Effects of Access to Recreational Cannabis on Home Values

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1 Introduction

The legalization of cannabis has been advancing rapidly in the United States. Since 2012, 18 states and Washington D.C. have legalized recreational marijuana for adults over the age of 21. Nearly three-fourths of Americans live in a state in which cannabis has been legalized recreationally or medically. Dispensaries and delivery services have made access to the drug easier than ever.

However, the effects of legalization – good and bad – are still hotly debated in communities across the country. One one hand, the proponents say legalizing marijuana can free up police to focus on more serious offenses. Additionally, they say legalization will pump millions of tax dollars into state coffers. The biggest impact of all, they say, is that it can help many people through its medicinal properties (Jones 2019).

On the other hand, opponents fear that legalization will increase crime and cause a spike in the number of car crashes as people may drive under the influence. Critics worry that once marijuana is legalized, more people will use it and even turn to more addictive drugs (Jones 2019). Lastly, they worry that the presence of retail stores will devalue properties in their community. Ryan Smith, chief operating officer of cannabis dispensary Cure Holdings said, "We've faced some fierce opposition, with some zoning officials and some city councils not wanting us there," (Slane 2019).

This paper finds no conclusive effects of individual dispensaries on surrounding property values. However, this paper does find that statewide legalization of recreational marijuana increases average home values by $\$80k$ to $\$100k$ in the 4 to 8 years after legalization.

Section 2 provides background on previous legislation and reviews existing literature related to the effects of cannabis legalization. Section 3 introduces the data sets used in analysis, outlines the empirical method of a differences-in-differences approach using a dynamic event study model, and tests the necessary assumptions of parallel trends and stable unit treatment values (SUTVA). Section 4 describes the results of the analysis, and Section 5 comments on the implications of the results.

2 Background

2.1 Previous Legislation

In 1970, Congress enacted the Controlled Substances Act (CSA), which classified marijuana as a Schedule I controlled substance (Congressional Research Service 2020). Although the drug is illegal at the federal level, states are free to impose stricter or looser laws. In 1996, California became the first state to legalize medical marijuana, and in 2012, Colorado and Washington became the first states to legalize recreational marijuana (Ballotpedia 2022a). Today, marijuana is legal recreationally in 18 states and medically in 38 states.

In 2012, Massachusetts became the 18th state to legalize medical marijuana after voters passed the Massachusetts Medical Marijuana Initiative with 63% of votes in favor (Marijuana Policy Project 2022). In 2016, recreational marijuana became legal in Massachusetts after voters approved the Massachusetts Marijuana Legalization Initiative, with 53.66% of votes in favor (Ballotpedia 2022b).

However, the process for a dispensary to obtain a license can be lengthy, as it requires that the potential business owners draft several plans, hold a community outreach meeting, and sign an agreement with the municipality. Finally, the potential business owners submit an application to the Massachusetts Cannabis Control Commission, which can take up to 90 days to be approved or rejected (Cannabis Control Commission 2021). Since the process is so lengthy, it is necessary that I use dispensaries rather than legalization as my treatment variable, since legalization alone does not give individuals immediate access to the drug. Additionally, I am using a model that captures delayed time effects that would impact the price of a home over several time periods.

On November 20, 2018, nearly two years after marijuana was legalized in Massachusetts, New England Treatment Access (NETA) in Northampton became the state's first legal dispensary (Silva and Kaplan 2018). Since NETA's commencement, accessibility to cannabis has grown rapidly. Today, Massachusetts has more than 100 cannabis retailers and three delivery businesses, and statewide gross sales have surpassed $2 billion (Hanson 2021).

2.2 Related Literature

Much existing research has already been done on the effects of access to cannabis. My research adds to the existing literature by supporting the claim that legal cannabis increases housing values and decreases crime rates.

2.2.1 Effects on Housing Prices

A study published in Real Estate Economics analyzed the effect of retail marijuana establishments on house prices. Using a difference-in-differences approach, they compared houses that were within 0.1 miles of a retail marijuana store to those that were farther than 0.1 miles. They found that "single family residences close to a retail conversion increased in value by approximately 8% relative to houses that are located slightly farther away" (Conklin et al. 2017).

