The Effects of Recreational Cannabis Access on the Labor Market: Evidence from Colorado*

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Abstract

Recreational access to cannabis may have a positive effect on labor demand due to investments in growing, processing and retail cannabis facilities, and spillovers to interconnected industries such as manufacturing, and leisure and hospitality. Using county-level Colorado data from 2011-2018 and exploiting the variation in the timing of commencement of sale of dispensaries, we test for changes in the unemployment rate, employment and wages, overall as well as in manufacturing, construction, and services. Consistent with an increase in labor demand, we estimate that the sale of recreational cannabis through dispensaries is associated with a 0.7 percentage point decrease in the unemployment rate with no effect on total labor force participation. We also find a 4.5 percent increase in the overall number of employees, with effects concentrated in manufacturing and services. We do not find an effect on average weekly wages overall or by sector. Given the lack of a reduction in labor force participation or wages, negative effects on labor supply are likely limited, in line with the existing literature. The decrease in the unemployment rate, coupled with an increase in the number of employees, indicates that labor demand effects are likely to dominate. Our results suggest that policymakers considering recreational access to cannabis should account for increased employment as a possible outcome.

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In Colorado, recreational cannabis dispensaries currently outnumber Starbucks and McDonald's locations combined (Colorado Department of Revenue, 2019). As the number of recreational dispensaries grew between 2014-2019, so did the value of their sales.[1] When comparing sales for recreational and medical cannabis in Figure 1, medical cannabis sales stayed around $35 million, while recreational cannabis sales increased ten-fold from $10 to $110 million. Furthermore, Light, Orens, Rowberry, and Saloga (2016) predicted that sales for recreational cannabis in Colorado would grow by 11.3 percent annually by 2020.

The creation of a newly legal industry growing at this rate has the potential to affect the local economy, either directly or indirectly. For example, some associated benefits from the arrival of new casinos in local areas include doubling of earnings in the local gambling industry and an indirect spillover effect on employment growth in closely related local industries (Cotti, 2008; Humphreys & Marchand, 2013). Studies have also found that opening an ethanol plant in a county increases employment opportunities, labor earnings, and demand for land and housing, with spillover effects on other local industries (Low & Isserman, 2009). This prior literature suggests that retail cannabis dispensaries should be associated with an increase in labor demand.

However, the equilibrium effects of recreational cannabis dispensary entry on local communities and surrounding areas are less clear. The health effects of cannabis are ambiguous, with older studies using survey data typically identifying negative associations between cannabis use and health and productivity outcomes (Hanson et al., 2010; Van Ours, 2007; Van Ours, Williams, Fergusson, & Horwood, 2013; Volkow, Baler, Compton, & Weiss, 2014), while more recent studies of medical cannabis legalization indicate potential positive health and productivity effects (Li et al., 2019; Nicholas & Maclean, 2019; Stith, Vigil, Brockelman, Keeling, & Hall, 2018; Ullman, 2017).

The limited literature on the effects of Medical Marijuana Laws (MMLs) on the labor supply shows mixed results. On the one hand, the entry of medical cannabis dispensaries may have potential positive employment and earnings effects, at least in the older population (Nicholas & Maclean, 2019). On the other hand, Sabia and Nguyen

[1]Sales Value = Gross Sales − Wholesale. These are retail (recreational) and medical cannabis sales, as reported to the Colorado Department of Revenue.

(2018) find a small decrease in wages among males age 20 to 39. An older study using survey data on cannabis use rather than the introduction of legal medical cannabis finds cannabis use reduced wages by 10 percent (Van Ours, 2007).

The majority of these studies consider only medical legalization and associated dispensary access, which affects a significantly smaller population than recreational access. Medical legalization limits use to those with severely debilitating symptoms, typically for a limited range of conditions. Recreational access facilitates use not just for recreational purposes, but for medical use as well among those with conditions not previously approved or whose conditions were insufficiently severe to qualify for medical cannabis or by patients with severe approved conditions who were unwilling to join a registry.

This paper is the first to analyze the effects of recreational dispensary access on labor markets and the first to employ a county-level approach to explore the effect of the legalization of cannabis on labor markets. Using monthly data from Local Area Unemployment Statistics (LAUS) and quarterly data from Quarterly Census of Employment and Wages (QWEC) for the period 2011-2018, we test for changes in the unemployment rate, the number of people unemployed, total labor force, the number of employees, and wages in Colorado counties in response to the entry of recreational cannabis dispensaries. We investigate the effects on labor market outcomes by exploiting quasi-random variation in the timing of the entry of recreational cannabis dispensaries at the county-level. With a difference-in-differences research design, we compare labor market outcomes within and across counties, and across industries, before and after counties began selling recreational cannabis, controlling for the county, month, and year fixed effects, and the number of medical cannabis patients.

We find that the opening of recreational cannabis dispensaries is associated with a decrease in the number of unemployed and the unemployment rate, with no significant effect on the total labor force. We further find an increase in the total number of employees overall, with effects concentrated in manufacturing and service-providing industries. We find no significant effect on average weekly wages overall or by sub-industry. Our results

suggest that labor demand effects dominate any impact on labor supply.

In other words, cannabis dispensary entry acts as a local labor market shock that generates a significant, positive effect on labor markets directly through the opening of growing, processing, and retail cannabis facilities and through spillovers to interconnected industries such as tourism. These results parallel effects from the opening of casinos (Cotti, 2008; Humphreys & Marchand, 2013) in that the labor demand benefits from the introduction of a new industry appear to outweigh negative impacts on labor supply from the introduction of a previously illegal and potentially addictive product. Overall the findings in this paper provide evidence that recreational cannabis legalization provides an economic boost to the counties of Colorado. In assessing the costs and benefits of cannabis legalization, particularly with dispensary access, policymakers should consider employment benefits as a potential outcome from recreational cannabis legalization.

Background

Cannabis, classified as a Schedule I substance[2] under the Controlled Substances Act (CSA), became illegal at the federal level in the 1930s under President Franklin Roosevelt. Federal law continues to prohibit cultivation, possession and consumption of cannabis and related products. However, the majority of states have either decriminalized[3] cannabis possession or have begun to legalize cannabis through a regulated market. The shift toward legalization began in 1996 when California passed legislation that legalized cannabis possession for medical purposes. As of December 2018, 33 states and the District of Columbia allowed for medical cannabis in some form. In the context of recreational cannabis, Colorado and Washington were the first two states in 2012 to legalize commercial cultivation and sales of recreational cannabis to adults 21 years or older. Since then, other states have followed, and presently recreational cannabis is

[2]The federal government defines a Schedule 1 drug with no medical use, high potential for abuse, and a high probability of dependence.

[3]Criminal penalties for the possession and usage of cannabis are reduced or eliminated.

legalized in 11 states[4] and the District of Colombia (Figure 6).

Cannabis in Colorado

Colorado passed the Colorado Amendment 64[5] on 6th November 2012 to become one of the first states to legalize recreational cannabis, allowing anyone 21 years and above with a valid ID to buy, have, or use cannabis from licensed retail dispensaries. The law permits cannabis consumption anywhere other than public places with a buying limit of 1 ounce of cannabis at a time. It also allows residents over 21 to grow up to six cannabis plants in their homes for personal use. However, laws vary by county and municipality. In Denver, for instance, a residence has a limit of 12 plants irrespective of the number of adults present.

Although Colorado legalized recreational cannabis in 2012, dispensary cannabis sales began in January 2014. Over the last several years, access to recreational cannabis across counties has increased, but with heterogeneity in the timing of the commencement of sale. Figure 5 plots this heterogeneity with the number of counties starting to sell recreational cannabis from 2014 through 2018 by month. A person opening or financing a dispensary or working as an employee must meet certain criteria. First, they must be at least 21 years old and be a Colorado resident for at least two years (or be married to a Colorado resident). Second, they cannot have convictions involving controlled substances within the last ten years and must be fully discharged of any other felony convictions for at least five years. Third, the person should not be employed by the local or State Licensing Authority. In addition to meeting these state-mandated requirements for getting a license, one has to pay expensive application fees ($> \$8000$) and find a real estate.

Moreover, as cannabis is not legalized at the federal level, getting a bank loan for opening a dispensary is not possible. Thus there are significant barriers to opening a dispensary in Colorado. By the end of January 2014, out of a total of 64 counties in

[4]Alaska, California, Illinois, Maine, Massachusetts, Michigan, Nevada, Oregon, Vermont, and Washington.

[5]A ballot to amend Colorado's constitution to legalize and regulate cannabis passed with 55 percent approval. (`https://marijuana.procon.org/legal-recreational-marijuana-states-and-dc/`. Accessed 05/18/2020.)

Colorado, 15 counties were selling recreational cannabis (Figure 2). As of Dec 2018, there were a total of 37 counties with recreational cannabis dispensaries (Figure 3), out of which 29 counties already had medical cannabis dispensaries (Figure 4).

Cannabis and Labor Supply

Cannabis access increases cannabis use, which may affect the labor supply.[6] Increased cannabis consumption and dependence have varied effects on individuals, depending on the intensity, amount of use, and even individual-specific characteristics. If the effects of cannabis on health are negative, increased use should manifest in worse labor market outcomes, including decreased labor force participation, higher unemployment, and/or lower wages, as a result of lower productivity. However, if the effects of cannabis on health are positive, either through direct effects or indirectly through substitution away from more harmful substances, then an increase in labor market participation and wages should be expected. We first briefly summarize the vast literature on the health effects of cannabis use and then describe in greater detail results from the literature on the effect of MMLs on labor supply.

When investigating the effect of cannabis use on health, earlier studies tend to find negative effects from over-consumption, generally in contexts in which cannabis is not legal and based on retrospective survey data. These studies find that cannabis use may lead to higher suicidal ideation for males (Van Ours et al., 2013), adverse mental and physical health (Van Ours & Williams, 2011, 2012), and a decrease in cognitive functioning (Volkow et al., 2014; Winward, Hanson, Tapert, & Brown, 2014). Among these studies, an earlier start to cannabis use is associated with a larger negative wage impact (Van Ours, 2007), lower acquisition of human capital (Chatterji, 2006), a greater decrease in concentration and mental functioning (Hanson et al., 2010; Volkow et al., 2016), and a greater increase in laziness (Irons, Babson, Bergeria, & Bonn-Miller, 2014).

[6]Wen, Hockenberry, and Cummings (2014) find that MMLs are associated with an increase in cannabis use of 15 to 25 percent, with some increase in the incidence of cannabis dependence as well. Choi, Dave, and Sabia (2019) find a 2 to 3 percentage point increase in cannabis consumption for adults. Chu (2014) shows that MMLs increase arrests for cannabis possession by 10 to 20 percent.

Conversely, some studies find that legal medical use successfully treats adverse health conditions (Bonn-Miller, Zvolensky, & Bernstein, 2007), lowers pain (Li et al., 2019; Nicholas & Maclean, 2019), improves disease symptoms (Stith, Vigil, Brockelman, Keeling, & Hall, 2019; J. Vigil et al., 2018), leads to better self-assessed health (Nicholas & Maclean, 2019), encourages substitution away from opioids and other medications (Bradford, Bradford, Abraham, & Adams, 2018; Doremus, Stith, & Vigil, 2019; Stith et al., 2019; J. M. Vigil, Stith, Adams, & Reeve, 2017), lowers rates of workplace fatalities for workers aged 25 to 44 (Anderson, Rees, & Tekin, 2018), decreases job absences by 8.4 to 8.7 percent among workers 15 to 65 (Ullman, 2017), and reduces suicide rates among young men ages 20 to 39 (Anderson, Rees, & Sabia, 2014). These outcomes could be associated with increases in labor productivity, which, in competitive markets, should lead to higher wages.

In general, although some studies document direct benefits from cannabis consumption (Stith et al., 2018), indirect benefits may also be significant and arise from individuals substituting away from other substances towards cannabis. For example, Chu (2015) found that with the legalization of medical cannabis, arrests for possession of cocaine and heroin combined decreased by 0 to 15 percent, and admissions for heroin-related treatment decreased by 20 percent (Chu, 2015). Other studies have found that alcohol consumption decreases (Baggio, Chong, & Kwon, 2018), alcohol-related traffic fatalities decrease by 13 to 15 percent (Anderson, Hansen, & Rees, 2013), and the number of cigarettes consumed by smokers also decrease, leading to $4.6 to $6.9 billion per year in tobacco-related health-care cost savings (Choi et al., 2019). Although short-term impairment effects may be similar, the long-term consequences of chronic cannabis consumption appear to be better than those from opioids, alcohol, and tobacco. In particular, no deaths have been documented as a result of the negative health consequences of cannabis, while opioid overdoses killed 47,000 people in 2017 (Scholl, Seth, Kariisa, Wilson, & Baldwin, 2019), on average 88,000 people die from alcohol-related causes annually (Centers for Disease Control & Prevention, 2013), and cigarette smoking is accountable for more than 480,000 deaths per year in the United States,

including greater than 41,000 deaths caused from secondhand smoking exposure (US Department of Health and Human Services, 2014).

Although potential health benefits from legal medical use have been documented, only a handful of previous studies have focused on the effects of MMLs on the labor market. One study, Sabia and Nguyen (2018), found no evidence of MMLs affecting working-age adult employment and work hours using the data from Current Population Survey Outgoing Rotation Groups. Even though they do find a decrease in wages among young men (aged 20 to 39) of 2 percent, there is no evidence of a reduction in overall hourly wage. Using Health and Retirement Study data, Nicholas and Maclean (2019) find that the state MMLs leads to an increase in labor supply among older adults, implying that MMLs may increase some individuals' ability to work and be more productive. The effects of recreational cannabis legalization on labor market outcomes have not been studied.

Cannabis and Labor Demand

Legal cannabis sales have a long supply chain that includes cannabis cultivators, extraction services, product manufacturers, testing facilities, distributors, and retail cannabis stores. Technology is exploding in the legal cannabis industry, with innovations in products created with THC and CBD extracts, concentration, product standardization, and consumption methods ranging from vaporizing flower, and concentrates to suppositories and pills. Given a long supply chain and increasing technological sophistication, the opening of dispensaries could increase manufacturing directly. In 2015, the Marijuana Policy Group (MPG)[7] calculated that in Colorado, legal cannabis activities created over 18,005 new Full-Time-Equivalent (FTE) positions. Of those jobs, 12,591 employees were directly affiliated with the marijuana businesses, including infused product manufacturing operations, cultivation, and in-store dispensaries. The remaining 5,414 FTE positions were created by input purchases for general business goods and services from the cannabis industry. This had an economic impact of around $2.39 billion

[7]A collaborative effort by experts from MPG and the University of Colorado Boulder, Leeds School of Business, Business Research Division.

on the state output (Light et al., 2016).

