The Effect of Legalizing Retail Marijuana on Housing Values: Evidence from Colorado

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Abstract

Does legalizing retail marijuana generate more benefits than costs? This paper provides a first step toward addressing that question by measuring the benefits and costs that are capitalized into housing values. We exploit the time-series and cross-sectional variations in the adoption of Colorado's municipality retail marijuana laws (RMLs) and examine the effect on housing values with a difference-in-differences strategy. Our estimates show that the legalization leads to an average 6 percent increase in housing values, indicating that the capitalized benefits outweigh the costs. In addition, we find suggestive evidence that this relatively large housing value appreciation is likely due to RMLs inducing strong housing demand while having no discernible effect on housing supply. Finally, we show that the effect of RMLs is heterogeneous across locations and property types.

Keywords: retail marijuana legalization; housing value; capitalization; difference-in-differences

JEL Codes: K20, R28

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1. Introduction

Almost 80 years after the U.S. government effected marijuana prohibition, and following a recent wave of states decriminalizing medical marijuana, a few states are experimenting with legalizing recreational marijuana. In 2012, voters in Colorado and Washington approved recreational marijuana legalization, followed by Alaska and Oregon in 2014, and California, Maine, Massachusetts, and Nevada in 2016. In all these states, adults 21 years or older can legally possess small amounts of marijuana for recreational purpose; however, it is local governments that determine whether the retail sale of recreational marijuana is allowed within their jurisdictions.[1] An important policy question therefore is whether legalizing retail marijuana brings net benefits given that the legalization could simultaneously generate significant benefits and costs. For example, potential benefits include legal and easier access to recreational marijuana, more job opportunities arising from both the retail marijuana and related industries, and increased tax revenues and budgetary savings for local governments, while there are also potential costs such as the adverse impacts on public health and increased illegal activities exacerbated by retail marijuana sales. However, this question has not been answered yet.

In this paper we attempt to shed light on this question by examining the benefits and costs of retail marijuana legalization that are capitalized by the housing market. Specifically, we measure the effect of legalizing retail marijuana on local housing values.[2] This strategy builds upon an extensive literature that assesses the benefits and costs of public programs that change local amenities and disamenities (e.g., housing characteristics, local labor market,

[1] Some states also allow legal cultivation of small amounts of recreational marijuana (e.g., Colorado), while some only permit licensed growers to do so (e.g., Washington). Washington DC legalized the possession and cultivation of recreational marijuana in 2014, but the retail sale is still illegal.

[2] Understanding the effect on housing values per se is also important because they account for a large portion of household wealth and government tax revenue. Iacoviello (2011) reports that housing wealth is about one half of total household net worth and almost two thirds of the total wealth of the median household. Research has shown that housing wealth affects important household decisions such as consumption (Campbell and Cocco 2007, Gan 2010), education (Lovenheim 2011, Lovenheim and Reynolds 2013), and fertility (Lovenheim and Mumford 2013). According to data compiled by the Tax Policy Center (2015), local property taxes account for about 70% – 80% of local tax revenue between 1977 and 2013.

school quality, demographics, and environment) through the lens of the housing market. The logic is straightforward: As home buyers and sellers respond to changes in local amenities and disamenities (Linden and Rockoff 2008), the associated benefits and costs of the public programs, such as legalizing retail marijuana, are capitalized into housing values. However, the net effect on housing values is ambiguous *ex ante* given the opposing effects of the benefits and costs. For example, on the one hand, the benefits of retail marijuana legalization potentially raise housing values by either increasing housing demand (e.g., attracting more home buyers) or decreasing housing supply (e.g., discouraging homeowners from selling their properties and moving). On the other hand, the costs have the opposite effects on demand and supply and, therefore, potentially lower housing values. Thus, this paper estimates the *net* effect of legalizing retail marijuana on housing values, which reflects the net capitalization of the benefits and costs by the housing market. Our analysis focuses on Colorado – the first state that legalized recreational marijuana in the U.S. – for which we can identify the municipalities that have passed retail marijuana legalization ordinance, referred to as "retail marijuana law" (RML), along with RML effective dates. By August 2015, 17 percent of Colorado's municipalities adopted RML, accounting for about 30 percent of the state population. We link such information on RMLs with detailed information on the near-universe of residential property transactions in Colorado from 2010 to 2015 to identify the effect of RMLs on housing values.

In order to distinguish the effect of RMLs from the effect of other housing value determinants, we use a difference-in-differences (DD) strategy to exploit both time-series and cross-sectional variations in RML adoptions. Specifically, we compare housing value *changes* in municipalities that allow retail marijuana (treatment group) before and after enacting RML, relative to similar changes in other municipalities that do not (control group). In order to control for potential common time-varying housing price shocks, we further

compare treatment and control municipalities that are of similar population sizes and within the same metropolitan or micropolitan statistical areas. The identifying assumption of the DD strategy requires that housing values in both adopting and non-adopting municipalities should have trended similarly in the absence of RMLs. We find this assumption appears quite plausible for several reasons. First, we find changes in housing characteristics and municipality demographics are not significantly different between adopting and non-adopting municipalities. Along similar lines, controlling for these covariates does not affect the DD estimate. Second, we use an event study to examine housing value trends and find no evidence of divergence before adopting RMLs. More importantly, we find that the divergence of housing values occurred right after retail marijuana was legalized, suggesting a causal interpretation of our results.

Our estimates show that on average legalizing retail marijuana in Colorado increases housing values by approximately 6 percent, or $15,600 per property, which can explain about 27 percent of the overall housing price appreciation in adopting municipalities during the examination period. This net positive effect indicates that the benefits of RMLs that are capitalized into housing values outweigh corresponding costs. While this estimated effect may seem large, especially considering the relatively short post-adoption period, we find it is likely due to that RMLs increase housing demand but have little impact on housing supply. In addition, our event study shows that housing values experienced an immediate jump of 3 percent within one quarter after the adoption of RMLs, followed by a steady increase henceforth. Moreover, we show that the effect of RMLs is heterogeneous across different locations and property types: The effect is largest in populous areas (urban municipalities and metropolitan statistical areas) and strongest among properties in low and middle price tiers (below $500,000). Finally, our findings are robust to a number of sensitivity checks.

This paper contributes to several literatures. First, to the best of our knowledge, it is

the first empirical analysis of the benefits and costs of recreational marijuana legalization in the U.S. By focusing on the benefits and costs that are capitalized into housing values, it provides causal empirical evidence and informs the debate and policy formation regarding the overall benefits and costs of marijuana legalization. Second, this paper joins a growing literature that uses quasi-experimental methods to evaluate the housing market capitalization of the benefits and costs of various public programs that change local amenities and disamenities, such as those related to crime (Linden and Rockoff 2008, Pope 2008), education (Black 1999, Figlio and Lucas 2004), and environment (Bui and Mayer 2003, Chay and Greenstone 2005, Currie, Davis, Greenstone, and Walker 2015, Davis 2004, 2011, Greenstone and Gallagher 2008, Muehlenbachs, Spiller, and Timmins 2015). Broadly, it joins the voluminous hedonic pricing literature, as reviewed by Sirmans, Macpherson, and Zietz (2005), that estimates the implicit prices of housing and local amenities. Finally, our study is closely related to studies on the U.S. state medical marijuana laws that focus on the effects on public health.[3]

2. Background

2.1. Retail Marijuana Legalization in Colorado

In November 2012, Colorado became one of the first two states in the United States to legalize recreational marijuana as voters passed Amendment 64, which allows adults 21 years or older to legally possess one ounce or less of marijuana, grow no more than six marijuana plants, and transfer up to one ounce of marijuana to another adult without remuneration. One important aspect of Amendment 64 is that local governments, namely counties and municipalities, can decide on whether to permit retail sale of recreational marijuana, as there are valid concerns over the associated negative health, social, and economic

[3] See Anderson and Rees (2014) and Wen, Hockenberry, and Cummings (2015) for a review.

consequences. As a result, the common practice for local governments is to initially ban or impose a moratorium on retail marijuana. If a local government later elects to legalize retail marijuana by passing a retail marijuana ordinance (i.e., RML), a license-based regulatory system would be established to issue licenses through an application process for operating retail marijuana businesses.[4] This paper focuses on RMLs at the incorporated municipality level as they can supersede county-level RMLs when there is a conflict.[5] By August 2015, 46 out of 271 Colorado incorporated municipalities had passed RML, according to Colorado Department of Revenue (2015).

