 360. Apart from year and county dummies, control variables include county population, county unemployment rate, and county median household income. Distances are measured in the unit of 100 miles. MMRP enrollees are the Colorado Medical Marijuana Registry Program enrollees per 1,000 people in the nearest Colorado county.