In addition to the legalization of cannabis, Colorado is also famous as a tourist destination for skiing and other outdoor activities. The blending of the two has led to an appeal to more tourists by new cannabis-friendly accommodations. Colorado is building more cannabis stores, cultivation sites, testing facilities, restaurants, and new hotels to accommodate this enormous demand from the tourists (Armijo, 2019; Mitchell, 2019).

In summation, the legalization of recreational cannabis might affect the market for labor via different mechanisms. With the increase in demand for cannabis, we expect an increase in the quantity of labor demanded through increases in cannabis production and spillovers to the tourism industry. Given this increase in the demand for labor, assuming no changes in labor supply, we would expect a decrease in the unemployment rate and an increase in the number of jobs or employees. If labor markets are tight, this could translate into higher wages for hired workers as well.

However, forces on the labor supply side may mediate effects from labor demand. On the one hand, if the harmful effects of cannabis consumption dominate, then we expect a reduction in labor force participation leading to a decrease in labor supply. This decrease in labor supply would further reduce the unemployment rate without any effect on the number of employees. If consumption affects productivity, we might also expect a decrease in the equilibrium wage.

On the other hand, if the positive effects of cannabis consumption dominate, then we should observe an increase in labor force participation leading to an increase in labor supply. With this increase, the effect on the unemployment rate will be indeterminate, as it will depend on the relative magnitude of the shift in labor demand and supply. Likewise, the effect on wages will be less clear, but the number of employees should increase unambiguously.

Data

We assembled data for all 64 counties of Colorado on labor market outcomes, recreational access, and county characteristics from various federal and state-level agencies. Table A.1 in the appendix summarizes a timeline for the period covered by each variable type we use and its data sources.

Labor Market Outcomes: The data on labor market outcomes is from the U.S. Bureau of Labor Statistics (BLS). The employment and labor force participation data is from Local Area Unemployment Statistics (LAUS), a joint federal-state initiative that provides monthly estimates of total employment and unemployment. The LAUS data's underlying concepts and definitions come from the Current Population Survey (CPS), the household survey that is the source of the national unemployment rate. The county-level LAUS data are cross-validated and updated using data from multiple sources, including the CPS, CES, State UI systems, and American Community Survey (ACS).

Data containing the number of employees and wages by industry are from the Quarterly Census of Employment and Wages (QCEW). The QCEW reports quarterly county-level payroll data on private employment and wages for narrowly defined industries. In accordance with the unemployment insurance program, these details are obtained from the paperwork employers register. They use the North American Industrial Coding System (NAICS) to define each industry in the data and then aggregate the data by county, industry, and quarter. Specifically, the analysis in this paper uses the number of employees and average weekly wage data for each county, overall and by industry category: Natural Resources and Mining (Agriculture, Forestry, Fishing, and Mining), Construction, Manufacturing, and Service-Providing (Trade, Information, Financial Activities, Education and Health Services).

The county-level data from the QCEW have some advantages. Compared with other datasets, QCEW is the only source with census observations of employment and wages reported in detail, covering over 95 percent of U.S. jobs. The quarterly counts are available at the county, Metropolitan Statistical Area (MSA), state, and national levels by industry. A comprehensive count of employment and wages are available, classified

by industry, on the basis of quarterly reports filed by employers for more than 7 million unemployment insurance companies. The amalgamation of these characteristics makes QCEW a compelling and rich resource for the study of labor market outcomes.

However, there are some drawbacks to the QCEW data set. The monthly dependent variable, employees, and the quarterly dependent variable, average weekly wage, have data points missing for some counties.[8] There is also no distinction between part-time and full-time employees nor a measure of average hours worked by county. The only information on earnings is the average weekly wage per worker overall and by industry subgroup, measured at the county level.[9] Nonetheless, the QCEW provides the most complete and precise county-level data on employment and earnings, with county-level information required for our identification strategy.

Recreational Dispensary and Medical Cannabis Patients: Our key variable of interest, the location and timing of recreational dispensary entry in Colorado counties are compiled from the Colorado Department of Revenue (CDOR). The data come from the Marijuana Sales Report (Colorado Department of Revenue, 2019) of recreational cannabis dispensaries openings, starting in January 2014. The Marijuana Sales Reports reflect sales made in each county by month. Although the data show whether any cannabis sales occurred for all Colorado counties, the amount of sales for some counties is not released for confidentiality reasons, i.e., sales data are disclosed only when there are at least three taxpayers in a given category, and none of them account for more than 80 percent of the total. The number of medical cannabis patients by month is collected from the Colorado Department of Public Health and Environment (CDPHE). Their website reports medical cannabis patients by month for each county in Colorado (CDPHE, 2019).

Using these datasets from the Colorado Department of Revenue (CDOR), Colorado Department of Public Health and Environment (CDPHE), Local Area Unemployment

[8]BLS withholds the release of data to protect the identity and data of cooperating employers when necessary. Since QCEW receives reports from each U.S. employer, there are many cases where QCEW detailed data could consist of a single employer in a county in some industries. In QCEW publications, these data are retained or "suppressed." Totals for the States and the Nation at the industry level include the undisclosed data suppressed in the detailed tables.

[9]Wages include bonuses, stock options, severance pay, the cash value of meals and lodging, tips and other gratuities.

Statistics (LAUS) and Quarterly Census of Employment and Wages (QWEC), we construct a county-level panel data set for the period 2011-2018, in order to compare changes in labor market outcomes in counties with recreational dispensaries to those without.

In Table 1, we present the overall summary statistics for the main dependent and independent variables. The full monthly data sample includes 6144 observations, and the quarterly data has 2048 observations. However, some observations are missing for the construction, manufacturing, and natural resource & mining industries due to the reasons mentioned in the previous section. In the analysis of the sub-industries, we only include the counties with consistent documentation over time and exclude the counties with missing observations. In this way, for each sub-industry there are different sets of counties that we analyse; 34 selling counties,[10] and 18 not-selling counties[11] for Construction, 32 selling and 15 not selling counties for Manufacturing, and 32 selling and 21 not selling counties for Natural Resources and Mining. The differences between the minimum and maximum values are substantial and support using a natural log transformation.

Table 2 presents the averages for selling (treated) counties before (Column 1) and after (Column 2) they started selling recreational cannabis, and for not selling counties evaluated pre-January (Column 3) and post-January 2014 (Column 4). The last three columns compare Columns 1 and 2, Columns 1 and 3, and Columns 2 and 4. Panel A shows monthly data and Panel B shows quarterly data. In both panels, for each variable, the first rows are the means (Columns 1 to 4) and the differences in means with a two-sided t-tests (Columns 5 to 7), and the second rows are the number of observations (N).

Comparing Columns 1 and 2 in Column 5, i.e., pre/post dispensary entry, we see statistically significant difference in means for all our variables except that the number of medical patients and the number of employees in Natural Resources and Mining remain unchanged. Among industry sectors, Natural Resources and Mining is hypothesized to

[10]Counties which sold cannabis at any point of time between 2011-2018

[11]Counties which never sold cannabis between 2011-2018

be the sector least closely related to the recreational cannabis market, as supported by these t-tests. The unemployment rate and the number unemployed decreases, while labor force and employees and wages both overall and by sector increase, suggesting that both supply and demand may be positively affected by dispensary entry. The changes pre- and post-dispensary entry are not consistent with a decrease in labor supply or demand. In Column 6 and 7, however, the reported differences indicate the importance of controlling for differences in levels across the counties and over time. Statistically significant differences exist prior to dispensary entry between selling and not selling counties for all variables except manufacturing and service-industry wages. Selling counties have a higher unemployment rate, higher labor force participation, more unemployed, more employees overall and by sector, more medical cannabis patients, and higher wages prior to dispensary entry. The difference in the unemployment rate disappears and the marginal significant difference for the number of manufacturing wages switches sign in Column 7, but the other differences persist or even increase.

In addition to the summary statistics, we include Figures A.1, A.2 & A.3 comparing the changes for our dependent variables over time for counties with dispensaries to those without. As in Table 2, apparent differences in levels exist between selling and not selling counties that persist over time, again indicating the importance of controlling for county and time fixed effects in our regression analysis. An informal evaluation of parallel trends suggests that parallel trends exist for the unemployment rate, labor force, the number unemployed, and wages. Although we do not see strong evidence of a violation of the parallel trends assumption for our other outcomes, we do see potentially small differences in pre-trends for employees overall, and for the Manufacturing and Natural Resources and Mining sectors. The obvious seasonality in the data supports the inclusion of month fixed effects.

Empirical Strategy

In order to estimate the impact of recreational dispensary entry on our variables of interest, we use a difference-in-differences (DD) model with fixed effects. The variation in the location and timing of dispensary entry across counties in Colorado is exploited to accurately identify local labor market spillovers, where counties in which recreational dispensaries enter are the treatment group and counties that never report any recreational cannabis sales are the comparison group.

All the dependent variables except the unemployment rate have been transformed using the natural logarithm to reduce the impact of outliers. We analyze the unemployment rate, the size of the labor force, the number of unemployed, and the number of employees and the average weekly wages overall, as well as the number of employees and the average wage by industry sector.

We estimate the following two specifications of our model:

$$ln(Y_{cmy}) = \alpha_0 + \beta R_{cmy} + \theta X_{cmy} + \delta_y + \delta_m + \gamma_c + \epsilon_{cmy} \tag{1}$$

$$ln(Y_{cmy}) = \alpha_1 + \lambda_1 sales^{low}_{cmy} + \lambda_2 sales^{high}_{cmy} + \theta X_{cmy} + \delta_y + \delta_m + \gamma_c + \epsilon_{cmy} \tag{2}$$

Y_{cmy} is our main outcome variable for county c in month/quarter m and year y. R_{cmy} in equation 1 and $sales^{i}_{cmy}$ in equation 2 are the two types of treatment that we consider. R_{cmy} is a dummy variable indicating any recreational cannabis sales, whereas $sales^{low}_{cmy}$ indicates when $\$0 < sales \leq \$500,000$ and $sales^{high}_{cmy}$ when $sales > \$500,000$. β reports the average effect with the commencement of the sale of recreational cannabis, and λ_1 *and* λ_2 report the average effects of lower and higher levels of recreational cannabis sales relative to no sales. Thus β in equation 1 and λ_1 *and* λ_2 in equation 2 are our primary coefficients of interest, summarizing the policy effect. X_{cmy} controls for the number of medical cannabis patients, and δ_y, δ_m and γ_c are fixed effects at the year, month/quarter and county level respectively. It captures year and month/quarter effects that are common across counties and time-invariant county-level factors.

County-level fixed effects enable us to control for any population density and

demographics (e.g., age and socioeconomic status), which could bias our results, but which do not change over time during our sample period from 2011 to 2018. Month fixed effects account for seasonality that affects all counties and differs only in levels, not in terms of which months are peak tourism months. For example, even though some counties always have more tourism than others (captured by the county fixed effects), most Colorado counties have spikes in tourism in the summer and ski season. Robust standard errors, ϵ_{cmy}, are clustered at the county (treatment) level to correct for arbitrary correlation among the observations in a given county.

Our identification is based on both the timing and location of opening new dispensaries; thus, we use an "event-study" research design to ensure that pre-implementation factors do not drive the heterogeneity in the timing of implementation. Event studies estimate leads and lags in the effect of policies, which allows for assessment of policy endogeneity (Autor, 2003; D. S. Lee & Mas, 2012; Lovenheim, 2009) and policy effects that vary over time. We estimate equation 3 for our event-study model.

$$ln(Y_{cmy}) = \alpha_0 + \sum_k \tau_k Z^k_{cmy} + \theta X_{cmy} + \delta_y + \delta_m + \gamma_c + \epsilon_{cmy} \tag{3}$$

More specifically, we regress our outcomes, Y_{cmy}, on a series of "event-time" dummies Z^k_{cmy}.[12] For ease of exposition, Z^k_{cmy} equals one when a county c is k months/quarters from the commencement of recreational cannabis sale in month/quarter m and year y. For counties that never sell recreational cannabis during our given sample period from 2011-2018, these indicator variables are set to zero. Some τ's cannot be identified, as Z^k_{cmy}'s are perfectly collinear in the presence of the county effects. The τ_k coefficients identify treatment effects relative to the effect for the half-year[13] prior to commencement

[12]We may write it formally as

$$Z^k_{cmy} \equiv L[my - time_c = k],$$

where L[.] is an indicator function for the expression in brackets is accurate, and $time_c$ is the month-year combination in which county *'c'* began to sell recreational cannabis.

$$Z^k_{cmy} = \begin{cases} 1 & if \quad county\ 'c'\ is\ 'k'\ months/quarters\ from\ sale\ start\ in\ month/quarter\ 'm'\ year\ 'y' \\ 0 & otherwise \end{cases}$$

[13]For our event-study regressions we normalize $\tau_{-6} = 0$ for monthly data and $\tau_{-2} = 0$ for quarterly data.

of the sale. Thus, for our assumption of strict exogeneity to hold, $\tau_k = 0$ for all $k < 0$, for event-study regression at the month-level and quarter-level respectively. [14]

Results

We first report the results from event-study models to informally assess pre-trends and then turn to DD models that estimate the average effect of recreational cannabis legalization. These results pass several robustness tests, including controlling for population, county-specific seasonality, county-trends, most impacted county, and early-adopting counties.

Event Study

The validity of the DD model holds if the treatment (counties with dispensary entry) and control (counties with no dispensary entry) groups do not show significant differences in trends prior to the treatment, i.e., the parallel trends assumption. We expect that the coefficient τ_k for the pre-treatment period, $-40 \leq k \leq 0$ for monthly data and $-10 \leq k \leq 0$ for quarterly data, would be clustered around zero if the parallel trends assumption holds. This assumption could be violated if: (i) county-level time-varying unobservables are associated with the entry of dispensaries and labor market outcomes, (ii) pre-treatment patterns in labor market outcomes differ in counties that are treated compared to control counties, (iii) dispensaries open in response to trends in labor market outcomes.

Figures 7, 8 & 9 plot the estimated τ_k coefficients from Equation 3. For Figures 7 to 9, we generally observe no pre-treatment trend in the coefficients except for the unemployment rate. For the natural logs of the total labor force, unemployed, all industry employees, and employees in manufacturing, construction, service-providing industries, and natural resource and mining, and for the average wages overall and by industry

[14] To summarize, the τ_k coefficients represent the time path of our dependent variables relative to the date of the commencement of recreational cannabis sales. Through this specification, we are able to assess whether trends in our outcome variables precede the commencement of recreational cannabis sales or if policy effects change over time post-policy implementation.

sector, our assumption of no pre-trends holds. Because of its usefulness as a policy benchmark, we continue to include the unemployment rate as an outcome. Even for the unemployment rate, we still observe a significant change after recreational cannabis access. In particular, from Figure 7, we observe that the unemployment rate is higher in the pre-implementation period, whereas it declines post-dispensary entry in recreational cannabis selling counties. Similarly, the number of unemployed appears to be declining post-implementation.