Recently, Johns (2015) examines the adoption of RMLs in Colorado by surveying 110 local government officials (e.g., municipality managers, administrators and clerks) in 22 counties.[6] One-fifth of the municipalities that adopt RMLs indicated that public opinion, community culture, and economic considerations were important in administrators' legalization decisions. Nearly all respondents (95.5 percent) cited public opinion as a reason for adopting RMLs. Half of the municipalities chose community culture – shared beliefs, values, and common practices – as the reason. The respondents also acknowledged different sources of tax revenues as reasons for the adoption: revenues generated by taxes (50 percent), revenues generated by applications for marijuana establishments (27.3 percent), and revenues generated by other related businesses (18.2 percent). In comparison, factors that led non-adopting municipalities to ban retail marijuana include "morality/not good for community" (65.6 percent), "public safety issues" (49.2 percent), "public opinion" (49.2 percent), "enforcement costs are too high" (42.6 percent), and "planning and implementation costs are too high" (19.7 percent).

[4] The decision for a local municipality to pass its RML is ultimately determined by votes of council members. This makes us essentially estimate the "intent-to-treat" effect of RMLs.
[5] Incorporated municipalities are cities and towns that can pass laws to govern themselves as they see fit. In comparison, unincorporated municipalities are governed by larger administrative divisions, such as a county or state.
[6] The study also includes a penal discussion with 6 local managers and administrators, which yields similar findings to the survey.

2.2. Major Examples of Benefits and Costs of RMLs

Legalizing retail marijuana brings adopting municipalities significant benefits and costs that change local amenities and disamenities. Below we briefly discuss some major examples of the legalization-led benefits and costs for two reasons. First, it is difficult to enumerate all possibilities in each category. Second, understanding how home buyers and sellers respond to these benefits and costs would sufficiently illustrate their response to all the benefits and costs in general.

On the benefit side, the easier and regulated access to recreational marijuana stands out as the most straightforward benefit, which becomes available at licensed marijuana dispensaries after the legalization. The second major benefit is that retail marijuana legalization – also widely known as the "green rush" – creates unprecedented business and employment opportunities. According to ArcView Market Research (2016), a marijuana industry investment and research firm, the U.S. adult-use marijuana sales experienced an explosive growth rate of 232 percent, up from $373.8 million in 2013 to $1.2 billion in 2014. In addition, the retail marijuana industry could also create many jobs and opportunities for related businesses, generating spillover benefits.[7] The third main benefit comes from the increased tax revenues and budgetary savings for local governments, which is expected to help improve the provision of local public goods in general. For instance, in the fiscal year 2014-2015, $6.3 million, or 15 percent, of the retail marijuana sales tax was distributed among local governments in Colorado.[8] Moreover, RMLs significantly free local governments from the burden of criminal justice related to marijuana law enforcement (Evans 2013). Miron (2010) estimates that nationwide marijuana legalization could reduce police service, prosecutional,

[7] For example, one CNN report finds retail marijuana legalization creates other job opportunities in areas such as branding, odor control, lightning panels, and web design. See http://money.cnn.com/2015/03/09/smallbusiness/marijuana-startups/.
[8] The other 85 percent of the retail marijuana sales tax, along with sales tax (2.9 percent rate) and retail marijuana excise tax (15 percent rate), transfer to the state marijuana tax cash fund. See https://www.colorado.gov/pacific/revenue/colorado-marijuana-tax-data.

judicial, and incarceration expenses by approximately $13.7 billion per year in the U.S., which is roughly twice the estimate of the related tax revenue ($6.4 billion). Miron's statistics also suggest that about 68 percent of the budgetary savings accrue to state and local governments.[9]

On the cost side, the most obvious cost would be the adverse effects arising from marijuana consumption on public health. As reviewed by Hall and Degenhardt (2009), 10 years of epidemiological, clinical, and laboratory studies find many adverse effects of non-medical marijuana use, with dependence syndrome, increased risk of motor vehicle crashes, impaired respiratory function, and cardiovascular disease being the most probable.[10] An annual report released by Colorado's Rocky Mountain High Intensity Drug Trafficking Area (Wong and Clarke 2015), part of the federal government, compiles data from different sources and provides consistent evidence of the adverse effects. It shows that in 2014, when retail marijuana businesses began operating in Colorado, marijuana-related traffic deaths increased by 32 percent, marijuana-related emergency room visits increased by 29 percent, marijuana-related hospitalizations increased by 38 percent, marijuana-related exposure increased by 72 percent, and marijuana-related impaired driving increased by 45 percent, compared to 2013. Another potential major cost could come from increased illegal activities caused by RMLs that create negative externalities to local residents. One possible reason is that retail marijuana dispensaries are operated cash-only because marijuana's illegal federal status prevents them from depositing cash in banks or using credit card services, which lures criminals.[11] Another possible reason is that RMLs could invite more marijuana trafficking to local communities as criminal groups exploit the retail sale legalization (Drug Enforcement Administration 2013).

[9] Miron (2010) finds that among the $48.7 billion annual budgetary savings due to legalizing drugs, including marijuana, cocaine, heroin, and other drugs, $33.1 billion would accrue to state and local governments and $15.6 million to the federal government.

[10] Despite the adverse effects of marijuana consumption on public health, Anderson and Rees (2014) argue that legalizing recreational marijuana could lead to reductions in alcohol use and therefore generate net public health benefits. This conclusion is based on economics studies that use clearly defined natural experiments to show marijuana and alcohol are substitutes (Anderson, Hansen, and Rees 2013, Crost and Guerrero 2012, DiNardo and Lemieux 2001).

[11] See http://www.nbcnews.com/storyline/legal-pot/high-crimes-robber-gangs-terrorize-colorado-pot-shops-n20111.

This is evidenced by a 55 percent increase in seized parcel packages containing marijuana sent from Colorado within one year after retail marijuana was allowed (Wong and Clarke 2015).

2.3. Conceptual Framework: Short-Run Capitalization Effects

There exists a large literature on assessing the effects of public programs through local housing markets.[12] For example, Hilber (2017) recently reviews the literature that examines how fiscal differentials (e.g., differences in local public services and property taxes) are capitalized into housing values as housing market participants respond to the perceived benefits and costs by "voting with their feet." Following these studies, we present a simple conceptual framework to illustrate the capitalization effects of legalizing retail marijuana, by focusing on housing market participants who are most likely responding to the legalization: new migrants and tenants on the demand side, as well as homeowners on the supply side.[13]

Specifically, the benefits and costs of retail marijuana legalization are capitalized into housing values through affecting both demand and supply of the residential housing market. On the benefit side, the benefits brought by RMLs obviously attract more migrants – whether it be marijuana users, entrepreneurs, or job seekers – to relocate, which drives up local housing demand. Similarly, such benefits improve local amenities and make existing residents more willing to stay, by either converting more tenants to home buyers or keeping more homeowners from selling their properties and moving out. Therefore, the benefits of retail marijuana legalization increase housing demand and decrease housing supply, leading housing values to rise. Meanwhile, the costs of RMLs dampen housing values by impacting housing demand and supply in the exactly opposite directions, through discouraging new migrants from relocating to adopting municipalities and crowding out existing residents. Combined together,

[12] This strand of literature dates back to Oates (1969) who argues that local public goods and taxes affect residents' location decisions and therefore impact local property values.
[13] Residential developers could also respond to the strong housing demand by building more properties, but this is more likely to happen in the medium and long run.