However, another study analyzed home prices in Vancouver. They found that home prices within 100m of a dispensary decreased by 37.6% (Tyndall 2019).

At a broader scale, another study looked at the home values in Colorado before and after legalization. They found that that legalization increased home values by 6% (Cheng et al. 2018).

2.2.2 Effects on Crime

A study published in Regional Science and Urban Economics analyzed crime data in Denver and found that "an additional dispensary in a neighborhood leads to a reduction of 17 crimes per month per $10,000$ residents" (Brinkman and Mok-Lamme 2017).

However, another study published in the IZA Institute of Labor Economics found no relationship between dispensaries and violent crime. The paper explored the effects of marijuana dispensary laws on California counties using a difference-in-differences design, and their results suggest "no relationship between county laws that legally permit dispensaries and reported violent crime" (Hunt et al. 2018). Additionally, they found "a negative and significant relationship" between dispensary allowances and property crime rates, which may have been a result of pre-existing trends.

A third study published in Justice Quarterly also found no effect on crime. This study analyzed the effect of marijuana legalization on crime in Colorado and Washington, the first 2 states to legalize marijuana. They used a multi-group interrupted time-series design and found that "marijuana legalization and sales have had minimal

to no effect on major crimes in Colorado or Washington" (Lu et al. 2019).

2.2.3 Additional Effects

Besides housing prices, other outcome variables of interest have been studied, with conflicting results. Specifically, one outcome variable that has been studied is the crime rate.

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Another outcome variable that has been studies is the rate of car crashes. A study published in Traffic Injury Prevention looked at monthly car crash rates in Colorado, Washington, and Oregon, which were compared to matched control states using segmented regression with autoregressive terms (Calvert and Erickson 2020). They found "no significant differences" in fatal motor vehicle crashes involving pedestrians, between states that have legalized cannabis versus control states.

However, another study published in the Journal of Studies on Alcohol and Drugs did find an increase in crashes. They found that legalization of recreational marijuana was associated with "a statistically significant 6.6% increase in injury crash rates and a nonsignificant 2.3% increase in fatal crash rates" (Farmer et al. 2021).

3 Data and Empirical Strategy

My analysis uses multiple datasets, which I describe in subsection 3.1. I then describe and justify the Event Study Model as my choice of empirical strategy in subsection 3.2. In subsection 3.3, I provide evidence in favor of the parallel trends assumption and single unit treatment values assumption (SUTVA).

3.1 Data

The independent variable for my research question is access to recreational cannabis. I have datasets that quantify the independent variable, measured by distance to a retail dispensary and legality at the state level. I describe and summarize these datasets in subsections 3.1.1 and 3.1.2, respectively. I describe the dependent variables, property values and housing prices in subsections 3.1.3 and 3.1.4.

3.1.1 Dispensary Data

I have a dataset of all approved applications for a license to operate a marijuana establishment in Massachusetts (Cannabis Control Commission 2022). For each approved application, the dataset includes the establishment's address and when it commenced operations. In Figure A1, I present a map showing the dispensary locations in the Boston area, with regions shaded to indicate whether properties in the region are considered "treated" or "untreated".

3.1.2 Legalization Data by U.S. State

To understand the legality of cannabis on a national scale, I have a state-wide dataset of recreational and medicinal legal status, along with the year of legalization. I manually compiled this data from Business Insider, which lists each state's current legal status, as well as Ballotpedia, which catalogs the history of marijuana referendums (Berke et al. 2022; Ballotpedia 2022a). In Figure A2, I present a map of this data, indicating each state's legal status, medically and recreationally. In Table 1, I display summary statistics outlining the number of states with each legal status.