From the event study in Figure 8, we observe the number of employees for all industries combined has a sustained and significant increase after dispensary entry for treated counties. The increase in employees overall appears to be driven by the manufacturing sector, which experiences an increase of about 10 months of post-dispensary entry for treated counties. These results also show that the sector arguably least likely to be affected by recreational cannabis dispensary entry, Natural Resources and Mining, shows no trend pre- or post-dispensary entry, as expected.

Difference-in-Differences Analysis

With the exception of the unemployment rate, our event study results show no significant pre-trends, and instead, provide evidence that the commencement of recreational cannabis sales is associated with an increase in the total number of employees overall, and that the manufacturing sector drives this effect. We, therefore, proceed with our difference-in-differences analysis, presenting our results in Tables 3, 4 and 5, each of which are split into two panels. Panel A presents our results using our {0,1} dispensary entry variable, and Panel B shows how the intensive or level of sales affects our outcomes.

We first discuss the results from Panel A of Tables 3, 4 and 5 before exploring the intensive margin results from Panel B of those tables. The effect of recreational cannabis law implementation on the unemployment rate, total labor force, and the number of unemployed are presented in Table 3. From Panel A, our results provide strong evidence that after recreational dispensary entry, there is a significant decrease in unemployment with a 0.684 percentage point ($p < 0.01$) decrease in the unemployment rate and a 6.6

percent ($p < 0.01$) decrease in the number of unemployed. The lack of a statistically significant effect on the natural log of the labor force indicates that an increase in employment is driving the effect. In Panel A of Table 4, estimates for employees, overall and by sector suggest demand for labor has increased employment rather than that the reduction in unemployment is driven by self-employment; recreational sale is associated with a 4.5 percent[15] ($p < 0.01$) increase in overall employment, driven by a 13.8 percent ($p < 0.01$) increase in the number of manufacturing employees and a 3.9 percent ($p < 0.05$) increase in the number of service sector employees. In Panel A of Table 5, we find no effect from dispensary entry on wages, which is consistent with some level of continued unemployment or excess supply of labor, i.e., the labor market has tightened but not so much as to increase wages.

Expanding our {0,1} dispensary entry treatment variable to account for the amount of sales in Panel B of Tables 3, 4, and 5, we do not find that effects are strictly increasing with sales. The reduction in the unemployment rate and the increase in manufacturing employees are greater with entry than with subsequent expansion as measured by the amount of sales. For the number of unemployed and the number of employees in the service sector, we find that larger recreational cannabis markets generate a more significant effect on these outcomes. One possible explanation for the difference across sectors is that labor is more of a variable cost in the service sector while it is more of a fixed cost in manufacturing.

Concerning our primary control variable, the natural log of the number of medical cannabis patients, we find that counties with growing populations of medical patients experience even greater unemployment reductions. However, for manufacturing employees, the natural log of the number of medical patients decreases the effect of dispensary entry, which is consistent with generally smaller effects from expansion of sales than from entry, i.e., newer markets experience greater returns to entry in terms of employment in manufacturing, an industry that may have relatively less variable labor costs. Although the coefficients are similar in some cases for dispensary entry and for the

[15] $100 * (e^{\beta} - 1)$

natural log of the number of medical patients, the magnitude of the effect is substantially smaller for the number of medical patients. For example, an increase in the number of medical cannabis patients by 1 percent, leads to a decrease in the number of employees in the manufacturing industry by 0.187 percent. For this decrease to completely negate the positive effect of recreational access, the number of medical patients has to increase by 68.9 percent, which is unlikely given the lack of evidence of major changes in the medical market during this time period as shown in Figure 1.

We test the sensitivity of our main DD results by considering various alternative specifications and samples with results available in the Online Appendix. More specifically, we run regressions including the natural log of the population (Table A.2-A.4), county-month fixed effects (Table A.5-A.7), and a county-year trend (Table A.8-A.10), and restricting our sample to omit Denver (Table A.11-A.13) and counties in which dispensaries entered on January 2014 (Table A.14-A.16). We furthermore include a specification splitting sales into four bins, $\$0 < sales \leq \$250,000$, $\$250,000 < sales \leq \$500,000$, $sales > \$500,000$, and the base bin is $sales = \$0$. We find our results are robust to these alternative specifications, noting that including population does render the coefficients on service and overall employees statistically insignificant, although still positive, and including a county-year trend affects the statistical significance and magnitude of some of our coefficients, but is likely excessive (Angrist & Pischke, 2008). More specifically, we lose magnitude and statistical significance for our dispensary entry variable for all outcomes except the log of unemployment, which is marginally significant, however, our results using the amount of sales indicates that sufficient sales still decrease the unemployment rate and the number unemployed, while increasing overall employment and employment in the service sector. Our results for manufacturing are statistically insignificant, although still positive in the presence of a county-year trend. Splitting our sales intensity into four bins suggests an inverted U-shape may exist in that higher sales are associated with a greater effect up to a certain point, after which increasing sales has a diminishing effect on labor market outcomes. Across specifications and subgroups, we see consistent evidence that recreational cannabis dispensary entry leads to a decrease in

the unemployment rate and the number of unemployed, and an increase in the number of employees overall and for the manufacturing and service sectors with no effect on wages.

Discussion

While prior studies have focused on the effects of self-reported cannabis use or state-level medical cannabis legalization on labor outcomes, this study contributes to the literature by exploring the relationship between recreational cannabis access through dispensaries and labor market outcomes. Prior studies have found that dispensary access may be the crucial driver of effects, even for medical cannabis legalization (Pacula, Powell, Heaton, & Sevigny, 2015). In addition, rather than focus on state-level differences, which may be moderated by a variety of unobservable factors, we exploit county-level variation in the timing of commencement of sale in Colorado, lending potentially greater internal validity to our results. We furthermore distinguish outcomes across industries, as has not yet been explored in the literature on illegal, medical, or recreational cannabis legalization and use.

Using a difference-in-differences estimation strategy, including an event study, we find consistent evidence of a decrease in the unemployment rate and the number of unemployed and increases in the number of employees overall and for the manufacturing and service sectors. We do not find any effect on the size of the labor force or on average wages overall or by industry sector.

The decrease in the number unemployed without a change in the size of the labor force, suggests a tightening of the labor market, driven by demand-side effects rather than by a decrease in labor supply. The lack of an effect on wages most likely arises from labor supply continuing to exceed labor demand in excess of frictional unemployment. These results match the overall results found in Sabia and Nguyen (2018) in that we find no overall effect on wages. We do not find an effect on the size of the labor force as would be predicted by Nicholas and Maclean (2019); however, this could be explained by their smaller affected population (elderly adults) and a different treatment variable,

state-level medical cannabis access rather than county-level recreational dispensary access in Colorado.

Our industry-level results indicate that the increase in labor demand arose primarily from changes in demand for manufacturing and service employees. Manufacturing is a primary component of the cannabis supply chain, and the increase in service employees could arise from cannabis tourism, even within Colorado, leading to an increase in demand for the leisure and hospitality sector workers. Manufacturing effects seem to primarily arise with entry, while service sector effects increase with increasing sales. These differences could be explained by labor being more of a fixed cost in manufacturing and a variable cost in service-providing industries.

Our findings that the presence of cannabis dispensaries has the potential for employment growth is in keeping with employment effects from the legalization of other previously illegal activities, namely gambling. For example, opening a casino will connect residents to a potentially addictive entertainment option while at the same time attracting consumers through more distant tourism leading to spillovers into the service sector, through effects on leisure and hospitality markets. Cotti (2008) finds that total county-level employment increases by 8 percent after a casino opens, relative to counties without a casino. The indirect spillover effects are also positive and important but are mainly limited to differential employment growth in closely related service-providing sector (lodging, beverage and food services, and other leisure and entertainment services). Reece (2010) finds that with the establishment of riverboat casinos in Indiana counties, the number of hotel rooms increases in the third, fourth, and fifth years. On a similar note, there is evidence from Humphreys and Marchand (2013) that opening a new casino has positive effects on Canada's local labor markets. In particular, it is highly likely that positive spillovers to construction and manufacturing industries exist. Further supporting the existence of spillovers, employment levels increased after casinos opened in 1991 in Tunica County, Mississippi. In fact, from 1992 to 2001, the service sector in Tunica grew by more than 1000 percent (Garrett et al., 2004). Consistent with this prior literature, our results provide suggestive evidence of labor demand effects dominating the labor

supply effects, although we cannot rule out the existence of supply-side effects.

This study does have limitations with respect to cross-border travel, substitution between medical and recreational cannabis, and the generalizability of the results for future recreational legalization. Cross-county border travel likely leads to underestimation in general and may affect our supply-side estimates more than our demand-side estimates. On the demand side, we expect that increased employment occurs through the cannabis industry itself and spillovers to related industries that are geographically proximate. Some cross-county spillovers are possible, likely leading to some underestimation of any increases in labor demand. However, for the supply-side the potential for cross-county border travel contaminating our results is much higher and again in the direction of underestimation of effects. Firms are much more localized to a specific county than are workers or the labor force more generally and cannabis users seem likely to cross borders to purchase cannabis, perhaps affecting labor markets in which dispensaries are not located. These differing levels of precision with respect to demand versus supply also affect our results through the different data sources we use. Our data on employees derives from payroll information reported by firms in a county, but our data on unemployment and labor force participation relies on household reporting, meaning many affected households may not be showing up as treated even though they work in a county in which a dispensary entered. Therefore, our estimates using the QCEW data to measure effects on the number of employees are likely more accurate than our estimates for the unemployment rate, labor force, and number unemployed.

The medical market for cannabis in Colorado was quite mature at the time of recreational cannabis legalization and graphing sales over time for medical cannabis shows little change with recreational legalization. However, we did find that while increases in the number of medical patients may augment the effect of recreational dispensary entry on the unemployment rate, an increase in the number of medical patients reverses some of the increase in the number of manufacturing employees associated with recreational dispensary entry. The magnitude of the effect from increases in the number of medical patients is much smaller than for recreational dispensary entry, but the opposite sign

associated with the number of manufacturing employees suggests that markets in which the number of medical patients is growing may be associated with fewer benefits from dispensary entry, perhaps through market saturation or heterogeneity in the quality of dispensary entrants. In addition, the manufacturing sector may involve more labor-intensive work than other sectors, and therefore, might be less likely to employ medical marijuana patients with medical conditions, making counties with large increases in the number of medical patients less attractive to manufacturers. Future studies should be conducted to understand the level of substitution between recreational and medical cannabis and how differences in these target markets could lead to different labor market effects from dispensary entry.

Lastly, while this study finds that the introduction of a legal recreational cannabis market has a statistically significant impact on the number of employees in selling counties, this evidence should be interpreted carefully, given that the industry's long-term evolution may be uncertain. Although the increase in employment across counties in Colorado is sizable, it is difficult to predict the impact of recreational cannabis legalization on employment if all states were to legalize recreational cannabis. At present, as we observe from Figure 6, Colorado is the only state among its neighbors with a legal recreational sale, and it is closer to the east coast than Washington, California, and Oregon. Recently, Illinois has also started to sell recreational cannabis, beginning in January 2020. In addition, voters and legislators in many other states have been working to legalize recreational cannabis, including Colorado's neighbor, New Mexico. If New Mexico legalizes recreational cannabis (M. Lee, 2019), Colorado will likely lose some of its market power, reducing employment benefits. In contrast, as a new entrant to a pre-existing market, New Mexico may experience fewer gains in employment than Colorado did as a "first-mover" into recreational cannabis, at least regionally. As more states are likely to consider legalizing recreational cannabis, understanding how local effects vary with greater access at a national level is an essential question for future research.

Conclusion

The Governor of Colorado recently stated concerning the cannabis industry, "It's going very well. ... It's creating tens of thousands of jobs, tax revenue for the state, filling up buildings for landlords, and reducing crime..." (Rosenbaum, 2019).

Overall, the findings in this paper provide evidence that recreational cannabis legalization offers an economic boost to the counties of Colorado, with no negative effects on wages. Although some studies in the literature show adverse effects on the labor markets, the equilibrium outcomes that we observe lend support to the argument that with the creation of jobs and associated spillover effects to other industries, labor demand-side effects may have a substantial impact on employment.

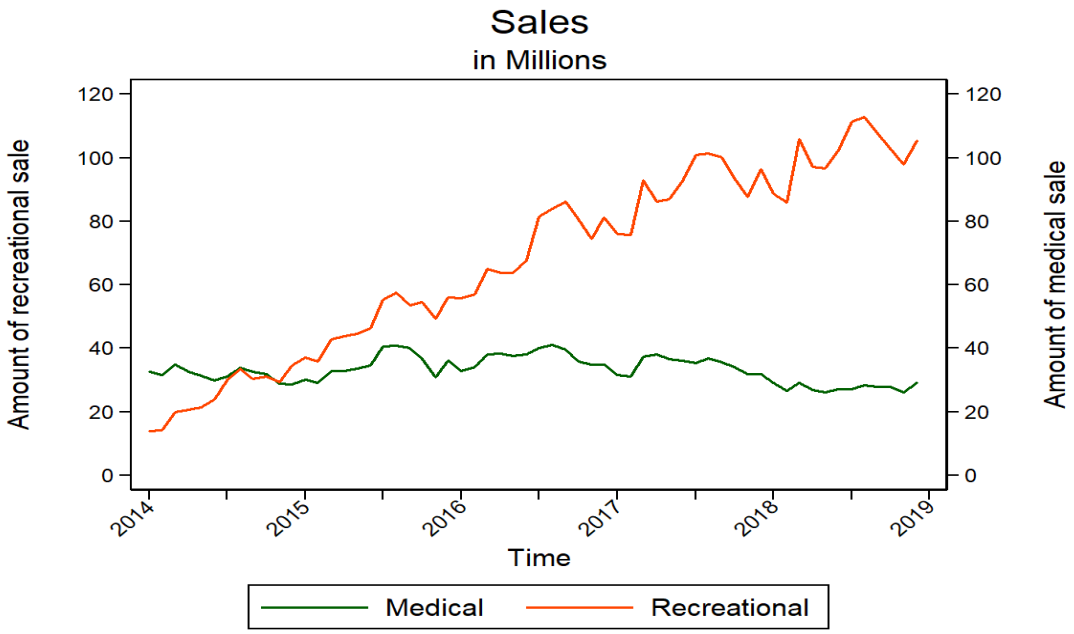
Of course, we cannot disregard the downside associated with the positive effects. From the perspective of policymakers, any positive effects on the unemployment rate through an increase in the number of employees needs to be balanced against the adverse effects. Medical cannabis legalization has been shown to increase consumption (Martins et al., 2016), and excessive use of cannabis may lead to adverse health issues (Irons et al., 2014; Van Ours, 2007; Van Ours & Williams, 2011, 2012; Van Ours et al., 2013; Volkow et al., 2014). It may be that these negative effects can be extrapolated to recreational cannabis markets as well; however, they should be weighed against evidence of substitution between cannabis and more harmful substances such as alcohol (Anderson et al., 2013; Baggio et al., 2018), and opioids (Bradford et al., 2018; Doremus et al., 2019; Stith et al., 2019; J. M. Vigil et al., 2017). Besides, federal law still restricts cannabis markets, e.g., through banking and taxation practices, so it may be that federal legalization would generate even more significant labor market effects than quasi-legal state-level markets. However, the returns to legal access would likely be more widely distributed rather than concentrated as they currently are in the nine states with operating recreational cannabis dispensaries as of May 2020.