the net effect of RMLs on housing values is ambiguous *ex ante*, and housing could rise or fall, depending on whether the benefits or costs of legalizing retail marijuana would dominate.[14]

3. Identification Strategy

To identify the reduced form effect of legalizing retail marijuana on housing values, we adopt a difference-in-differences (DD) strategy and estimate the following baseline unbalanced panel data model by ordinary least squares (OLS):

$$(1) \quad Outcome_{inmy} = \beta_0 + \beta_1 RML_{inmy} + \mathbf{X}_{inmy}\boldsymbol{\gamma} + \eta_n + \mu_{my} + \lambda_i + \theta_{cy} + \rho_{sy} + \varepsilon_{inmy},$$

where $Outcome_{inmy}$ is the natural logarithm of the sale price of property i in municipality n in month m of year y, RML_{inmy} is an indicator variable that equals 1 if the sale of property i in municipality n in month m of year y happened after RML became effective and 0 otherwise, $\mathbf{X}_{inmy}$ is a vector of property characteristics, municipality-level time-varying demographic factors, including an indicator of whether a medical marijuana licensing system is in place, η_n is the municipality fixed effects, μ_{my} includes month and year fixed effects, λ_i is the property fixed effects, θ_{cy} is the municipality type-by-year fixed effects, ρ_{sy} is the core based statistical area-by-year fixed effects, and ε_{inmy} is the idiosyncratic term.[15] Importantly, we use λ_i to control for the effect of time-invariant unobserved housing characteristics, a common strategy adopted by many other studies (Currie, Davis, Greenstone, and Walker 2015, Figlio and Lucas 2004). We also include θ_{cy} and ρ_{sy} to account for the common housing price shocks to the same municipality types (classified by population size) and core based statistical areas over time. We cluster robust standard errors at the municipality level to account for potential serial error correlation following Bertrand, Duflo,

[14] The benefits of RMLs to some housing market participants could be costs to the others. For example, legalizing retail marijuana could signal a municipality's political leanings, which attract homebuyers who share the same political beliefs and discourage others who do not.

[15] Municipality types and core based statistical areas are discussed in detail in Section 4.

and Mullainathan (2004). The parameter of interest is β_1, which represents the effect of RMLs on the log of housing prices and, thus, the net capitalization of the benefits and costs of legalizing retail marijuana.

Conceptually, the identification strategy compares *changes* in housing prices between properties in adopting municipalities and properties in non-adopting municipalities before and after adopting RMLs. Causal inference hinges crucially on the identifying assumption that housing values in both types of municipalities should have followed a parallel trend in the absence of RMLs. This assumption only requires that adopting and non-adopting municipalities are comparable in *changes*, rather than *levels*, in aspects like housing characteristics and local demographics in the absence of RMLs. Under this assumption, any divergence in the housing value trend after the adoption of RMLs should be interpreted as the causal effect of legalizing retail marijuana. A natural concern about this assumption is that there might already exist diverging housing value trends before RMLs were adopted. We address this concern by using an event study to investigate whether there was divergence in the pre-adoption period.

4. Data

Our empirical analysis combines several sources of data. The first is information on the adoption of RMLs, including the set of adopting municipalities and the timing of the adoptions. Using data from Colorado Department of Revenue (2015), we identify 46 out of the 271 Colorado incorporated municipalities that passed RML by August 12, 2015. We further identify the effective dates of RMLs from retail marijuana ordinances, via media reports, and by contacting local authorities.

The second data source is a dataset that covers the near-universe of the residential property transactions in Colorado, provided by FNC, Inc., a national real estate data provider

that provides detailed transaction-level information by assembling data from tax assessors and county records. Specifically, this transaction dataset contains data on sale price, sale date, location, and other property characteristics including property age, number of bedrooms, number of bathrooms, and gross living area, which are important housing price determinants (Dorsey, Hu, Mayer, and Wang 2010, Hill 2013). Importantly, we use sale price to measure the outcome of interest, housing value. We do so by following the literature: restricting our attention to arm's length transactions. This is because property sale prices are more likely to reflect their fair market values in arm's length transactions, in which home buyers and sellers are not related to each other and act independently. To ensure that extreme property sales do not drive the result, we further drop sales with prices over $10 million. Data on sale date and location, combined with RML effective dates, enable us to construct the key explanatory variable RML in Equation (1), as discussed in Section 3. Moreover, we limit the sample to properties with repeat sales in the main analysis, as our identification strategy aims at reducing the effect of unobserved confounders and focuses on comparing price changes within the same properties. Along similar lines, our research design controls for the common time-varying housing price shocks to the same municipality types and core based statistical areas (CBSAs). In doing so, we classify three municipality types based on population size: large urban areas (population $\geqslant$ 250,000), small urban areas (2,500 < population < 250,000), and rural areas (population $\leqslant$ 2,500). CBSAs are geographic entities that contain a core urban area and have "a high degree of social and economic integration" (U.S. Census Bureau 2013) and have two categories: metropolitan statistical area (MSA: containing an urban cluster of at least 50,000 population) and micropolitan statistical area (MA: containing an urban cluster of at least 10,000 but less than 50,000 population). Colorado has seven MSAs and ten MAs.[16] Since

[16] The seven MSAs include Boulder, Colorado Springs, Denver-Aurora-Lakewood, Fort Collins, Grand Junction, Greeley, and Pueblo. The ten MAs include Breckenridge, Cañon City, Craig, Durango, Edwards, Fort Morgan, Glenwood Springs, Montrose, Steamboat Spring, and Sterling.

the vast majority of the property sales are from core based statistical areas (CBSAs), our main analysis focuses on CBSA sales.

Another data source we use is the American Community Survey (ACS) published by U.S. Census Bureau (2010 - 2014), which provides time-varying municipality demographics and allows us to control for their potential confounding effects on housing values. This includes data on population, proportion of males, proportion of whites, proportion of Hispanics, percentage of population with a high school diploma, and percentage of population with a bachelor's degree. Additionally, similar to how RML data were collected, we collected information on municipality medical marijuana policies that regulate the commercial distribution of medical marijuana.

We merge the above-mentioned data sources and choose the sample period between January 1, 2010 and August 12, 2015; housing prices are adjusted using dollar value in 2010.[17] This yields a dataset of 91,943 sales from 141 incorporated municipalities; the 30 municipalities that have adopted RMLs and the 111 non-adopting municipalities are listed in Table 1.[18] Among the 30 adopting municipalities, most (70 percent) are urban areas and about half (53 percent) are MSAs. Figure 1 presents the geographical distribution of these 141 cities and towns. Figure 2 shows the variation in the timing of the 30 RMLs, most of which were adopted in the second half of 2013 and in the first quarter of 2014. Table 2 presents descriptive statistics for the full sample (Column 1), as well as for both adopting and non-adopting municipalities before and after the adoption of RMLs separately (Columns 2 through 5). As municipalities in our sample started to adopt RMLs in the second half of 2013 and demographic data are only available annually, Table 1 does not include the 2013 data when

[17] Since the complete 2015 ACS data are not available as of this writing, we extrapolate them using ACS data from 2010 to 2014.

[18] It is important to note that our merged dataset is still representative, in which the 141 incorporated municipalities cover 95 percent of the population in all 271 incorporated municipalities and the 30 adopting municipalities cover nearly 98 percent of the population in all 46 municipalities that have passed RMLs.

examining subsamples.[19] Column 6 compares adopting and non-adopting municipalities before the adoption of RMLs, showing statistically significant differences in all housing characteristics and most municipality features, which suggests self-selection. However, these differences in *levels* are not necessarily a threat to our identification, because our research design relies on the assumption that adopting and non-adopting municipalities are comparable in differences in *changes*. Column 7 directly calculates the relative time-series changes between adopting and non-adopting municipalities, which supports the DD assumption. Consistent with the identifying assumption, differences in relative changes are statistically insignificant for all covariates except for the adoption of medical marijuana policy, which we find is driven by two municipalities deciding to regulate the medical marijuana distribution while passing RMLs. In contrast, changes in housing prices are systematically different between adopting and non-adopting municipalities, coinciding with the adoption of RMLs, which suggests a positive effect of retail marijuana legalization.