3.1.3 Property Values in Boston

To analyze the housing prices in the greater Boston area, I have panel property-level assessment data with detailed characteristics. The assessments are conducted as a

	Legal	Illegal	Total
Medical	39	12	51
Recreational	19	32	51

Table 1. Number of U.S. states with legal cannabis

	Properties within 1 mi.			**Properties outside 1 mi.**		
	Mean	SD	Obs	Mean	SD	Obs
Assessed Value ($)	409057.20	499836.72	122789	306731.42	200534.27	189244
Living Area (sq.ft.)	2761.98	1092.69	122789	2173.00	922.30	189244
Price per Square Foot	150.87	112.82	122789	148.41	68.99	189244
Number of Floors	2.45	0.59	122789	2.00	0.57	189244
Number of Bedrooms	5.22	2.14	122789	4.26	1.73	189244

Table 2. Summary statistics of assessed property values, by proximity to a dispensary

census every fiscal year. Aside from the address of the property and its assessed value, other characteristics in the dataset include the square footage of the building, the year it was built, the year it was renovated, the number of bedrooms, bathrooms, and kitchens, and the type of heating and A/C. Additionally, the dataset includes the type of property: apartment/dorm, condominium, essential building (medical, church, office, etc.), or other residential buildings (i.e. single-family homes). Since these variables influence the assessed price of a property, I include them in my analysis as covariates. The dataset was published by the Department of Innovation and Technology and made available by Analyze Boston (Analyze Boston 2021). To visualize this dataset, I present maps of the average price per square foot (Fig. A3) and the average number of floors (Fig. A4) for a property in a given zipcode. In Table 2, I compare summary statistics of properties in "treated" regions versus those in "untreated" regions, where a property is treated if a dispensary will open within a mile of it at any point. Before generating the summary statistics table, I first filter the properties to only include those assessed before 2019, and thus before any dispensaries opened in the Boston area. I do this in order to evaluate the similarity between regions that would eventually be treated versus those that wouldn't, before they were treated (or not).

3.1.4 Housing Prices

To analyze housing prices on a broader scale, I have a zipcode-level dataset of the Zillow Home Value Index (ZHVI) from Zillow Research (Zillow Research 2021). The

ZHVI is a smoothed, seasonally adjusted measure of the value for homes in the 35^{th} to 65^{th} percentile range, provided each month.

3.2 Event Study Model

I perform a differences-in-differences (DID) analysis using a dynamic event study model. The first set of regressions, outlined in subsection 3.2.1, measures the effect of dispensaries on surrounding property values in the Greater Boston Area. The second set of regressions, outlined in 3.2.3, measures the effect that statewide legalization has on that state's housing prices.

3.2.1 Regression of Dispensaries on Property Values

Since the first retail cannabis dispensary in Massachusetts opened in November 2018, more than 200 more have opened statewide. It is natural to ask how the different neighborhoods in Boston were affected by these businesses. A micro level analysis will help to understand and quantify the impact a dispensary in a given zip code has on property values of the surrounding area.

For this set of regressions, the treatment variable is the distance from a property to a dispensary, implemented as rings around dispensaries at 1-mile increments. The regression equation is given by equation (1).

$$Y_{i,z,t} = \mu_z + \delta_t + \sum_{j=-\underline{j}}^{\overline{j}} \sum_{d \in D} \beta_{j,d} \, \texttt{treatment}_{i,t+j,d} + \theta X_{i,t} + \varepsilon_{i,t} \tag{1}$$

$\beta_{j,d}$ is the coefficient of interest, which measures the effect a dispensary has on a property's value located between $d-1$ and d miles away, experienced j years after the dispensary opens. $Y_{i,z,t}$ is the assessed value (in dollars per square foot) at time t of property i, which is located in zip code z, μ_z measures the fixed effects of zip code z, δ_t measures the fixed effects of time t, $\overline{j}$ and $\underline{j}$ are the number of lags and leads considered, and $D = \{\text{0-1 mi.}, \text{1-2 mi.}, \text{2-3 mi.}, \text{3-4 mi.}, \text{4-5 mi.}\}$ is the set of distance rings considered. $\texttt{treatment}_{i,t+j,d}$ is an indicator variable equaling 1 if a dispensary opened between $d-1$ and d miles away from property i at time t. $X_{i,t}$ is the set of time-varying covariates[1], and $\varepsilon_{i,t}$ is the error term.