Although this study focuses solely on Colorado and is limited by the data available, this study represents an important step in understanding the impact of recreational cannabis laws on labor markets. Our results suggest that policymakers considering

recreational access to cannabis should consider employment effects as a potential outcome from recreational cannabis legalization, but should also account for significant heterogeneity in effects at the county-level, depending on recreational dispensary access. Overall, the hope is that these estimates will provide a broader picture of the impact of recreational cannabis entry on county-level labor markets, which policymakers might use to improve future public policy decisions. Our analysis emphasizes the importance of accounting for heterogeneity within a state and across industries in future work on this topic.

Figures

Figure 1: Sales Over the years



Note: We observe all legal sales of medical and recreational cannabis in this figure.

Figure 2: Counties Selling Recreational Cannabis- Jan 2014

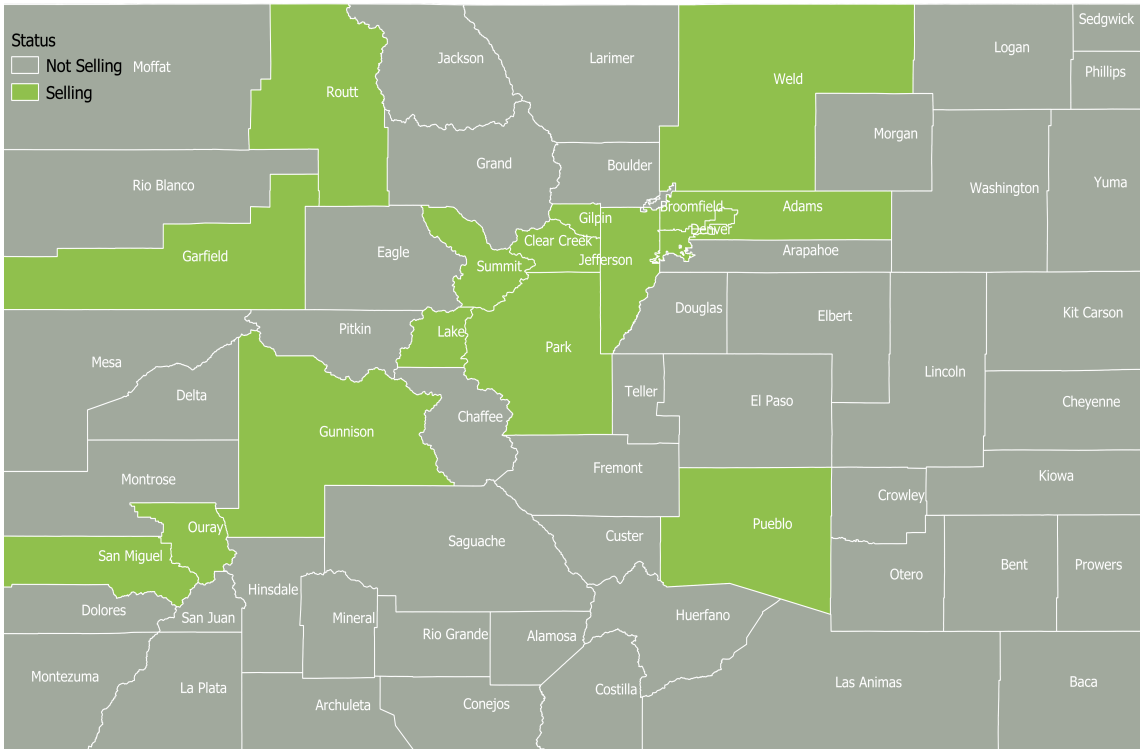


Figure 3: Counties Selling Recreational Cannabis- Dec 2018

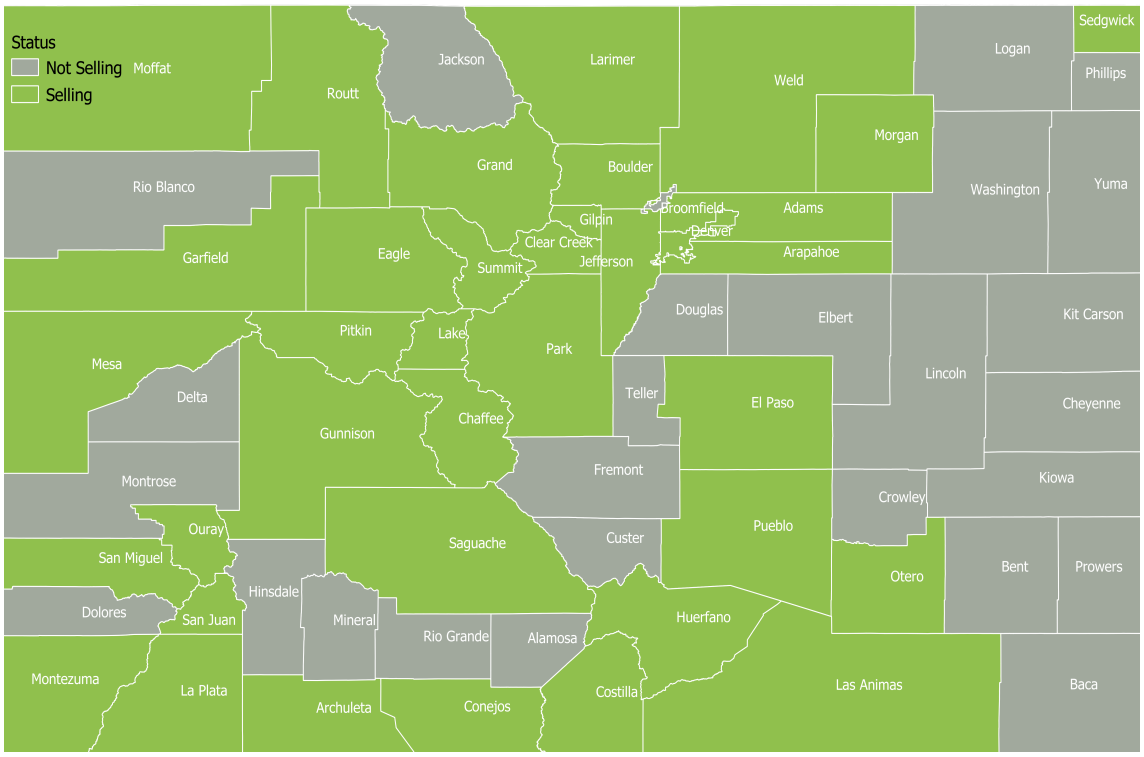


Figure 4: Counties Selling Recreational & Medical Cannabis- Dec 2018

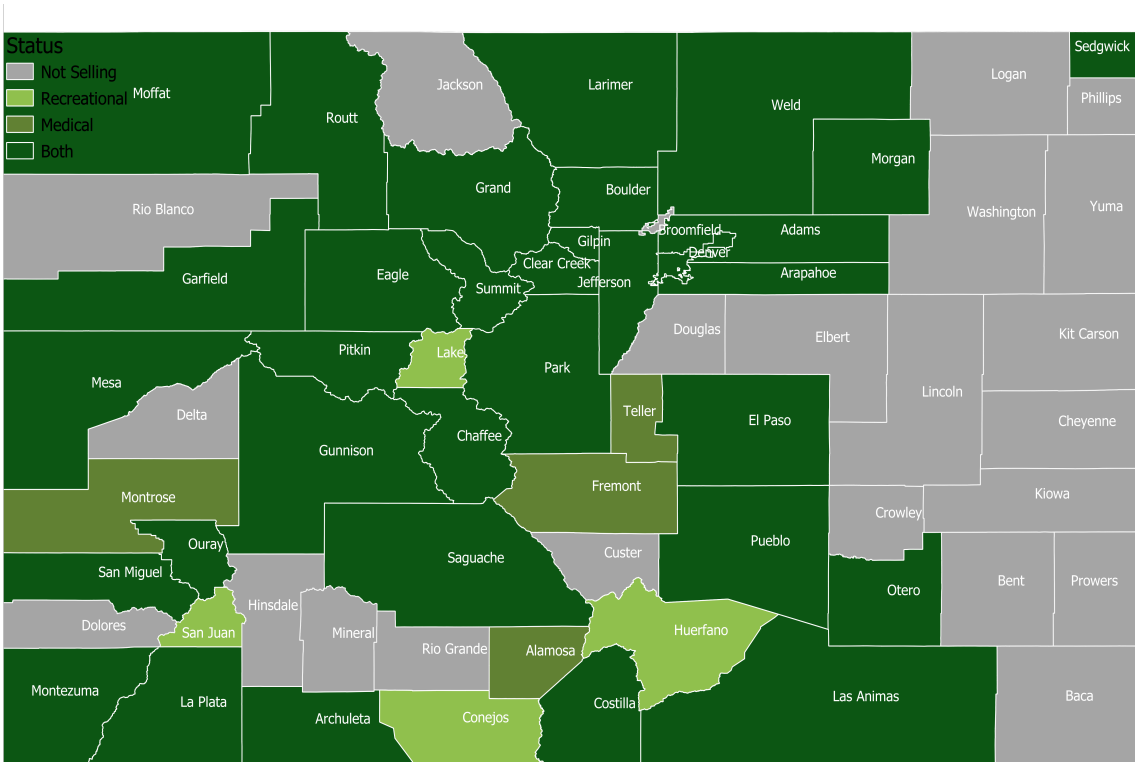
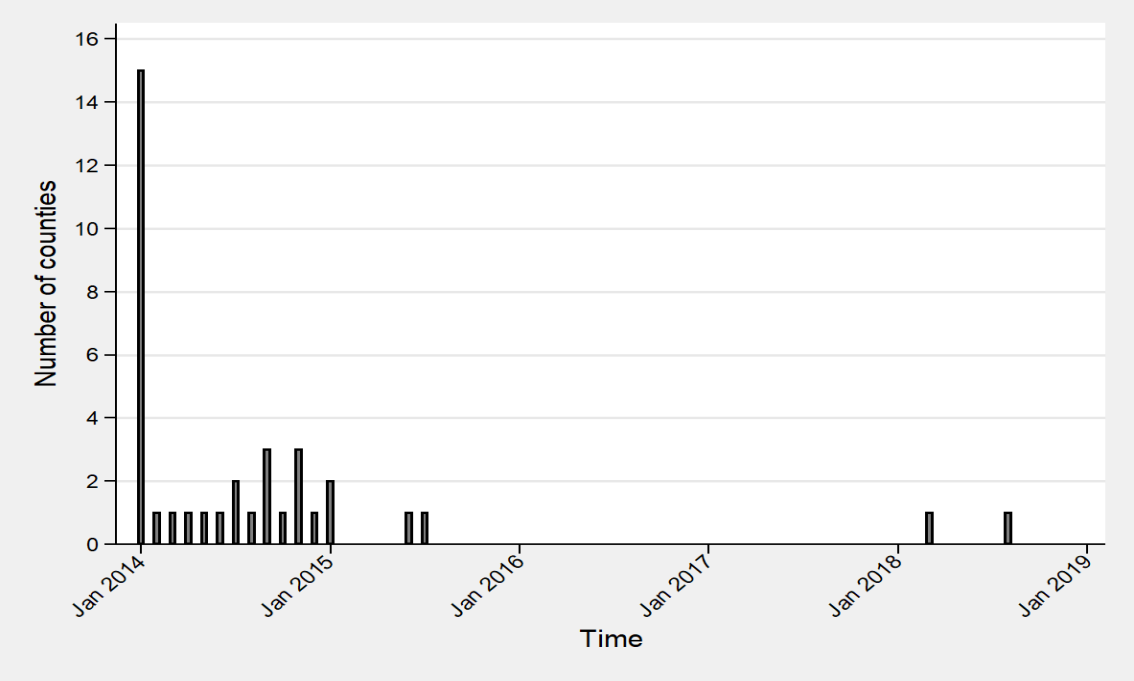
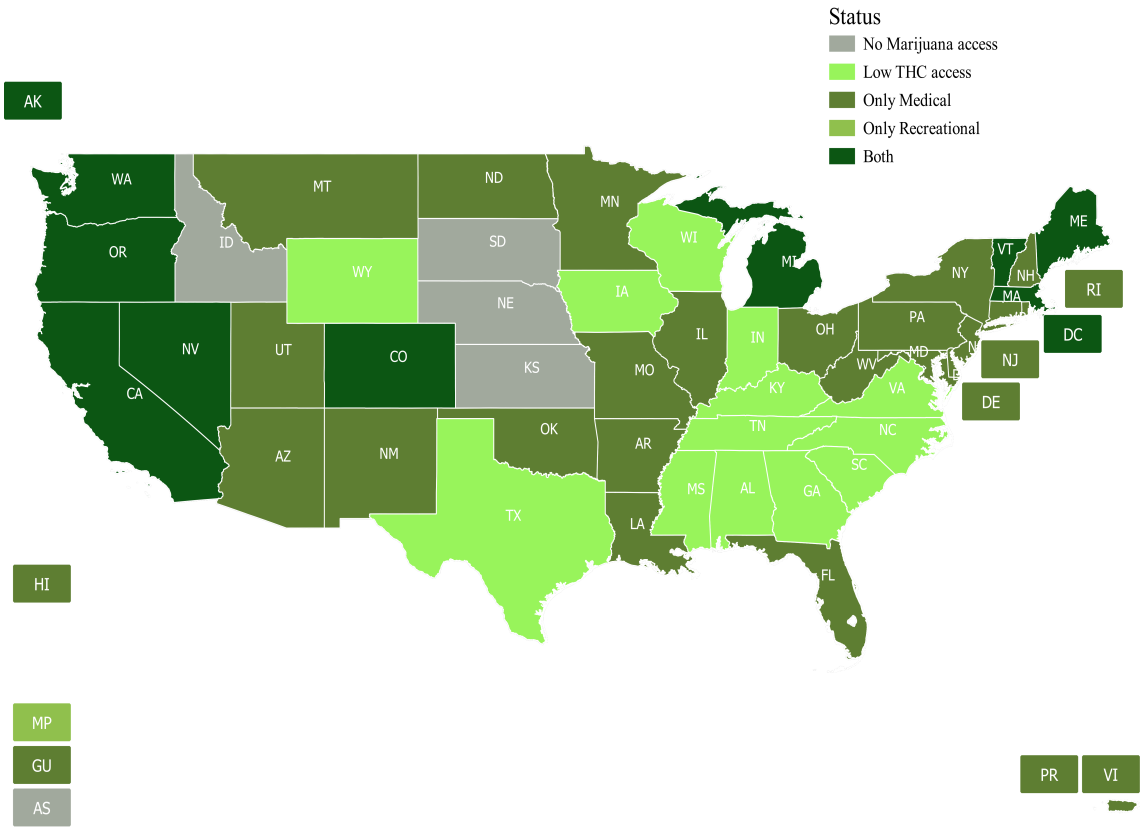


Figure 5: Counties starting to sell recreational cannabis over the years



Note: We observe all legal sales of recreational cannabis in this figure. The number of counties starting the sale of recreational cannabis by month. The following counties started sale from 2014: Adams, Clear Creek, Denver, Garfield, Gilpin, Gunnison, Jefferson, Lake, Ouray, Park, Pueblo, Routt, San Miguel, Summit, and Weld (Jan 2014); Boulder (Feb 2014); Pitkin (Mar 2014); Larimer (Apr 2014); Eagle (May 2014); Sedgwick (June 2014); El Paso and Saguache (July 2014); Chaffee (August 2014); Archuleta, La Plata, Morgan (Sep 2014); Arapahoe (Oct 2014); Costilla, Grand, and Las Animas (Nov 2014); Montezuma (Dec 2014); Mesa and San Juan (Jan 2015); Huerfano (June 2015); Conejos (July 2015); Moffat (Mar 2018); Otero (August 2018).