To complement our main analysis, we also make use of FNC's multiple listings (MLS) dataset to further examine the effect of RMLs on housing market participants.[20] This dataset provides property-listing-level information – listing date, listing price, sale date, and sale price – along with other property-level information (e.g., property location, property age, number of bedrooms, number of bathrooms, and gross living area). Hence, we construct an outcome measure of sale price premium, defined by (sale price / listing price – 1), in order to capture home buyers' willingness to pay. Similarly, we aggregate the number of new listings at the monthly level to assess housing supply by existing homeowners. Particularly, we use MLS data that are from a subset of the 141 incorporated municipalities used in the main analysis, because the MLS and transaction datasets do not have exactly the same municipality coverage.

[19] Only 2014 data are used for the post-adoption period because demographic data are extrapolated for 2015.
[20] This dataset is licensed through a Colorado-based company that specializes in monitoring nationwide real estate for-sale advertising and has an excellent coverage of Colorado's MLS data particularly.

5. Results

5.1. Event Study

In order to motivate the regression analyses that would follow, we present an event study to examine the evolution of the housing value difference between adopting and non-adopting municipalities. This helps better understand the effect of retail marijuana legalization on housing values from two perspectives. First, it allows us to examine how the treatment effect evolves over time. Second, and more importantly, it provides an opportunity to evaluate the validity of the common trend assumption of our DD identification strategy. In doing so, we add leading and lagging indicators to Equation (1) and estimate the following equation in order to calculate housing value differences before and after adopting RMLs:

$$(2)\quad Outcome_{inmy} = \alpha_0 + \sum_{q=1}^{Q} \alpha_q^{Pre} Pre_{inmy}^{q} + \sum_{q} \alpha_q^{Post} Post_{inmy}^{q} + \mathbf{X}_{inmy}\boldsymbol{\gamma} + \eta_n + \mu_{my} + \lambda_i + \theta_{cy} + \rho_{sy} + \varepsilon_{inmy},$$

where Pre_{inmy}^{q} is a dummy variable that equals 1 if the sale of property *i* in municipality *n* in month *m* of year *y* occurred within the q^{th} quarter before municipality *n* passed RML and 0 otherwise; $Post_{inmy}^{q}$ is similarly defined that equals 1 if the sale was within the q^{th} quarter after municipality *n* passed RML and 0 otherwise. Hence, α_q^{Pre}s and α_q^{Post}s measure property value differences between treatment and control municipalities beginning from the Q^{th} quarter before the adoption of RMLs, *relative* to the price differences in omitted time periods, after controlling for $\mathbf{X}_{inmy}$, η_n, μ_{my}, λ_i, θ_{cy}, and ρ_{sy}. Figure 3 plots estimates of α_q^{Pre}s and α_q^{Post}s along with their 95 percent confidence intervals.[21] By choosing Q = 12, we can examine a relatively longer pre-adoption period of three years. The 12 estimates of α_q^{Pre}s are similar and statistically indistinguishable from each other, all of which are also

[21] The estimate corresponding to "6+" in Figure 2 measures the average effect during periods $q \geq 6$.

statistically insignificant from 0, providing strong evidence that there were no diverging housing value trends between treatment and control municipalities before the adoption of RMLs, which supports the validity of our research design. In comparison, there is clear evidence of divergence in housing values immediately after the adoption; the divergence becomes increasingly stronger over time. Taken together, Figure 3 not only implies that RMLs increase housing values, it also points toward a causal interpretation of this positive price effect.

5.2. Main Results

Now we present the main regression results of the average intent-to-treat effect of RMLs on housing values based on Equation (1). We begin in Table 3 with OLS estimates. Column 1 is the most parsimonious DD specification that controls for time-invariant municipality-specific unobservables (e.g., public opinion and community culture regarding marijuana legalization) and common time-series effects on housing values with municipality fixed effects and month and year fixed effects, respectively. The point estimate shows that legalizing retail marijuana is associated with a 7.7 percent significant increase in housing values. Column 2 additionally controls for a wide range of housing characteristics (e.g., property age, number of bedrooms, number of bathrooms, and gross living area) and time-varying municipality covariates (e.g., demographics and the adoption of medical marijuana policy). Adding these controls almost does not affect the DD estimate, indicating that the adoption of RMLs is uncorrelated with changes in observables that are not driven by RMLs. This is consistent with the evidence found in Table 2 and from the event study in Figure 3, which further validates our DD research design. In Column 3, we additionally include property fixed effects to control for property-specific time-invariant omitted variables, such as neighborhood characteristics, effectively allowing us to compare housing price changes within

the same properties. The inclusion of property fixed effects only slightly increases the estimate to 0.0823.[22]

While we have shown that the treatment and control municipalities are comparable in changes in observable characteristics and also that their housing value trends were similar before legalizing retail marijuana, there may still be concerns that other unobserved time-varying factors could lead to differential housing value changes *after* the legalization and hence bias the DD estimate. One major concern is that Colorado's housing market rebound that started in late 2012 – largely driven by investors exploiting investment opportunities when the housing market was near the bottom (Blevins 2013) – could result in stronger housing price appreciation in urban areas and thus in most of the adopting municipalities.[23] For example, investors could buy more properties, for either resale or rental purpose, in populous areas in order to obtain higher expected returns, which would confound our estimated effect and cause an upward bias. To address this concern, we include municipality type-by-year fixed effects in Column 4 so that we compare housing price changes in municipalities of the same urban or rural types. This adjustment has a small impact and slightly reduces the estimate to 0.0788. Along similar lines, in Column 5 we additionally add CBSA-by-year fixed effects to control for annual housing market shocks that are common to municipalities within the same CBSAs, considering that economic activities in these cities and towns are closely related. The specification in Column 5 that includes a rich set of control variables and fixed effects is our preferred specification, which also yields the most conservative estimate (0.0617). In addition, Columns 6 through 10 report parallel estimates using weighted least squares (WLS), for which observations are weighted by the total number of properties observed at the municipality-year level; they are very similar to their OLS counterparts. Overall, all estimates

[22] Municipality fixed effects are absorbed by property fixed effects when the latter are included, because factors that are time-invariant at the property level are also time-invariant at the municipality level.
[23] http://www.colorado.gov/legcouncil/Forecast/12decemberforecast.pdf

in Table 3 are positive and statistically significant at the 1% level, showing that RMLs increase housing values. More importantly, this positive impact implies that the benefits of legalizing retail marijuana that are capitalized into housing values outweigh the corresponding costs.

According to our preferred estimate, legalizing retail marijuana on average increases housing values by approximately 6 percent. Relative to the average sale price in adopting municipalities before passing RMLs ($260,144), this estimate translates into a price appreciation of about $15,600. In addition, our estimated effect shows that legalizing retail marijuana is able to explain about 27 percent (0.06/0.22) of housing value appreciation during the examination period that saw housing values increase by 22 percent in adopting municipalities.

Finally, motivated by the graphical evidence in Figure 3, we directly estimate the dynamic effects of RMLs on housing values with Equation (3):

$$(3)\quad Outcome_{inmy} = \beta_0 + \sum_{q=1}^{5} \beta_q^{Post} Post_{inmy}^{q} + \beta_{6+}^{Post} Post_{inmy}^{6+} + \mathbf{X}_{inmy}\boldsymbol{\gamma} + \eta_n + \mu_{my} + \lambda_i + \theta_{cy} + \rho_{sy} + \varepsilon_{inmy},$$

where $Post_{inmy}^{6+}$ equals 1 if the sale of property i in municipality n in month m of year y occurred after the 5^{th} quarter since municipality n passed RML and 0 otherwise. This equation simply replaces RML_{inmy} in Equation (1) by $Post_{inmy}^{q}$s (q = 1, 2, 3, 4, 5, 6+) and decomposes the average effect of RMLs over time non-parametrically. Table 4 reports both OLS and WLS estimates of β_q^{Post}s and β_{6+}^{Post} that measure the quarterly effects on housing values after adopting RMLs, which are all highly significant. In particular, estimates in Column 1 show a prompt response as housing values jumped by about 3 percent within the first quarter after the legalization. This immediate impact gradually built up to about 8 percent within one year and ultimately reached 10 percent, as evidenced by estimates in Columns 2 through 6.