[1]Covariates in this regression include: the size of living area, the number of floors, the number of bedrooms, the number of full bathrooms, the number of half bathrooms, the number of kitchens, how many years since the property was built, how many years since the property was remodeled (if applicable), the type of heating, and the type of property: apartments/dorms, condominiums, essential buildings (medical, government, church, office, etc.), and other residential buildings (i.e. single family homes).

3.2.2 Regression of Dispensaries on Crime Rates

In addition to estimating the effects that a dispensary has on the assessed values of the surrounding properties, I also estimate its effects on crime rates of the surrounding neighborhood. For this set of regressions, the treatment variable is the distance from a crime that occurred to the nearest dispensary at that time. The regression equation is given by equation (2).

$$Y_{z,y,d,m,h} = \mu_z + \delta_y + \gamma_d + \kappa_m + \phi_h + \sum_{j=-\underline{j}}^{\overline{j}} \sum_{d \in D} \beta_{j,d} \, \texttt{treatment}_{i,t+j,d} + \varepsilon_{i,t} \tag{2}$$

$\beta_{j,d}$ is the coefficient of interest, which measures the effect a dispensary has on the crime rate of a region located between $0.5(d-1)$ and $0.5d$ miles away, experienced j years after the dispensary opens. $Y_{z,y,d,m,h}$ is the number of crimes that occur in zipcode z, during year y, day of the week d, month m, and hour h. μ_z measures the fixed effects of zip code z, δ_y measures the fixed effects of year y, γ_d measures the fixed effects of the day of the week d, κ_m measures the fixed effects of month m, and ϕ_h measures the fixed effects of hour h. $\overline{j}$ and $\underline{j}$ are the number of lags and leads considered, and $D = \{\text{0-0.5 mi.}, \text{0.5-1 mi.}, \text{1-1.5 mi.}, \text{1.5-2 mi.}, \text{2-2.5 mi.}, \text{2.5-3 mi.}\}$ is the set of distance rings considered. $\texttt{treatment}_{i,t+j,d}$ is an indicator variable equaling 1 if a dispensary opened between $0.5(d-1)$ and $0.5d$ miles away from property i at time t, and $\varepsilon_{i,t}$ is the error term.

3.2.3 Regression of Statewide Legality on Housing Prices

Since 2012, 18 states and Washington D.C. have legalized recreational cannabis. The move came through legislative action or voters approving ballot measures. At the macro level, I analyze the effect that statewide legalization of cannabis has on that state's home values, compared to other states that didn't legalize the drug. For this set of regressions, the treatment variable is the legalization of cannabis in a given state. The regression equation is given by equation (3).

$$Y_{z,s,t} = \mu_z + \kappa_s + \delta_t + \sum_{j=-\underline{j}}^{\overline{j}} \beta_j \texttt{treatment}_{s,t,j} + \varepsilon_{i,t}. \tag{3}$$

β_j is the coefficient of interest, which measures the cumulative effect on a zip code's

average home price, experienced j months after recreational cannabis legalization in a given state. $Y_{z,s,t}$ is the average price of a home (in dollars) at time t of zip code z in state s, μ_z measures the fixed effects of zip code z, κ_s measures the fixed effects of state s, δ_t measures the fixed effects of time t, and $\overline{j}$ and $\underline{j}$ are the number of lags and leads considered. $\texttt{treatment}_{s,t,j}$ is an indicator variable equaling 1 if state s legalized marijuana in year $t - j$.

3.3 Testing Assumptions

While the Event Study Model has potential to show a causal relationship between variables, there are some critical assumptions that must be satisfied. I will outline these assumptions and how I test them in subsections 3.3.1, 3.3.2, and 3.3.3.

3.3.1 Parallel Trends

One critical assumption for the validity of DID is that of parallel trends. This assumes that in the absence of treatment, the difference between the treatment and control groups is constant over time (Columbia University 2022). For my specific examples, this assumption states:

- **3.2.1:** In the absence of a new dispensary opening in the Boston area, the difference between assessed property values across zip codes in Boston would stay constant over time.
- **3.2.2:** In the absence of a new dispensary opening in the Boston area, the difference between crime rates across zip codes in Boston would stay constant over time.
- **3.2.3:** In the absence of statewide legalization of recreational cannabis, the difference between typical home values across states would stay constant over time.