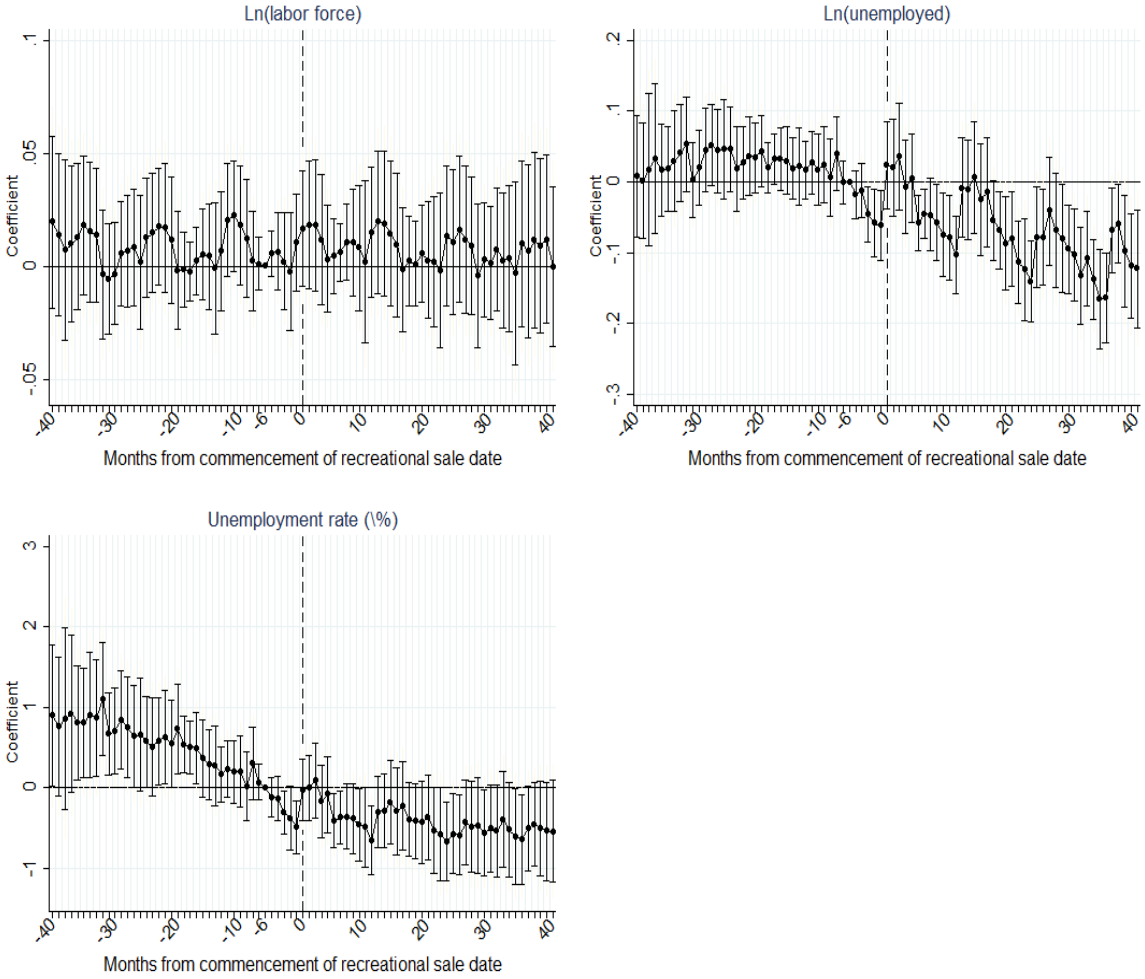
Figure 6: Present state of cannabis Laws



Note: For this figure, information is till 2018. In 2019, Illinois and Guam legalized recreational cannabis.

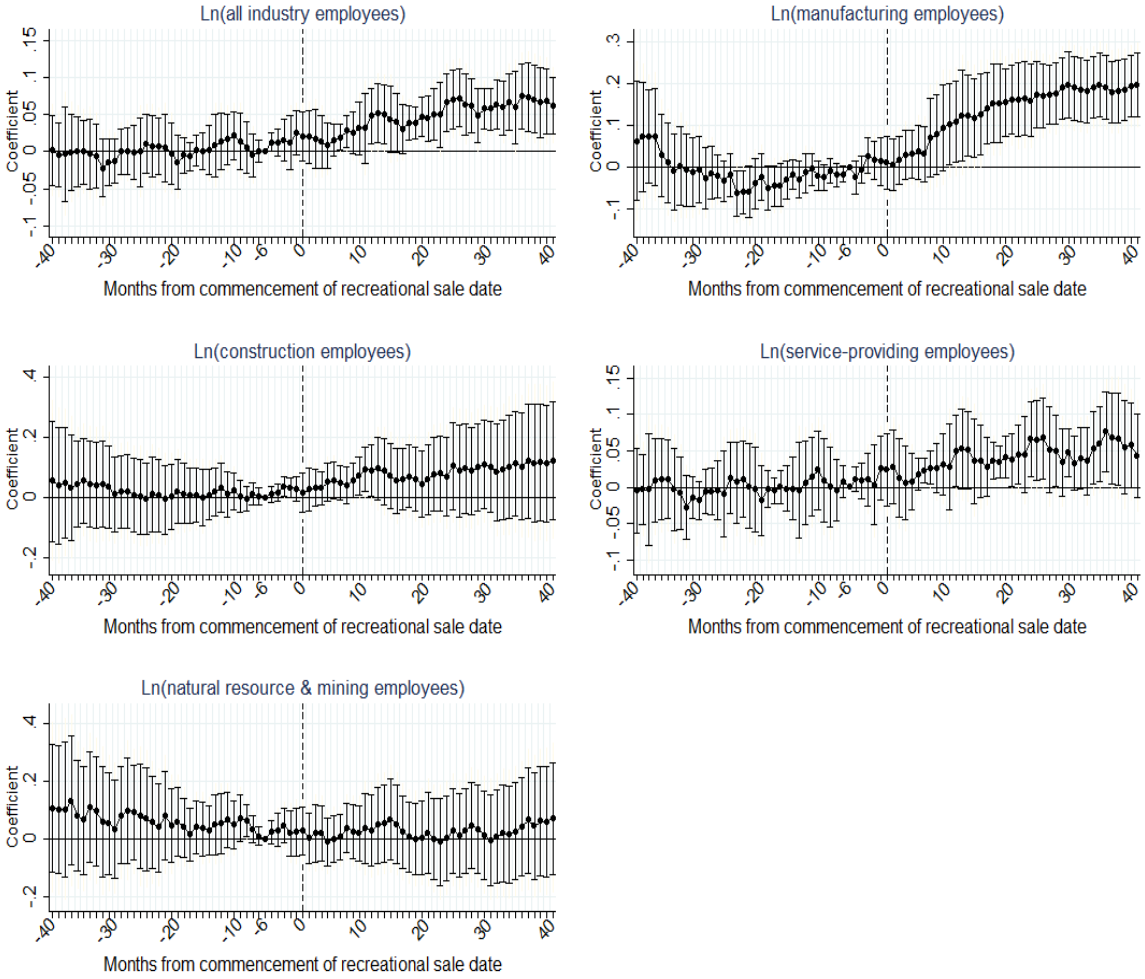
Event Studies

Figure 7: Effect of Recreational cannabis Dispensary entry Using an Event Study: 2011-2018 Qualifying Sample.



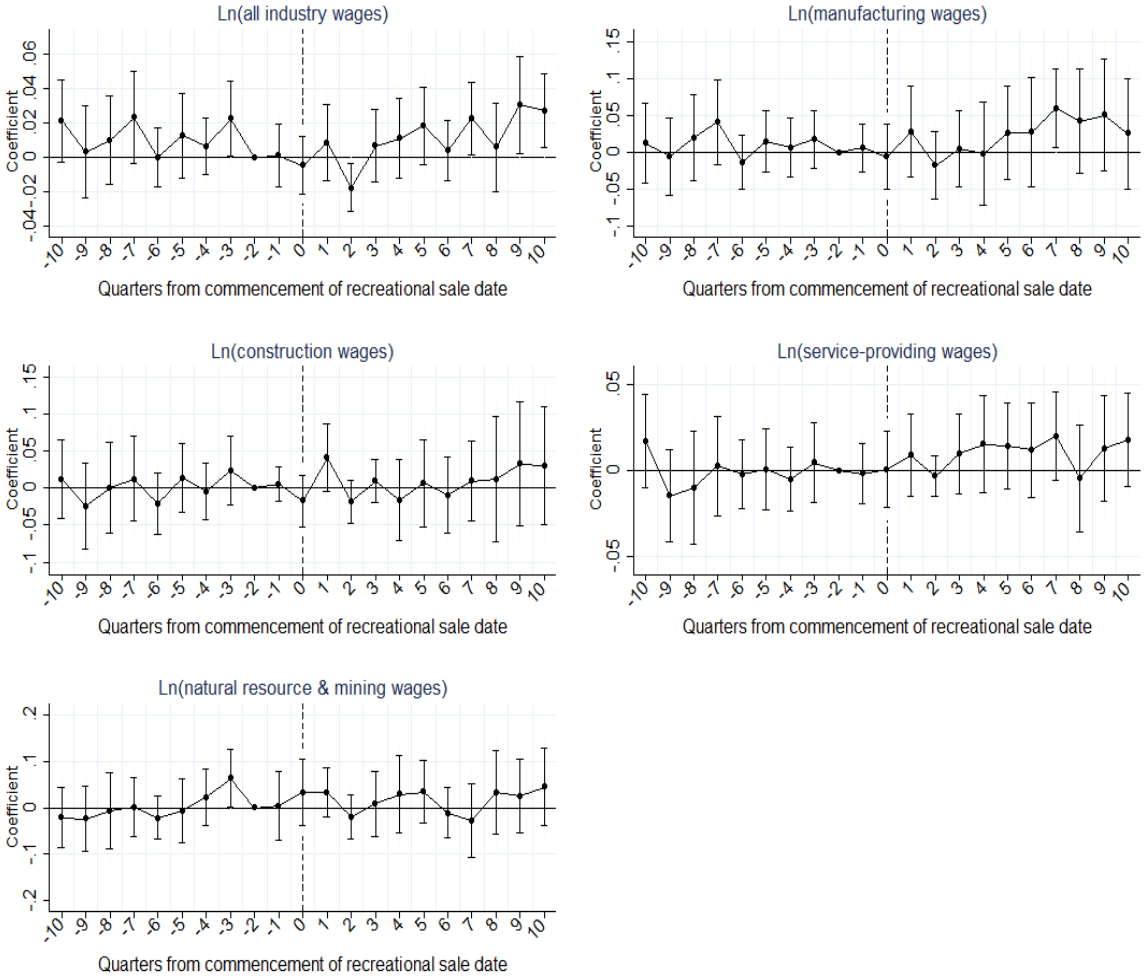
Note: The points represent the τ_k coefficient estimates from the estimation of Eq 3. The bars extending from each point represent a 95 percent confidence interval calculated from the standard errors that are clustered at the county-level. There are no standard error bars for the relative half-year $k = -6$ as the plot reflects that the zero is imposed rather than estimated. The x-$axis$ denotes time with respect to the commencement of the sale. Period 0 is when the sale begins. Relative month -6 is omitted in order to make all estimates relative to 6 months prior to commencement of sale (in period $k = -6$). The period used in the event study analysis is from 2011-2018.

Figure 8: Effect of Recreational cannabis Dispensary entry on Employees Using an Event Study: 2011-2018 Qualifying Sample.



Note: The points represent the τ_k coefficient estimates from the estimation of Eq 3. The bars extending from each point represent a 95 percent confidence interval calculated from the standard errors that are clustered at the county-level. There are no standard error bars for the relative half-year $k = -6$ as the plot reflects that the zero is imposed rather than estimated.The *x-axis* denotes time with respect to the commencement of the sale. Period 0 is when the sale begins. Relative month -6 is omitted in order to make all estimates relative to 6 months prior to commencement of sale (in period $k = -6$). The period used in the event study analysis is from 2011-2018.

Figure 9: Effect of Recreational cannabis Dispensary entry on Average Weekly Wage Using an Event Study: 2011-2018 Qualifying Sample.



Note: The points represent the τ_k coefficient estimates from the estimation of Eq 3. The bars extending from each point represent a 95 percent confidence interval calculated from the standard errors that are clustered at the county-level. There are no standard error bars for the relative half-year $k = -2$ as the plot reflects that the zero is imposed rather than estimated. The x-$axis$ denotes time with respect to the commencement of the sale. Period 0 is when the sale begins. Relative quarter -2 is omitted in order to make all estimates relative to 2 quarters prior to commencement of sale (in period $k = -2$). The period used in the event study analysis is from 2011-2018.