5.3. Discussion: Magnitude, Mechanism, and Possible Confounder

To put our preferred estimate (6 percent) into perspective, recent studies that estimate the causal effects of changes in local amenities find similar or larger effects in the housing market. For example, our estimated average effect of RMLs on housing values is comparable to the effect of moving a sex offender into the adjacent property (4 percent) found by Linden and Rockoff (2008), the effect of power plant openings (3 – 7 percent) found by Davis (2011), and the effect of toxic plant openings (11 percent) found by Currie, Davis, Greenstone, and Walker (2015).[24] In particular, in a recent related study, Conklin, Diop, and Li (2016) report a very similar estimate of the effect of retail marijuana legalization on housing values in Denver. They find that Denver's RML increases housing values by approximately 9 percent for single family residences that are close to retail marijuana dispensaries relative to houses that are further away.

However, the effect of RMLs we have found might still appear large, especially considering that the post-adoption period of about two years is relatively short. This leads us to explore the two channels through which RMLs affect housing values – housing demand and housing supply – following the simple conceptual framework as outlined in Section 2.3. Empirical results are presented in Table 5. We start by probing the demand side, by using the MLS dataset to examine how RMLs change a sold property's sale price relative to its listing price. The estimate in Column 1 indicates that legalizing retail marijuana on average increases sale prices by nearly 20 percent, compared to the initial listing prices requested by home sellers.[25] This large sale price premium shows that RMLs give home sellers significant bargaining power in price negotiations, suggesting stronger willingness to pay on the demand

[24] Other studies also find relatively smaller and larger effects on housing values, such as the effect of EPA regulations (2 percent) found by Chay and Greenstone (2005), the effect of better school quality (2.5 percent) found by Black (1999), the effect of a cancer cluster (14 percent) by Davis (2004), and the effect of schools receiving an "A" grade (20 percent) found by Figlio and Lucas (2004).

[25] The regression is similar to those that use transaction data based on Equation (1). Similarly, we focus on properties with multiple listings and define the indicator RML to be 1 if the beginning listing date of property i in municipality n in month m of year y was after RML became effective and 0 otherwise.

side. Consistently, we find that the legalization makes it much more likely for listed properties to be sold, with the probability being driven up by 21 percentage points, as shown by the linear probability model estimate in Column 2. Then we turn to the supply side and estimate the effect of RMLs on the number of newly listed properties, which directly measures the short-run supply of residential properties by homeowners. In Column 3, we report a quantitatively small and statistically insignificant effect, which indicates that the housing supply is inelastic in the short run.[26] Finally, we examine whether in our examination period it is possible for residential developers to quickly respond to the higher sale prices by contributing to the stock of housing properties, measured by the number of housing units. The small and insignificant estimate in Column 4 suggests no evidence of that.[27] Collectively, we find evidence that RMLs lead to stronger housing demand and have no discernible effect on housing supply, which is in line with the large positive impact of RMLs on housing values we have estimated.

Broadly, the strong housing demand and the large housing price appreciation we have documented could be explained by the so-called "early adopters effect", because Colorado was one of the first two U.S. states to legalize recreational marijuana in 2012. With more states legalizing recreational marijuana and more cities and towns adopting RMLs, it is expected that the positive housing price effect of RMLs in Colorado would be attenuated gradually in the long run, as more retail marijuana markets become available nationwide.

Given the evidence found in the event study and the robustness of the estimates in Table 3, it is worth considering the conditions for a possible confounder to cause the observed housing price appreciation other than retail marijuana legalization. First, this confounder should increase housing values in adopting municipalities relative to non-adopting

[26] Data for this regression are aggregated at the municipality-year-month level.
[27] Since only annual data on the number of housing units are available from ACS, this regression is at the municipality-year level.

municipalities immediately after passing RMLs but not before the adoption. Importantly, the confounding effect needs to coincide with the timing of RMLs, which are different across adopting municipalities. Second, this confounder should not be driven by RMLs and also must be uncorrelated with changes in housing characteristics, local demographics, and the regulation of medical marijuana. Third, this confounder must cause an increase in housing values in adopting municipalities after the adoption but not have a similar housing price impact in non-adopting municipalities that are of the same municipality types or within the same CBSAs. We are unable to think of any confounder that would satisfy these conditions. Furthermore, it is worth emphasizing that our specifications deliberately omit those time-varying factors that would be directly affected by the benefits or costs of RMLs (e.g., employment and crime), which should not be considered as confounders.[28] Therefore, we interpret the estimated housing value increase as the causal effect of retail marijuana legalization.

5.4. Additional Checks: Differential Effects and Robustness Tests

After estimating the average effect of RMLs on housing values, we turn to investigate the potential heterogeneous effects across locations and property types in Table 6. First, we compare the price effects of RMLs across the three municipality types: large urban areas, small urban areas, and rural areas. Estimates in Columns 1 through 3 show a quantitatively larger impact on urban areas than in rural areas: the housing value increase in urban areas is more than 5 percent and statistically significant; in comparison, the price appreciation in rural areas is an insignificant 4.17 percent that is not precisely estimated. This finding is probably not quite surprising, because adopting urban areas – municipalities that have larger retail marijuana markets and offer arguably better amenities and infrastructure – would appear more attractive

[28] The effects of these housing value determinants are already captured by the estimated effect of RMLs; additionally controlling for them leads to the "bad control" problem described in Angrist and Pischke (2009).

than their rural counterparts especially when the housing market was still in the process of adjusting to a new equilibrium, as is likely the case in our sample period. Along similar lines, we examine the differential effects between metropolitan and micropolitan statistical areas, where the former have larger urban cores. Consistently, we find the effect is driven by MSAs, as shown by estimates in Columns 4 and 5. Finally, we ask whether RMLs might have differential price effects on housing properties of different types. To do so, we classify properties into three price tiers based on each property's transaction price first observed in our data: high tier ($500,000 $\leqslant$ price $\leqslant$ $10,000,000), middle tier ($200,000 < price < $500,000), and low tier (price $\leqslant$ $200,000). Estimates in the last three columns show that the price effects are strongest on low and middle tier properties (6.5 percent and 5.6 percent) and smaller on high tier properties (3.8 percent).

Next, we test the sensitivity of our findings by performing a set of robustness checks. The results are summarized in Table 7, in which we report the preferred estimate 0.0617 (from Column 5 in Table 3) in Column 1 as the baseline. Column 2 adds over 1,600 additional property sales from non-CBSAs (exclude from our main analysis) and yields the same estimate. In Column 3, we drop Denver from the main regression and still obtain a sizable and highly significant price effect (4.5 percent); the estimate is also within the 95 percent confidence interval of the baseline estimate. This provides direct evidence that Denver – the city that many believe to be drastically different from the rest of Colorado – does not drive our result. Next, we perform two tests by choosing slightly different treatment and control groups. In Column 4, we use a different treatment group that only includes properties in adopting municipalities that are sold both before and after the adoption of RMLs, a strategy similar to that used by repeat-sales models (Case and Shiller 1987, Ngai and Tenreyro 2014). In Column 5, we focus on properties that are sold only twice in the examination period in order to ensure that properties with high-frequency sales do not dominate our results. Estimates

stay robust in both exercises. Lastly, we use two alternative weights in WLS regressions: population and the number of property sales at the municipality level. Estimates in the last two columns are still very similar to the baseline OLS estimate and the corresponding WLS estimate in Column 10 of Table 3 (0.0638), for which the weight is the number of properties.