3.3.2 Stable Unit Treatment Value Assumption (SUTVA)

Another important assumption for DID is SUTVA, which assumes that (1) a subject's outcome is not affected by other subjects' exposure to the treatment, and (2) there are no different forms or versions of each treatment level, which lead to different outcomes (Columbia University 2022). For my specific examples, assumption (1) states:

- **3.2.1:** The assessed property values in one Boston zip code are not affected by dispensaries opening in another Boston zip code.
- **3.2.2:** The crime rates in one Boston zip code are not affected by dispensaries opening in another Boston zip code.
- **3.2.3:** The typical home values in one state are not affected by cannabis legalization in another state.

Assumption (2) states:

- **3.2.1, 3.2.2:** There are no different forms or versions of the opening of a dispensary.
- **3.2.3:** There are no different forms or versions of a statewide cannabis legalization.

3.3.3 Demographic Balance

Demographic balance, which assumes that the demographics of the treatment and control groups are not significantly different, is not a necessary assumption for DID, but provides additional evidence in support of the parallel trends assumption outlined in subsection 3.3.1.

In Table 3, I present the results of a two-sample t-test comparing assessed property values in treated regions (located within a mile of a dispensary) to those in untreated regions, where I define treatment as being in a zipcode that will eventually receive a dispensary or be within a mile of a dispensary. From this table, we can conclude that regions that are treated have a lower building value, price per square foot, living area, number of floors, and number of bedrooms, compared to regions that are untreated.

	Treated	Untreated	Diff.	S.E.	Obs.
Building value	369231.5	550462.9	-181231.4	1294.088	561554
Price per square foot	199.7694	277.2996	-77.53012	.5946863	561554
Living area	2093.385	2484.713	-391.328	2.87863	561554
Number of floors	1.952544	2.253087	-.3005425	.0018614	561554
Number of bedrooms	4.094271	4.661969	-.5676981	.005559	561554
Observations	561554				

Table 3. Two-sample t-test comparing assessed property values in treated vs. untreated regions

4 Results

4.1 Effects of Dispensaries on Housing Prices

The results of the regression of dispensaries on assessed property values (as described in section 3.2.1) are presented in Table 4 and Figure 1. In this table, `treatment_d` represents the overall effect of receiving a dispensary at all. The variables `treatment_j_d` for values $j = \{-5, ..., 2\}$ represent the coefficient $\beta_{j,d}$.

From this table and figure, one coefficient of interest is `treatment_0_d` for $d = 0-1$ miles, which is 39.249. This implies that the assessed price of a property will be nearly $40 more per square foot in the year that a dispensary opens within a mile of the property, relative to the year before treatment. However, given that the standard error is 30.65, this change is not significant.

All of the confidence intervals span zero. Therefore, we can conclude that after controlling for year fixed effects, zip code fixed effects, and covariates, the presence of a dispensary will not significantly effect the assessed value of surrounding properties. These results are likely the result of two factors: the first being that dispensaries in Boston are relatively recent (the first opened in 2019, so we can only look at 2-3 years of effects) and there are only 11 dispensaries, which makes for a small sample size. The second reason is that the property-level dataset did not have more specific information on its location, likely due to privacy concerns. To find the distance from a property to a dispensary, I used the geographic centroid of the property's zipcode. Therefore, any localized effects of dispensaries were not able to be captured by my analysis.