Tables

Table 1: Descriptive Statistics County Level 2011-2018

	Panel A: Monthly				
	Mean	SD	Min	Max	N
Unemployment rate (%)	5.23	2.77	1.1	17.4	6,144
Labor force	44,682	90,397	273	417,717	6,144
Unemployed	2,268	5,017	7	33,083	6,144
All industry employees	37,909	84,671	195	524,919	6,144
Construction employees	2,720	5,099	14	24,163	4,992
Manufacturing employees	2,929	5,427	10	21,436	4,512
Natural resource & mining employees	802	1,821	8	13,120	5,088
Service-providing employees	26,692	62,824	81	401,921	6,144
Amount of recreational sales	629,296	2,712,311	0	35,343,772	6,144
Number of medical patients	1,622	3,568	2	20,976	6,144
	Panel B: Quarterly				
	Mean	SD	Min	Max	N
All industry wages	749.06	200.83	410	2,102	2,048
Construction wages	881.75	227.47	415	2,489	1,664
Manufacturing wages	844.94	339.17	310	2,650	1,504
Natural resource & mining wages	1,071.30	641.53	376	6,475	1,696
Service-providing wages	684.91	216.46	294	2,619	2,048

Note: Summary statistics of our dependent and main independent variable. Dependent variables come from two sources: a) Local Area Unemployment Statistics (LAUS), b) Quarterly Census of Employment and Wages (QWEC), and main independent variable from Colorado Department of Revenue (CDOR). The full sample for monthly data contains 6144 observations and for quarterly data 2048 observations. However, the number of observations (N) differs for each industry as BLS withholds the release of data to protect the identity and data of cooperating employers when necessary.

Table 2: Descriptive Statistics by treatment status: County Level

	Selling county		Not selling county		Differences		
	Before (1)	After (2)	Before (3)	After (4)	Diff (5)=(2)-(1)	Diff (6)=(3)-(1)	Diff (7)=(4)-(2)
Panel A: Monthly							
Unemployment rate (%)	7.856	3.589	7.094	3.489	-4.268**	-0.763**	-0.099+
N	1,604	1,948	972	1,620			
Ln(labor force)	9.477	9.735	8.381	8.429	0.258**	-1.096**	-1.306**
N	1,604	1,948	972	1,620			
Ln(unemployed)	6.887	6.347	5.677	4.986	-0.539**	-1.210**	-1.362**
N	1,604	1,948	972	1,620			
Ln(number of medical patients)	6.434	6.549	4.705	4.658	0.115+	-1.730**	-1.892**
N	1,604	1,948	972	1,620			
Ln(population)	10.204	10.421	9.003	9.010	0.216**	-1.202**	-1.411**
N	1,604	1,948	972	1,620			
Ln(all industry employees)	9.107	9.425	8.030	8.065	0.318**	-1.077**	-1.359**
N	1,604	1,948	972	1,620			
Ln(construction employees)	6.503	6.939	5.936	6.007	0.436**	-0.567**	-0.931**
N	1,416	1,752	540	900			
Ln(manufacturing employees)	6.060	6.529	6.322	6.314	0.470**	0.262+	-0.215+
N	1,281	1,503	432	720			
Ln(natural resource & mining employees)	5.855	5.961	5.549	5.595	0.105	-0.307**	-0.366**
N	1,274	1,510	684	1,140			
Ln(service-providing employees)	8.583	8.932	7.306	7.363	0.349**	-1.276**	-1.569**
N	1,604	1,948	972	1,620			
	Selling county		Not selling county		Differences		
	Before (1)	After (2)	Before (3)	After (4)	Diff (5)=(2)-(1)	Diff (6)=(3)-(1)	Diff (7)=(4)-(2)
Panel B: QUARTERLY							
Ln(all industry wages)	6.550	6.669	6.489	6.587	0.119**	-0.061**	-0.082**
N	527	657	324	540			
Ln(construction wages)	6.726	6.842	6.630	6.705	0.116**	-0.096**	-0.136**
N	466	590	180	300			
Ln(manufacturing wages)	6.620	6.757	6.649	6.740	0.137**	0.029	-0.016
N	421	507	144	240			
Ln(natural resource & mining wages)	6.864	6.982	6.742	6.823	0.119**	-0.122*	-0.160**
N	419	509	228	380			
Ln(service-providing wages)	6.442	6.568	6.398	6.496	0.125**	-0.044+	-0.072**
N	527	657	324	540			

Note: Summary statistics of our dependent variables and the main independent variable by selling status. The N after each variable represents the number of observations for the respective variable by column. Column (1)-(2) reports means for selling counties, before and after they started selling. Column (3)-(4) reports means for not selling counties, before and after 2014. Column (5)-(7) reports difference in means with a two-sided t-test.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table 3: Estimates of the effect of start of recreational sale and sales value

	Panel A: Start of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
Recreational sale	-0.684**	0.001	-0.068**
	(0.2522)	(0.0115)	(0.0194)
Ln(number of medical patients)	-0.621*	-0.006	-0.025
	(0.2692)	(0.0126)	(0.0249)
R^2	0.881	0.999	0.995
Observations	6144	6144	6144
	Panel B: Amount of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
\$0 < sales ≤ \$500000	-0.727**	0.003	-0.058**
	(0.2803)	(0.0109)	(0.0223)
sales > \$500000	-0.630**	-0.001	-0.081**
	(0.2641)	(0.0144)	(0.0245)
Ln(number of medical patients)	-0.613**	-0.006	-0.027
	(0.2724)	(0.0128)	(0.0261)
R^2	0.882	0.999	0.995
Observations	6144	6144	6144
Month FE	✓	✓	✓
Year FE	✓	✓	✓
County FE	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table 4: Estimates the effect on Employees, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	0.044**	0.058	0.129**	-0.015	0.038*
	(0.0151)	(0.0546)	(0.0352)	(0.0665)	(0.0153)
Ln(number of medical patients)	-0.022	-0.175+	-0.187**	0.172	-0.026
	(0.0144)	(0.0914)	(0.0597)	(0.1163)	(0.0183)
R^2	0.998	0.989	0.996	0.970	0.998
Observations	6144	4608	3936	4608	6144

	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.029+	0.054	0.147**	-0.031	0.025
	(0.0155)	(0.0486)	(0.0379)	(0.0659)	(0.0173)
sales > \$500000	0.063**	0.062	0.108**	0.003	0.056**
	(0.0177)	(0.0662)	(0.0370)	(0.0804)	(0.0169)
Ln(number of medical patients)	-0.019	-0.174+	-0.192**	0.175	-0.024
	(0.0149)	(0.0918)	(0.0582)	(0.1168)	(0.0180)
R^2	0.998	0.989	0.996	0.970	0.998
Observations	6144	4608	3936	4608	6144
Month FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variable by Columns:- (1) ln(all industry employees); (2) ln(construction employees); (3) ln(manufacturing employees); (4) ln(natural Resource employees); (5) ln(service-Providing employees). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table 5: Estimates the effect on Wages, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	0.001	0.008	0.010	0.025	0.004
	(0.0100)	(0.0264)	(0.0192)	(0.0316)	(0.0126)
Ln(number of medical patients)	0.003	-0.082^{+}	-0.035	0.063^{+}	0.002
	(0.0112)	(0.0466)	(0.0268)	(0.0337)	(0.0175)
R^2	0.937	0.777	0.932	0.909	0.925
Observations	2048	1536	1312	1536	2048
	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.006	0.009	0.026	0.029	0.010
	(0.0106)	(0.0254)	(0.0248)	(0.0293)	(0.0138)
sales > \$500000	-0.006	0.007	-0.010	0.022	-0.003
	(0.0116)	(0.0331)	(0.0190)	(0.0376)	(0.0132)
Ln(number of medical patients)	0.002	-0.082^{+}	-0.039	0.063^{+}	0.001
	(0.0109)	(0.0467)	(0.0276)	(0.0334)	(0.0172)
R^2	0.937	0.777	0.933	0.909	0.925
Observations	2048	1536	1312	1536	2048
Quarter FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variable by Columns:- (1) ln(all industry wages); (2) ln(construction wages); (3) ln(manufacturing wages); (4) ln(natural Resource wages); (5) ln(service-Providing wages). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

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Appendix A: Online Only

We test the sensitivity of our main DD results by considering various alternative specifications and by using some restrictive samples. First, we conduct robustness checks with our original sample for three additional specifications, by including: (a) log of population as an additional independent variable (Tables A.2-A.4), (b) countyXmonth fixed effects (Tables A.5-A.7) to address cross-sectional differences in seasonality, (c) county-trends (Tables A.8-A.10) to capture the time-varying county factors and the unobservables. Even though the trends allow for arbitrary permanent heterogeneity between selling and not-selling counties and trends of their unobserved characteristics, these could lead to over-controlling bias (Angrist & Pischke, 2008).

Tables A.2-A.10 shows the robustness of our primary empirical specification to different fixed effects and population controls. Tables A.2-A.4 demonstrates the robustness of our DD results to the inclusion of the population as our independent variable. This adds an extra variation with population changing in the counties with more dispensary entry. The results from these tables are robust, both for unemployment rate and unemployed, and also for the number of employees in the manufacturing industry.

By controlling for countyXmonth fixed effects, results for unemployment rate, labor force, and the number of unemployed from Table A.5 show almost the same magnitude of change compared to our main results from Table 3. The total number of unemployed decreases by 6.7 percent, and the unemployment rate decreases by 0.693 percentage points with recreational cannabis sales. The recreational sale coefficient is unchanged with the number of employees as a dependent variable. With recreational cannabis sales, there is an increase in the total number of employees by 4.6 percent for all industries, 14 percent for the manufacturing industry, and 4 percent for service-providing industries. Therefore, Tables A.5-A.7 demonstrates that our results are robust to changes in seasonal and regional patterns.

Similarly, results with county-trends in Tables A.8-A.10 provide evidence of a decrease in unemployment and the number of unemployed, but with a decrease in magnitude. The recreational sale coefficient for all employees is negative but not significant when we

include county-trends. This may be due to over-controlling bias, as explained by Angrist and Pischke (2008).

Second, we conduct various analyses with our main specification from equations 1 & 2, as well as with the three additional specifications mentioned above with different samples of observation. We focus our main analysis consisting of the employees and wages results for counties with the consistent operation of the sub-industries. However, there can be cases where the inclusion or exclusion of some counties might be affecting our results. Finally, we verify the robustness of our analysis with the main sample by excluding some counties. Given the role played by access to the cannabis market by a county and the size of a county, we reran our baseline specifications using two different samples. Denver is the biggest county among the 64 counties in Colorado. The first model (Tables A.11-A.13) excludes Denver to ensure that a single large, early-adopting county does not drive our results. If the legalization of recreational cannabis is having a vast positive effect in Denver, that could counterbalance the decrease in the number of employees in other counties. Second, we restrict our sample to counties which entered the recreational cannabis market after Jan 2014 (Tables A.14-A.16). There are a total of 15 counties from our sample, which started selling from Jan 2014. These counties had a mature medical cannabis market. Counties with growing medical populations have large medical dispensary capacity and may not experience the same shock to their manufacturing sector as counties without growing recreational populations. Therefore effects might be more for the early-adopting counties, causing our overall coefficients to be misleading. We reran the regressions, excluding these early-adopting counties. The results are robust to our main results from Tables 3-5 when we exclude the early-adopting counties. The only notable difference is that the magnitude of effect on the unemployment rate is more when we omit early-adopting counties, as seen from Tables A.14. These results suggest that our findings are not driven by whether a county is an early or late adopter of recreational cannabis.

The next robustness check that we perform is by increasing the number of bins for sales value. Instead of using the three sales value bins from our preferred specification in

equation 2, we divide the sales value into four bins, $\$0 < sales \leq \$250,000$, $\$250,000 < sales \leq \$500,000$, $sales > \$500,000$, and the base bin is $sales = \$0$. The results for this model with different bins based on equation 2 is in Table A.17-A.19. Unemployment rate and the number of unemployed decreases at the same rate as in Table 3, with slightly higher effect for sales values between $\$250,000 < sales \leq \$500,000$. Similarly, we observe the increase in the coefficient for the number of employees to be more for $\$250,000 < sales \leq \$500,000$ bin.

Therefore, across specifications and subgroups, we see consistent evidence that recreational cannabis access has to lead to a decrease in the unemployment rate and the number of unemployed, an increase in the employees for manufacturing and for overall industry, and no effect on wages.

Contents

Table A.1: Sources for our variable of interest

Variable Type	Source	Chronology
Unemployed, Labor Force, and Unemployment rate *(2011-2018)*	Local Area Unemployment Statistics (LAUS)	2010 2015 2020
Employees and Wages *(2011-2018)*	Quarterly Census of Employment and Wages (QCEW)	2010 2015 2020
Recreational Cannabis *(2014-2018)*	Colorado Department of Revenue (CDOR)	2010 2015 2020
Medical Cannabis Patients *(2011-2018)*	Colorado Department of Public Health and Environment (CDPHE)	2010 2015 2020
Population *(2011-2018)*	United States Census Bureau	2010 2015 2020

Note: Labor contains number of employees(monthly) and average wage(quarterly). Recreational cannabis is monthly amount of cannabis sales value by county.