6. Conclusion

Marijuana legalization is a globally controversial issue. A handful of U.S. states recently legalized recreational marijuana, which has fueled the heated national debate about whether the legalization generates more benefits than costs. This paper represents a first step toward answering this overarching question by measuring the net capitalization of the benefits and costs of Colorado's municipality retail marijuana laws into housing values. In identifying the causal effect, we exploit the time-series and cross-sectional variations in the adoption of RMLs with a difference-in-differences strategy. According to our estimates, legalizing retail marijuana leads to an average 6 percent housing value appreciation. Importantly, we find evidence that this large price effect is likely due to that RMLs cause stronger housing demand and restricted housing supply. In addition, we show the effect of RMLs on housing values exhibits substantial heterogeneity and is driven by urban and metropolitan areas, as well as by properties in low and middle price tiers. In conclusion, this paper provides convincing causal evidence that legalizing retail marijuana generates net benefits, as measured through the housing market. Our study is the first to examine the recent recreational marijuana legalization move in the U.S. and opens the door for future research to comprehensively evaluate the overall benefits and costs of the legalization.

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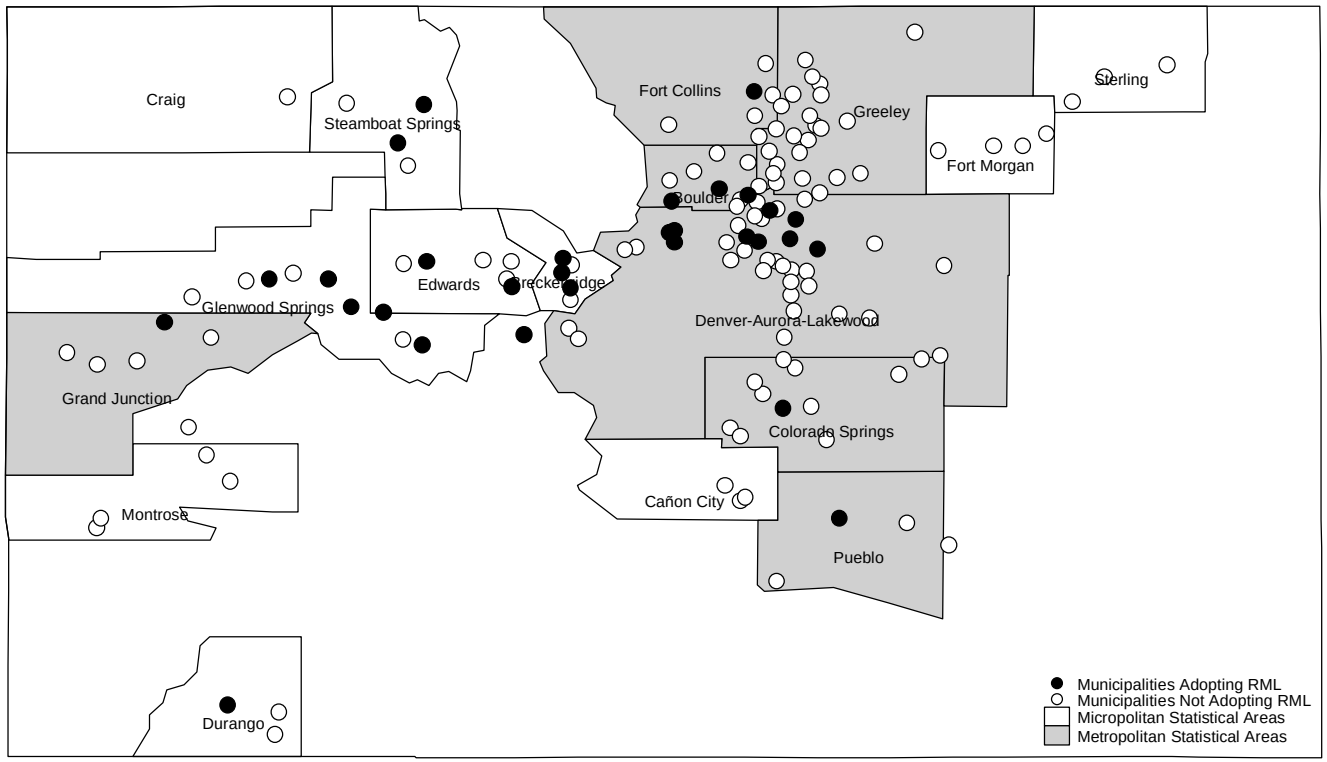
Figure 1. Map of Municipalities that Adopt Retail Marijuana Laws and Non-Adopting Municipalities



Notes: This map includes 141 municipalities used in the main analysis, including 30 adopting municipalities and 111 non-adopting municipalities.

Figure 2. Number of Municipalities that Adopt Retail Marijuana Laws by Time

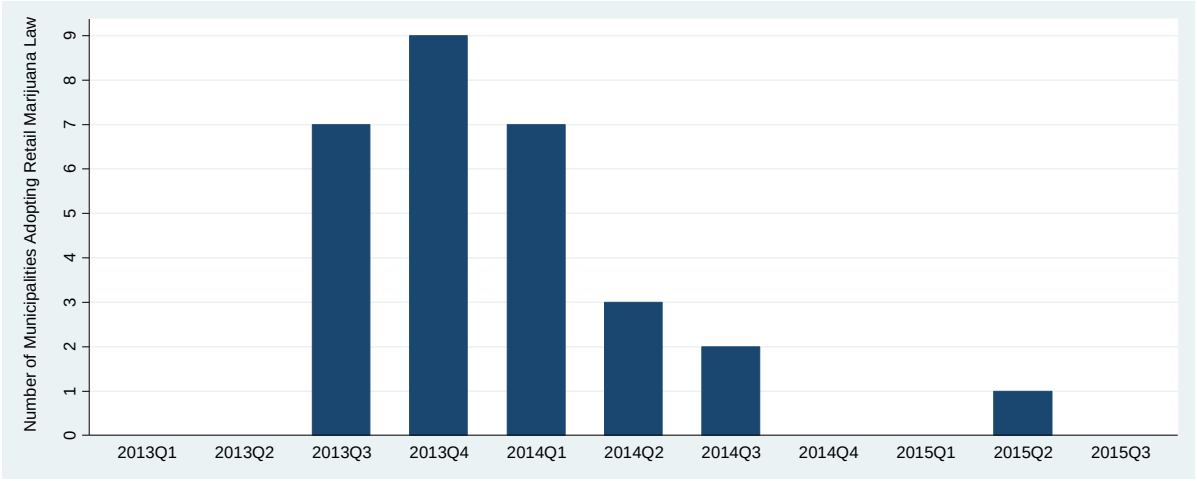


Figure 3. Estimated Differences in Housing Values between Adopting and Non-Adopting Municipalities Before and After the Adoption of Retail Marijuana Laws

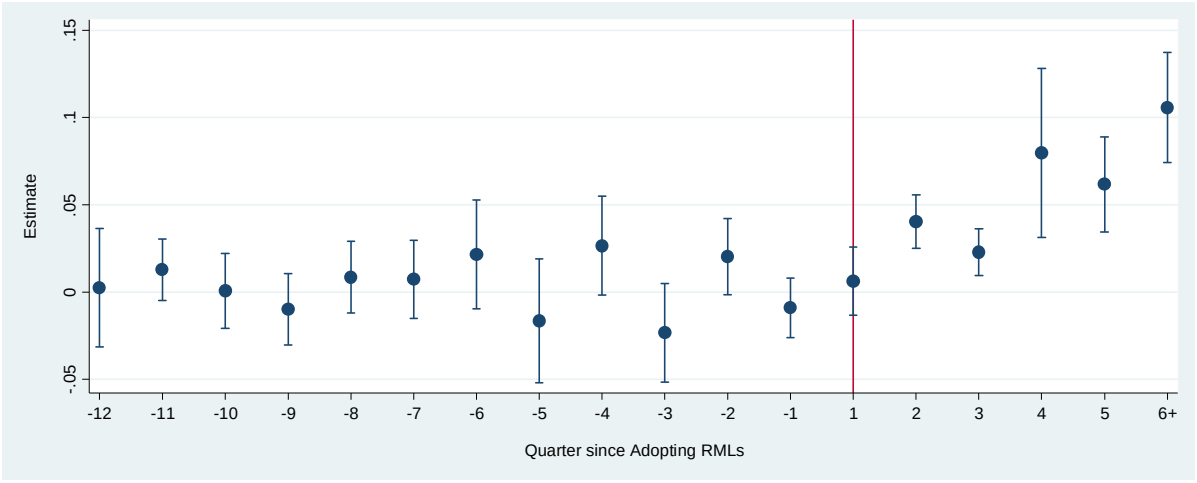


Table 1. Adopting and Non-Adopting Municipalities

Municipalities Adopting RML (Treatment Group)			Municipalities Not Adopting RML (Control Group)											
Municipality	**Municipality Type**	**CBSA**	**Municipality**	**Municipality Type**	**CBSA**	**Municipality**	**Municipality Type**	**CBSA**	**Municipality**	**Municipality Type**	**CBSA**	**Municipality**	**Municipality Type**	**CBSA**
Aspen	Small Urban	MA	Alma	Rural	MSA	Erie	Small Urban	MSA	Keenesburg	Rural	MSA	Platteville	Small Urban	MSA
Aurora	Large Urban	MSA	Arvada	Large Urban	MSA	Estes Park	Small Urban	MSA	Kersey	Rural	MSA	Ramah	Rural	MSA
Basalt	Small Urban	MA	Ault	Rural	MSA	Evans	Small Urban	MSA	Kiowa	Rural	MSA	Rifle	Small Urban	MA
Black Hawk	Rural	MSA	Avon	Small Urban	MA	Fairplay	Rural	MSA	LaSalle	Rural	MSA	Rye	Rural	MSA
Boulder	Large Urban	MSA	Bayfield	Rural	MA	Federal Heights	Small Urban	MSA	Lakewood	Large Urban	MSA	Severance	Small Urban	MSA
Breckenridge	Small Urban	MA	Bennett	Rural	MSA	Firestone	Small Urban	MSA	Larkspur	Rural	MSA	Silver Plume	Rural	MSA
Carbondale	Small Urban	MA	Berthoud	Small Urban	MSA	Fleming	Rural	MA	Littleton	Large Urban	MSA	Simla	Rural	MSA
Central City	Rural	MSA	Blue River	Rural	MA	Florence	Small Urban	MA	Lochbuie	Small Urban	MSA	Snowmass Village	Small Urban	MA
Commerce City	Large Urban	MSA	Boone	Rural	MSA	Fort Lupton	Small Urban	MSA	Lone Tree	Small Urban	MSA	Sterling	Small Urban	MA
De Beque	Rural	MSA	Brighton	Large Urban	MSA	Fort Morgan	Small Urban	MA	Longmont	Large Urban	MSA	Superior	Small Urban	MSA
Denver	Large Urban	MSA	Broomfield	Large Urban	MSA	Fountain	Large Urban	MSA	Louisville	Small Urban	MSA	Thornton	Large Urban	MSA
Durango	Small Urban	MA	Brush	Small Urban	MA	Fowler	Rural	MSA	Loveland	Large Urban	MSA	Timnath	Rural	MSA
Eagle	Small Urban	MA	Calhan	Rural	MSA	Foxfield	Rural	MSA	Lyons	Rural	MSA	Vail	Small Urban	MA
Edgewater	Small Urban	MSA	Canon City	Small Urban	MA	Frederick	Small Urban	MSA	Mead	Small Urban	MSA	Victor	Rural	MSA
Fort Collins	Large Urban	MSA	Castle Pines	Small Urban	MSA	Fruita	Small Urban	MSA	Merino	Rural	MA	Ward	Rural	MSA
Frisco	Small Urban	MA	Castle Rock	Large Urban	MSA	Georgetown	Rural	MSA	Milliken	Small Urban	MSA	Wellington	Small Urban	MSA
Glenwood Springs	Small Urban	MA	Centennial	Large Urban	MSA	Gilcrest	Rural	MSA	Minturn	Rural	MA	Westminster	Large Urban	MSA
Idaho Springs	Rural	MSA	Cherry Hills Village	Small Urban	MSA	Golden	Small Urban	MSA	Montrose	Small Urban	MA	Wiggins	Rural	MA
Lafayette	Small Urban	MSA	Coal Creek	Rural	MA	Grand Junction	Large Urban	MSA	Monument	Small Urban	MSA	Windsor	Small Urban	MSA
Leadville	Small Urban	MA	Collbran	Rural	MSA	Greeley	Large Urban	MSA	Morrison	Rural	MSA	Woodland Park	Small Urban	MSA
Manitou Springs	Small Urban	MSA	Colorado Springs	Large Urban	MSA	Green Mountain Falls	Rural	MSA	Naturita	Rural	MA	Yampa	Rural	MA
Nederland	Rural	MSA	Craig	Small Urban	MA	Greenwood Village	Small Urban	MSA	New Castle	Small Urban	MA			
Northglenn	Large Urban	MSA	Cripple Creek	Rural	MSA	Grover	Rural	MSA	Nucla	Rural	MA			
Oak Creek	Rural	MA	Dacono	Small Urban	MSA	Gypsum	Small Urban	MA	Nunn	Rural	MSA			
Pueblo	Large Urban	MSA	Deer Trail	Rural	MSA	Hayden	Rural	MA	Olathe	Rural	MA			
Red Cliff	Rural	MA	Delta	Small Urban	MA	Hillrose	Rural	MA	Palisade	Small Urban	MSA			
Silt	Small Urban	MA	Dillon	Rural	MA	Hudson	Rural	MSA	Palmer Lake	Rural	MSA			
Silverthorne	Small Urban	MA	Eaton	Small Urban	MSA	Ignacio	Rural	MA	Parachute	Rural	MA			
Steamboat Springs	Small Urban	MA	Elizabeth	Rural	MSA	Jamestown	Rural	MSA	Parker	Large Urban	MSA			
Wheat Ridge	Large Urban	MSA	Englewood	Large Urban	MSA	Johnstown	Small Urban	MSA	Pierce	Rural	MSA			

Notes: The main analysis uses property transaction data from 30 adopting municipalities and 111 non-adopting municipalities.