Figure A.1: Over the years

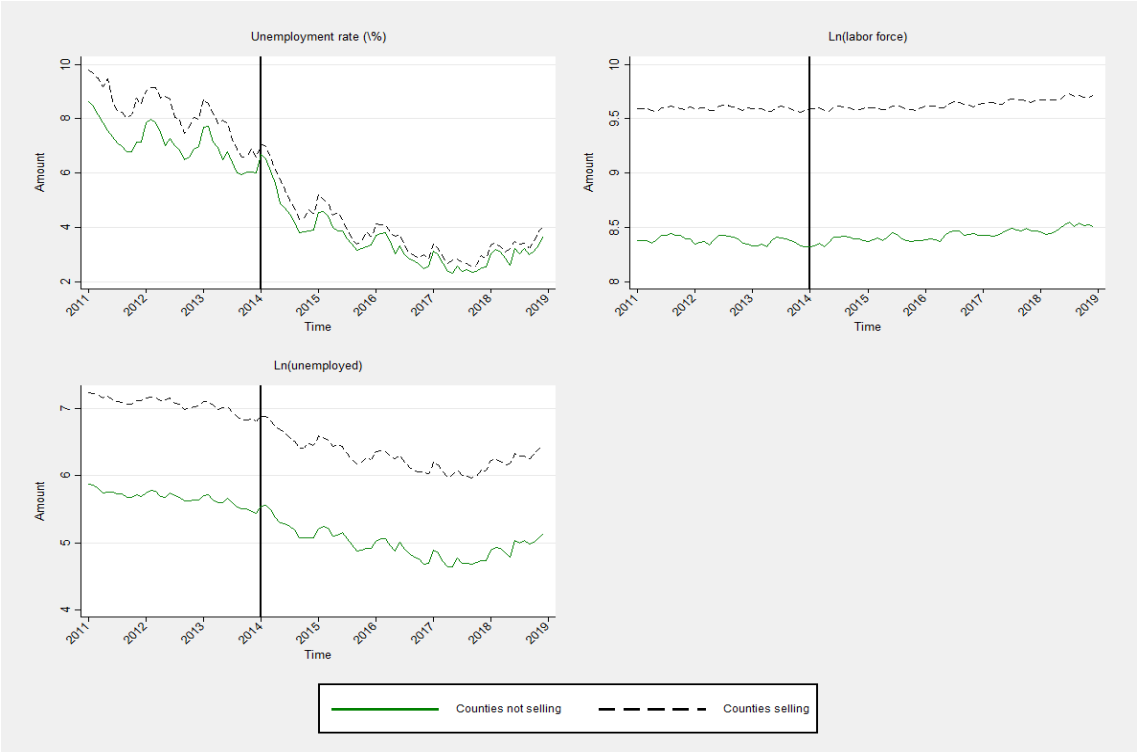


Figure A.2: Employees Over the years, by sector

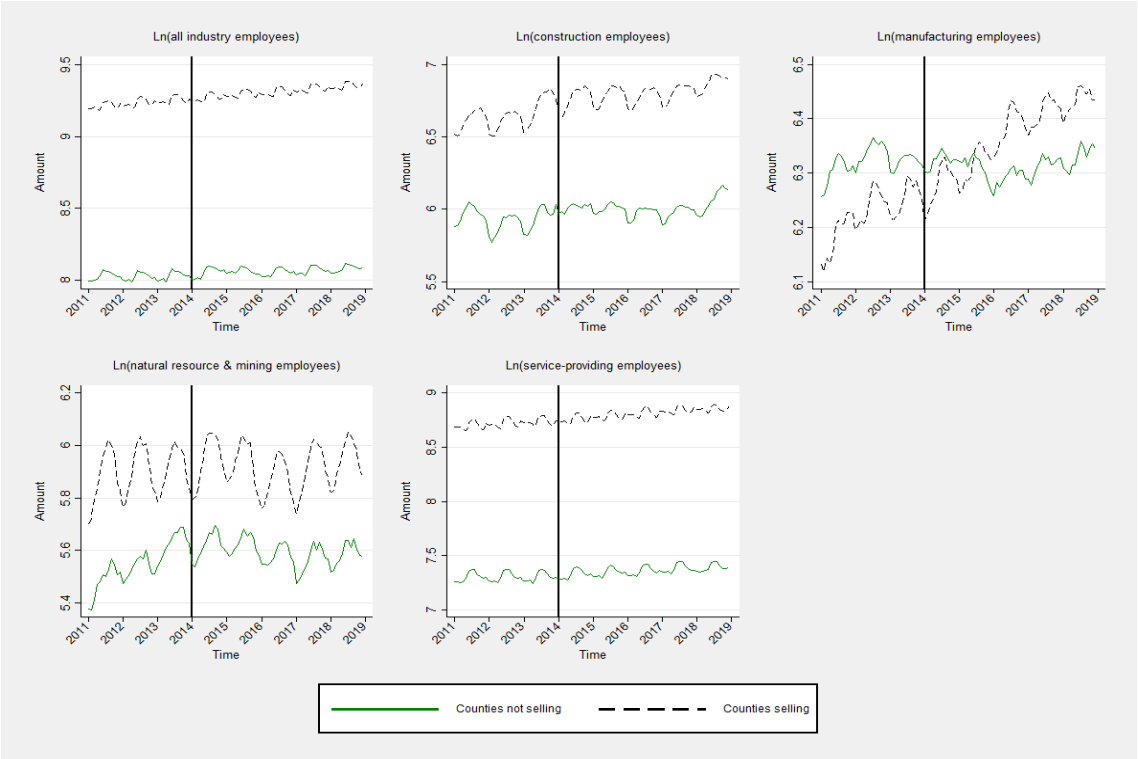
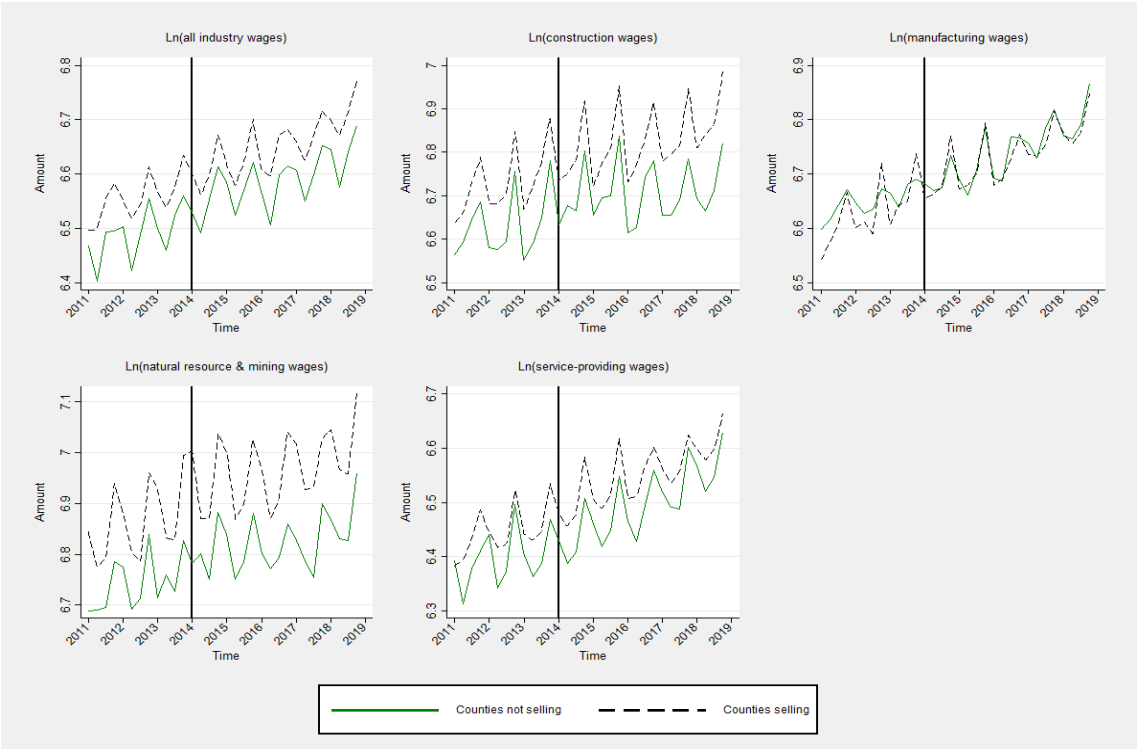


Figure A.3: Wages Over the years, by sector



1 Tables

1.1 Robustness with qualifying sample

1.1.1 Including population

Table A.2: Estimates of the effect of start of recreational sale and sales value

	Panel A: Start of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
Recreational sale	-0.718**	-0.014	-0.078**
	(0.2428)	(0.0105)	(0.0200)
Ln(number of medical patients)	-0.607*	0.001	-0.021
	(0.2714)	(0.0111)	(0.0250)
Ln(population)	1.158	0.531**	0.338+
	(2.4361)	(0.1261)	(0.1900)
R^2	0.882	0.999	0.995
Observations	6144	6144	6144

	Panel B: Amount of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
\$0 < sales ≤ \$500000	-0.752**	-0.009	-0.066**
	(0.2720)	(0.0099)	(0.0224)
sales > \$500000	-0.669**	-0.021	-0.094**
	(0.2515)	(0.0125)	(0.0251)
Ln(number of medical patients)	-0.601**	0.000	-0.023
	(0.2737)	(0.0108)	(0.0260)
Ln(population)	1.069	0.543**	0.369+
	(2.4483)	(0.1276)	(0.1872)
R^2	0.882	0.999	0.995
Observations	6144	6144	6144
Month FE	✓	✓	✓
Year FE	✓	✓	✓
County FE	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.3: Estimates the effect on Employees, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	0.016	0.020	0.113**	-0.066	0.014
	(0.0120)	(0.0633)	(0.0396)	(0.0712)	(0.0132)
Ln(number of medical patients)	-0.010	-0.130	-0.166**	0.205	-0.015
	(0.0128)	(0.0904)	(0.0541)	(0.1224)	(0.0158)
Ln(population)	0.953**	1.993+	0.732	1.576	0.834**
	(0.1578)	(1.0110)	(0.5178)	(1.0049)	(0.1491)
R^2	0.998	0.989	0.996	0.970	0.998
Observations	6144	4608	3936	4608	6144

	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.007	0.022	0.133**	-0.074	0.006
	(0.0138)	(0.0550)	(0.0403)	(0.0693)	(0.0159)
sales > \$500000	0.029**	0.017	0.086+	-0.057	0.026+
	(0.0136)	(0.0757)	(0.0434)	(0.0860)	(0.0142)
Ln(number of medical patients)	-0.009	-0.130	-0.171**	0.206+	-0.014
	(0.0132)	(0.0901)	(0.0522)	(0.1222)	(0.0159)
Ln(population)	0.930**	1.996+	0.777	1.561	0.813**
	(0.1612)	(1.0238)	(0.5181)	(1.0195)	(0.1507)
R^2	0.998	0.989	0.996	0.970	0.998
Observations	6144	4608	3936	4608	6144
Month FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^i_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.4: Estimates the effect on Wages, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	-0.005	0.001	0.019	0.037	-0.004
	(0.0093)	(0.0290)	(0.0192)	(0.0347)	(0.0116)
Ln(number of medical patients)	0.006	-0.074	-0.046	0.055	0.006
	(0.0118)	(0.0452)	(0.0282)	(0.0343)	(0.0193)
Ln(population)	0.191	0.359	-0.391	-0.368	0.291^{+}
	(0.1207)	(0.4475)	(0.2890)	(0.2931)	(0.1620)
R^2	0.937	0.778	0.933	0.910	0.926
Observations	2048	1536	1312	1536	2048

	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.001	0.003	0.032	0.038	0.002
	(0.0100)	(0.0273)	(0.0245)	(0.0318)	(0.0127)
sales > \$500000	-0.014	-0.001	0.000	0.036	-0.014
	(0.0108)	(0.0364)	(0.0173)	(0.0420)	(0.0125)
Ln(number of medical patients)	0.005	-0.074	-0.049^{+}	0.055	0.005
	(0.0114)	(0.0453)	(0.0281)	(0.0341)	(0.0189)
Ln(population)	0.208^{+}	0.362	-0.358	-0.366	0.310^{+}
	(0.1213)	(0.4527)	(0.2822)	(0.2991)	(0.1615)
R^2	0.937	0.778	0.933	0.910	0.926
Observations	2048	1536	1312	1536	2048
Quarter FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

1.1.2 With County-Month FE

Table A.5: Estimates of the effect of start of recreational sale and sales value

	Panel A: Start of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
Recreational sale	-0.693**	0.002	-0.070**
	(0.2522)	(0.0116)	(0.0195)
Ln(number of medical patients)	-0.588*	-0.009	-0.021
	(0.2675)	(0.0127)	(0.0252)
R^2	0.915	0.999	0.996
Observations	6144	6144	6144
	Panel B: Amount of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
\$0 < sales ≤ \$500000	-0.807**	0.006	-0.070**
	(0.2798)	(0.0111)	(0.0214)
sales > \$500000	-0.552**	-0.003	-0.070**
	(0.2653)	(0.0144)	(0.0244)
Ln(number of medical patients)	-0.568**	-0.009	-0.021
	(0.2727)	(0.0127)	(0.0259)
R^2	0.915	0.999	0.996
Observations	6144	6144	6144
Month FE	✓	✓	✓
Year FE	✓	✓	✓
County FE	✓	✓	✓
Month X County	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.
∗ Statistically Significant at the 5% level.
∗∗ Statistically Significant at the 1% level.

Table A.6: Estimates the effect on Employees, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	0.045**	0.056	0.131**	-0.018	0.040*
	(0.0152)	(0.0551)	(0.0357)	(0.0673)	(0.0153)
Ln(number of medical patients)	-0.026+	-0.171+	-0.186**	0.170	-0.031+
	(0.0142)	(0.0917)	(0.0604)	(0.1165)	(0.0179)
R^2	0.999	0.989	0.996	0.973	0.999
Observations	6144	4608	3936	4608	6144

	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.035**	0.050	0.156**	-0.035	0.034+
	(0.0158)	(0.0493)	(0.0394)	(0.0675)	(0.0173)
sales > \$500000	0.057**	0.062	0.103**	0.000	0.046**
	(0.0176)	(0.0670)	(0.0366)	(0.0814)	(0.0166)
Ln(number of medical patients)	-0.024	-0.171+	-0.192**	0.173	-0.030+
	(0.0147)	(0.0922)	(0.0581)	(0.1169)	(0.0179)
R^2	0.999	0.989	0.996	0.973	0.999
Observations	6144	4608	3936	4608	6144
Month FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓
Month X County	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.7: Estimates the effect on Wages, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	-0.000	0.006	0.007	0.023	0.004
	(0.0100)	(0.0264)	(0.0189)	(0.0319)	(0.0125)
Ln(number of medical patients)	0.004	-0.082^{+}	-0.036	0.056^{+}	0.004
	(0.0109)	(0.0470)	(0.0262)	(0.0320)	(0.0170)
R^2	0.956	0.817	0.950	0.941	0.951
Observations	2048	1536	1312	1536	2048
	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.004	0.004	0.021	0.025	0.009
	(0.0107)	(0.0253)	(0.0247)	(0.0300)	(0.0141)
sales > \$500000	-0.007	0.009	-0.011	0.020	-0.002
	(0.0119)	(0.0332)	(0.0187)	(0.0376)	(0.0131)
Ln(number of medical patients)	0.003	-0.082^{+}	-0.040	0.055^{+}	0.003
	(0.0106)	(0.0470)	(0.0270)	(0.0317)	(0.0168)
R^2	0.956	0.817	0.951	0.941	0.951
Observations	2048	1536	1312	1536	2048
Quarter FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓
Quarter X County	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

$+$ Statistically Significant at the 10% level.

$*$ Statistically Significant at the 5% level.

$**$ Statistically Significant at the 1% level.