Table 2. Summary Statistics

Variable	Full Sample	Before Adopting RMLs: 2010 - 2012		After Adopting RMLs: 2014		Column 2 - Column 3	(Column 4 - Column 2) - (Column 5 - Column 3)
		Adopting Municipalities	Non-Adopting Municipalities	Adopting Municipalities	Non-Adopting Municipalities		
	1	2	3	4	5	6	7
Housing Characteristics							
Housing Value ($)	264,827.49	260,614.88	243,800.97	288,918.17	257,320.48	16813.91***	14783.78***
	(233,072.14)	(281,364.57)	(193,002.77)	(271,714.30)	(200,540.21)	(2535.67)	(4354.95)
Bedrooms	2.89	2.74	3.07	2.65	2.99	-0.33***	-0.00
	(1.05)	(0.89)	(1.03)	(0.93)	(1.51)	(0.00)	(0.02)
Bathrooms	2.34	2.24	2.47	2.13	2.41	-0.24***	-0.03
	(1.14)	(1.00)	(1.09)	(1.09)	(1.51)	(0.01)	(0.02)
Age (years)	34.38	42.42	26.56	44.75	29.32	15.86***	-0.43
	(27.29)	(31.54)	(21.76)	(31.59)	(21.51)	(0.28)	(0.49)
Gross Living Area (square feet)	1,605.15	1,477.29	1,723.03	1,448.43	1,677.68	-245.74***	16.49
	(815.27)	(716.40)	(806.93)	(727.73)	(956.82)	(7.72)	(14.29)
Municipality Characteristics							
RML	0.07	0.00	0.00	0.93	0.00	0.00	0.93***
	(0.26)	(0.00)	(0.00)	(0.25)	(0.00)	(0.00)	(0.05)
Population	28,701.24	49,497.16	18,397.50	52,349.83	19,384.35	31099.65**	1865.83
	(76,527.74)	(119,694.23)	(47,231.58)	(129,356.75)	(49,825.64)	(12851.01)	(27052.76)
% Male	50.93	51.31	50.85	52.50	50.73	0.46	1.31
	(3.95)	(3.53)	(4.29)	(4.18)	(3.81)	(0.44)	(0.95)
% White	89.60	87.13	90.41	87.90	90.43	-3.28***	0.75
	(6.85)	(8.46)	(6.98)	(7.11)	(6.10)	(0.97)	(1.71)
% Hispanic	18.05	19.19	17.24	20.10	17.45	1.94	0.70
	(13.69)	(13.45)	(13.76)	(13.99)	(14.17)	(1.61)	(3.29)
% High School Diploma	89.72	90.26	88.46	90.62	89.90	1.80**	-1.08
	(7.72)	(6.63)	(8.49)	(6.27)	(7.49)	(0.84)	(1.58)
% Bachelor's Degree	32.66	36.94	28.71	38.36	29.84	8.23***	0.29
	(18.00)	(17.75)	(17.93)	(16.91)	(17.60)	(2.12)	(4.08)
Medical Marijuana Policy	0.21	0.67	0.05	0.87	0.07	0.62***	0.18**
	(0.41)	(0.47)	(0.22)	(0.35)	(0.25)	(0.05)	(0.08)
Observations of Housing Transactions	91,581	16,511	22,784	8,170	11,491	39295	58956

Notes: Standard deviations are reported in parentheses.

* Significant at the 10% level

** Significant at the 5% level

*** Significant at the 1% level

Table 3. Mean Effect of Retail Marijuana Laws on Housing Values

	1	2	3	4	5	6	7	8	9	10
	OLS					WLS				
RML	0.0765***	0.0748***	0.0823***	0.0788***	0.0617***	0.1131***	0.0776***	0.0816***	0.0809***	0.0638***
	(0.0238)	(0.0204)	(0.0228)	(0.0238)	(0.0097)	(0.0279)	(0.0120)	(0.0110)	(0.0113)	(0.0073)
Observations	91943	91943	91943	91943	91943	91943	91943	91943	91943	91943
Municipality, Month, and Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls		Yes	Yes	Yes	Yes		Yes	Yes	Yes	Yes
Property Fixed Effects			Yes	Yes	Yes			Yes	Yes	Yes
Municipality Type-by-Year Fixed Effects				Yes	Yes				Yes	Yes
CBSA-by-Year Fixed Effects					Yes					Yes

Notes: Each column represents a separate regression. The unit of observation is individual property sale. Robust standard errors are clustered at the municipality level. Controls include property characteristics (property age, number of bedrooms, number of bathrooms, and gross living area) and time-varying municipal-level covariates on population, gender, race, ethnicity, educational attainment, and medical marijuana policy. WLS uses the number of properties at the municipality-year level as the weight.

* Significant at the 10% level

** Significant at the 5% level

*** Significant at the 1% level

Table 4. Dynamic Effects of Retail Marijuana Laws on Housing Values

	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Quarter 5	Quarter 6+
	1	2	3	4	5	6
Panel A. OLS	0.0282***	0.0420***	0.0482***	0.0785***	0.0766***	0.0966***
	(0.0100)	(0.0089)	(0.0087)	(0.0171)	(0.0103)	(0.0131)
Panel B. WLS	0.0314***	0.0414***	0.0556***	0.1030***	0.0865***	0.1081***
	(0.0068)	(0.0073)	(0.0061)	(0.0098)	(0.0101)	(0.0121)
Municipality, Month, and Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Property Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Type-by-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
CBSA-by-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Each row represents a separate regression. The unit of observation is individual property sale. Robust standard errors are clustered at the municipality level. Controls include property characteristics (property age, number of bedrooms, number of bathrooms, and gross living area) and time-varying municipal-level covariates on population, gender, race, ethnicity, educational attainment, and medical marijuana policy.

* Significant at the 10% level

** Significant at the 5% level

*** Significant at the 1% level

Table 5. Effects of Retail Marijuana Laws on Housing Demand and Supply

	(Sale Price / Listing Price) - 1	Prob (Sold | Listed Property)	log (Monthly New Listings)	log (Annual Housing Units)
	1	2	3	4
RML	0.1958***	0.2115***	-0.0165	-0.0092
	(0.0336)	(0.0291)	(0.0380)	(0.0246)
Observations	126923	189018	7327	705
Municipality and Year Fixed Effects	Yes	Yes	Yes	Yes
Property Fixed Effects	Yes	Yes	-	-
Month Fixed Effects	Yes	Yes	Yes	-
Controls	Yes	Yes	Yes	Yes
Municipality Type-by-Year Fixed Effects	Yes	Yes	Yes	Yes
CBSA-by-Year Fixed Effects	Yes	Yes	Yes	Yes

Notes: Each column represents a separate regression. The unit of observation in the first two columns is individual property listing; the unit of observation in the last two columns is municipality. Robust standard errors are clustered at the municipality level. Controls include property characteristics (property age, number of bedrooms, number of bathrooms, and gross living area) and time-varying municipal-level covariates on population, gender, race, ethnicity, educational attainment, and medical marijuana policy.

* Significant at the 10% level

** Significant at the 5% level

*** Significant at the 1% level

Table 6. Differential Effects of Retail Marijuana Laws on Housing Values

	Municipalities			Statistical Areas		Properties (Grouped by Sale Price)		
	Large Urban Areas	Small Urban Areas	Rural Areas	Metropolitan (MSAs)	Micropolitan (MAs)	Low Tier	Middle Tier	High Tier
	1	2	3	4	5	6	7	8
RML	0.0549***	0.0514*	0.0417	0.0616***	0.0211	0.0617***	0.0559***	0.0380***
	(0.0091)	(0.0269)	(0.0414)	(0.0100)	(0.0264)	(0.0157)	(0.0147)	(0.0122)
Observations	77221	12386	2336	86807	5136	49289	37216	5438
Municipality, Month, and Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Property Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Type-by-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CBSA-by-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Each column represents a separate regression. The unit of observation is individual property sale. Robust standard errors are clustered at the municipality level. Controls include property characteristics (property age, number of bedrooms, number of bathrooms, and gross living area) and time-varying municipal-level covariates on population, gender, race, ethnicity, educational attainment, and medical marijuana policy.

* Significant at the 10% level

** Significant at the 5% level

*** Significant at the 1% level

Table 7. Robustness Checks

	Baseline	Including Non-CBSA Sales	Dropping Denver	Treatment Group: Properties with Sales Before and After Adopting RML	Keeping Properties with Only Two Sales	WLS: Weighted by Population	WLS: Weighted by Number of Property Sales
	1	2	3	4	5	6	7
RML	0.0617***	0.0617***	0.0454***	0.0846***	0.0577***	0.0534***	0.0594***
	(0.0097)	(0.0097)	(0.0112)	(0.0133)	(0.0084)	(0.0067)	(0.0069)
Observations	91943	93585	74106	69319	77692	91943	91943
Municipality, Month, and Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Property Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality Type-by-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
CBSA-by-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Each column represents a separate regression. The unit of observation is individual property sale. Robust standard errors are clustered at the municipality level. Controls include property characteristics (property age, number of bedrooms, number of bathrooms, and gross living area) and time-varying municipal-level covariates on population, gender, race, ethnicity, educational attainment, and medical marijuana policy. The baseline estimate is the estimate in Column 5 of Table 3.

* Significant at the 10% level

** Significant at the 5% level

*** Significant at the 1% level