1.1.3 With Trend

Table A.8: Estimates of the effect of start of recreational sale and sales value

	Panel A: Start of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
Recreational sale	-0.230	0.003	-0.038*
	(0.1384)	(0.0066)	(0.0174)
Ln(number of medical patients)	-0.550**	0.005	-0.063*
	(0.2050)	(0.0071)	(0.0300)
R^2	0.923	0.999	0.996
Observations	6144	6144	6144
	Panel B: Amount of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
\$0 < sales ≤ \$500000	-0.207	0.002	-0.026
	(0.1517)	(0.0069)	(0.0203)
sales > \$500000	-0.301**	0.007	-0.077**
	(0.1427)	(0.0077)	(0.0223)
Ln(number of medical patients)	-0.555**	0.005	-0.066**
	(0.2072)	(0.0073)	(0.0309)
R^2	0.923	0.999	0.996
Observations	6144	6144	6144
Month FE	✓	✓	✓
Year FE	✓	✓	✓
County FE	✓	✓	✓
County-trend	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.9: Estimates the effect on Employees, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	-0.001	0.022	0.040	-0.031	0.001
	(0.0097)	(0.0332)	(0.0545)	(0.0441)	(0.0097)
Ln(number of medical patients)	0.024*	-0.011	0.028	0.085	0.035**
	(0.0095)	(0.0520)	(0.0504)	(0.0955)	(0.0102)
R^2	0.999	0.993	0.997	0.981	0.998
Observations	6144	4608	3936	4608	6144
	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	-0.007	0.019	0.040	-0.037	-0.006
	(0.0106)	(0.0341)	(0.0590)	(0.0453)	(0.0113)
sales > \$500000	0.017+	0.032	0.043	-0.016	0.025**
	(0.0099)	(0.0348)	(0.0453)	(0.0560)	(0.0120)
Ln(number of medical patients)	0.026**	-0.010	0.028	0.086	0.037**
	(0.0101)	(0.0521)	(0.0494)	(0.0955)	(0.0106)
R^2	0.999	0.993	0.997	0.981	0.998
Observations	6144	4608	3936	4608	6144
Month FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓
County-trend	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variable by Columns:- (1) ln(all industry employees); (2) ln(construction employees); (3) ln(manufacturing employees); (4) ln(natural Resource employees); (5) ln(service-Providing employees). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.10: Estimates the effect on Wages, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	-0.005	-0.018	-0.006	0.003	0.017*
	(0.0094)	(0.0161)	(0.0189)	(0.0241)	(0.0076)
Ln(number of medical patients)	-0.002	0.010	-0.061+	0.010	-0.007
	(0.0098)	(0.0284)	(0.0329)	(0.0511)	(0.0153)
R^2	0.946	0.844	0.950	0.926	0.936
Observations	2048	1536	1312	1536	2048
	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	-0.002	-0.013	-0.003	0.007	0.019**
	(0.0096)	(0.0179)	(0.0192)	(0.0236)	(0.0081)
sales > \$500000	-0.013	-0.033+	-0.015	-0.015	0.011
	(0.0111)	(0.0179)	(0.0219)	(0.0337)	(0.0075)
Ln(number of medical patients)	-0.002	0.008	-0.062+	0.009	-0.008
	(0.0097)	(0.0288)	(0.0329)	(0.0504)	(0.0153)
R^2	0.946	0.844	0.950	0.926	0.936
Observations	2048	1536	1312	1536	2048
Quarter FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓
County-trend	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variable by Columns:- (1) ln(all industry wages); (2) ln(construction wages); (3) ln(manufacturing wages); (4) ln(natural Resource wages); (5) ln(service-Providing wages). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

1.2 Robustness without Denver county

Table A.11: Estimates of the effect of start of recreational sale and sales value

	Panel A: Start of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
Recreational sale	-0.688**	0.000	-0.069**
	(0.2548)	(0.0116)	(0.0197)
Ln(number of medical patients)	-0.618*	-0.006	-0.025
	(0.2703)	(0.0127)	(0.0250)
R^2	0.881	0.999	0.995
Observations	6048	6048	6048
	Panel B: Amount of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
\$0 < sales ≤ \$500000	-0.729**	0.003	-0.058**
	(0.2809)	(0.0109)	(0.0223)
sales > \$500000	-0.634**	-0.003	-0.083**
	(0.2693)	(0.0146)	(0.0253)
Ln(number of medical patients)	-0.610**	-0.006	-0.027
	(0.2736)	(0.0128)	(0.0263)
R^2	0.881	0.999	0.995
Observations	6048	6048	6048
Month FE	✓	✓	✓
Year FE	✓	✓	✓
County FE	✓	✓	✓

Note: Each column indicates an individual regression for sample with Denver omitted:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.12: Estimates the effect on Employees, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	0.043**	0.054	0.131**	-0.019	0.037*
	(0.0152)	(0.0552)	(0.0360)	(0.0674)	(0.0155)
Ln(number of medical patients)	-0.022	-0.175+	-0.190**	0.170	-0.026
	(0.0143)	(0.0918)	(0.0606)	(0.1178)	(0.0183)
R^2	0.998	0.988	0.995	0.965	0.998
Observations	6048	4512	3840	4512	6048
	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.029+	0.053	0.148**	-0.032	0.025
	(0.0155)	(0.0489)	(0.0381)	(0.0661)	(0.0173)
sales > \$500000	0.062**	0.055	0.110**	-0.003	0.054**
	(0.0181)	(0.0677)	(0.0387)	(0.0829)	(0.0172)
Ln(number of medical patients)	-0.019	-0.175+	-0.195**	0.173	-0.024
	(0.0149)	(0.0921)	(0.0593)	(0.1182)	(0.0181)
R^2	0.998	0.988	0.995	0.965	0.998
Observations	6048	4512	3840	4512	6048
Month FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for sample with Denver omitted:- Dependent variable by Columns:- (1) ln(all industry employees); (2) ln(construction employees); (3) ln(manufacturing employees); (4) ln(natural Resource employees); (5) ln(service-Providing employees). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.13: Estimates the effect on Wages, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	0.001	0.007	0.010	0.028	0.004
	(0.0101)	(0.0265)	(0.0197)	(0.0318)	(0.0127)
Ln(number of medical patients)	0.004	-0.081^{+}	-0.036	0.061^{+}	0.002
	(0.0113)	(0.0469)	(0.0271)	(0.0341)	(0.0176)
R^2	0.932	0.768	0.932	0.900	0.919
Observations	2016	1504	1280	1504	2016
	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.006	0.008	0.025	0.029	0.009
	(0.0106)	(0.0254)	(0.0249)	(0.0294)	(0.0139)
sales > \$500000	-0.007	0.006	-0.012	0.026	-0.004
	(0.0119)	(0.0338)	(0.0196)	(0.0384)	(0.0134)
Ln(number of medical patients)	0.002	-0.081^{+}	-0.041	0.061^{+}	0.001
	(0.0109)	(0.0469)	(0.0280)	(0.0339)	(0.0173)
R^2	0.932	0.768	0.932	0.900	0.919
Observations	2016	1504	1280	1504	2016
Quarter FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for sample with Denver omitted:- Dependent variable by Columns:- (1) ln(all industry wages); (2) ln(construction wages); (3) ln(manufacturing wages); (4) ln(natural Resource wages); (5) ln(service-Providing wages). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

1.3 Robustness without early-adopting(Jan 2014) counties

Table A.14: Estimates of the effect of start of recreational sale and sales value

	Panel A: Start of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
Recreational sale	-0.832*	-0.008	-0.072*
	(0.3147)	(0.0137)	(0.0273)
Ln(number of medical patients)	-0.457	-0.002	-0.028
	(0.3343)	(0.0147)	(0.0323)
R^2	0.879	0.999	0.994
Observations	4704	4704	4704

	Panel B: Amount of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
\$0 < sales ≤ \$500000	-1.002**	-0.003	-0.068**
	(0.3529)	(0.0134)	(0.0331)
sales > \$500000	-0.587+	-0.015	-0.079**
	(0.3319)	(0.0184)	(0.0359)
Ln(number of medical patients)	-0.412	-0.003	-0.029
	(0.3452)	(0.0151)	(0.0348)
R^2	0.880	0.999	0.994
Observations	4704	4704	4704
Month FE	✓	✓	✓
Year FE	✓	✓	✓
County FE	✓	✓	✓

Note: Each column indicates an individual regression for sample by omitting counties which started to sell on Jan 2014:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^i_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.15: Estimates the effect on Employees, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	0.041*	0.046	0.128**	-0.019	0.031+
	(0.0155)	(0.0718)	(0.0445)	(0.0745)	(0.0171)
Ln(number of medical patients)	-0.027+	-0.247+	-0.163+	0.003	-0.023
	(0.0139)	(0.1220)	(0.0826)	(0.1150)	(0.0199)
R^2	0.998	0.983	0.994	0.957	0.998
Observations	4704	3168	2880	3552	4704
	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.032+	0.056	0.143**	-0.038	0.027
	(0.0157)	(0.0647)	(0.0422)	(0.0738)	(0.0198)
sales > \$500000	0.054**	0.034	0.107+	0.005	0.037**
	(0.0197)	(0.0901)	(0.0552)	(0.0951)	(0.0179)
Ln(number of medical patients)	-0.024	-0.251**	-0.170**	0.008	-0.022
	(0.0148)	(0.1209)	(0.0827)	(0.1152)	(0.0199)
R^2	0.998	0.983	0.994	0.957	0.998
Observations	4704	3168	2880	3552	4704
Month FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for sample by omitting counties which started to sell on Jan 2014:- Dependent variable by Columns:- (1) ln(all industry employees); (2) ln(construction employees); (3) ln(manufacturing employees); (4) ln(natural Resource employees); (5) ln(service-Providing employees). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.16: Estimates the effect on Wages, by industry

	Panel A: Start of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
Recreational sale	0.001	0.023	0.018	0.034	-0.004
	(0.0108)	(0.0301)	(0.0192)	(0.0338)	(0.0142)
Ln(number of medical patients)	-0.001	-0.120*	-0.035	0.039	0.009
	(0.0110)	(0.0578)	(0.0360)	(0.0368)	(0.0229)
R^2	0.931	0.762	0.925	0.899	0.917
Observations	1568	1056	960	1184	1568
	Panel B: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$500000	0.004	0.031	0.031	0.029	-0.003
	(0.0116)	(0.0255)	(0.0227)	(0.0312)	(0.0154)
sales > \$500000	-0.002	0.013	-0.002	0.041	-0.006
	(0.0127)	(0.0410)	(0.0213)	(0.0436)	(0.0152)
Ln(number of medical patients)	-0.002	-0.123**	-0.042	0.041	0.008
	(0.0110)	(0.0570)	(0.0379)	(0.0366)	(0.0230)
R^2	0.931	0.763	0.925	0.899	0.917
Observations	1568	1056	960	1184	1568
Quarter FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for sample by omitting counties which started to sell on Jan 2014:- Dependent variable by Columns:- (1) ln(all industry wages); (2) ln(construction wages); (3) ln(manufacturing wages); (4) ln(natural Resource wages); (5) ln(service-Providing wages). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

1.4 Robustness with different bins

Table A.17: Estimates of the effect of start of recreational sale and sales value

	Panel A: Amount of sale		
	Unrate	Ln(labor force)	Ln(unemp)
	(1)	(2)	(3)
\$0 < sales ≤ \$250,000	-0.705*	-0.002	-0.045
	(0.2983)	(0.0115)	(0.0291)
\$250,000 < sales ≤ \$500,000	-0.781*	0.015	-0.089**
	(0.3365)	(0.0132)	(0.0296)
sales > \$500,000	-0.634*	-0.000	-0.084**
	(0.2675)	(0.0145)	(0.0251)
Ln(number of medical patients)	-0.622*	-0.004	-0.032
	(0.2787)	(0.0130)	(0.0285)
R^2	0.882	0.999	0.995
Observations	6144	6144	6144
Month FE	✓	✓	✓
Year FE	✓	✓	✓
County FE	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variables by Columns: (1) Unemployment Rate; (2) Log of Labor Force; (3) Log of Unemployed. Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.18: Estimates the effect on Employees, by industry

	Panel A: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$250,000	0.018	0.048	0.141**	-0.044	0.013
	(0.0155)	(0.0504)	(0.0383)	(0.0648)	(0.0175)
\$250,000 < sales ≤ \$500,000	0.055**	0.068	0.166**	-0.003	0.053*
	(0.0199)	(0.0502)	(0.0498)	(0.0920)	(0.0234)
sales > \$500,000	0.065**	0.064	0.110**	0.005	0.058**
	(0.0178)	(0.0667)	(0.0377)	(0.0806)	(0.0172)
Ln(number of medical patients)	-0.015	-0.171+	-0.187**	0.180	-0.019
	(0.0146)	(0.0918)	(0.0600)	(0.1154)	(0.0171)
R^2	0.998	0.989	0.996	0.970	0.998
Observations	6144	4608	3936	4608	6144
Month FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variable by Columns:- (1) ln(all industry employees); (2) ln(construction employees); (3) ln(manufacturing employees); (4) ln(natural Resource employees); (5) ln(service-Providing employees). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

+ Statistically Significant at the 10% level.

∗ Statistically Significant at the 5% level.

∗∗ Statistically Significant at the 1% level.

Table A.19: Estimates the effect on Wages, by industry

	Panel A: Amount of sale				
	All	Cons	Manu	NR	Service
	(1)	(2)	(3)	(4)	(5)
\$0 < sales ≤ \$250,000	0.006	0.002	0.015	0.029	0.008
	(0.0108)	(0.0253)	(0.0232)	(0.0311)	(0.0140)
\$250,000 < sales ≤ \$500,000	0.005	0.021	0.050	0.028	0.012
	(0.0125)	(0.0301)	(0.0341)	(0.0425)	(0.0158)
sales > \$500,000	-0.007	0.009	-0.007	0.022	-0.003
	(0.0116)	(0.0334)	(0.0198)	(0.0379)	(0.0134)
Ln(number of medical patients)	0.002	-0.078	-0.031	0.062^{+}	0.001
	(0.0107)	(0.0479)	(0.0258)	(0.0324)	(0.0176)
R^2	0.937	0.777	0.933	0.909	0.925
Observations	2048	1536	1312	1536	2048
Quarter FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
County FE	✓	✓	✓	✓	✓

Note: Each column indicates an individual regression for qualifying sample:- Dependent variable by Columns:- (1) ln(all industry wages); (2) ln(construction wages); (3) ln(manufacturing wages); (4) ln(natural Resource wages); (5) ln(service-Providing wages). Panel A: R_{cmy} (dummy) as a treatment; Panel B: $sales^{i}_{cmy}$ (sales value) as a treatment. All Standard errors corrected for clustering at the county-level are in parentheses. The FEs pertain to both the panels.

$^{+}$ Statistically Significant at the 10% level.

$*$ Statistically Significant at the 5% level.

$**$ Statistically Significant at the 1% level.