Table 4. Effect of dispensaries on assessed property value

	(1)	(2)	(3)	(4)	(5)
	0-1 mi.	1-2 mi.	2-3 mi.	3-4 mi.	4-5 mi.
	b/se	b/se	b/se	b/se	b/se
treatment_d	15.538	46.579	14.583	-24.824	-26.555*
	(18.92)	(28.97)	(15.80)	(11.11)	(10.12)
treatment_-5_d	-9.114	-25.401	-11.096	11.138	6.091
	(15.01)	(19.09)	(15.08)	(7.51)	(6.64)
treatment_-4_d	-2.360	-4.066	-5.650	5.502	-0.979
	(5.81)	(5.05)	(8.92)	(4.41)	(5.50)
treatment_-3_d	4.505	-9.468	-7.111	2.419	1.155
	(4.76)	(8.26)	(5.41)	(4.39)	(4.65)
treatment_-2_d	-8.769	-15.300	0.127	2.805	-4.545
	(16.68)	(13.20)	(8.07)	(4.70)	(5.42)
treatment_0_d	39.249	-16.031	-24.782	-4.757	-2.944
	(30.65)	(14.31)	(20.69)	(6.33)	(6.65)
treatment_1_d	-37.727	-11.381	49.818	-14.306	-24.510
	(30.03)	(12.37)	(24.18)	(15.13)	(17.99)
treatment_2_d	-56.599*	-25.046	22.223	4.436	-4.343
	(20.47)	(20.08)	(26.10)	(16.72)	(18.31)
Observations	561554	561554	561554	561554	561554

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

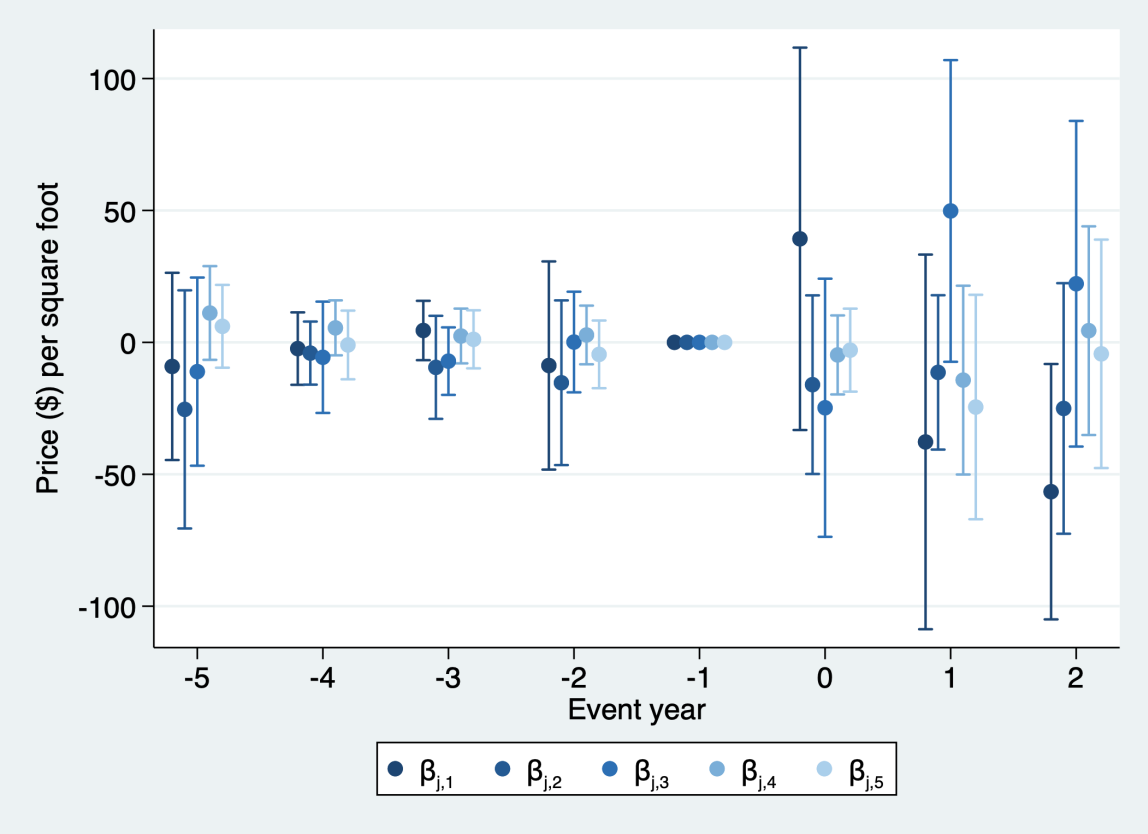

Figure 1. Effect of dispensaries on assessed property value

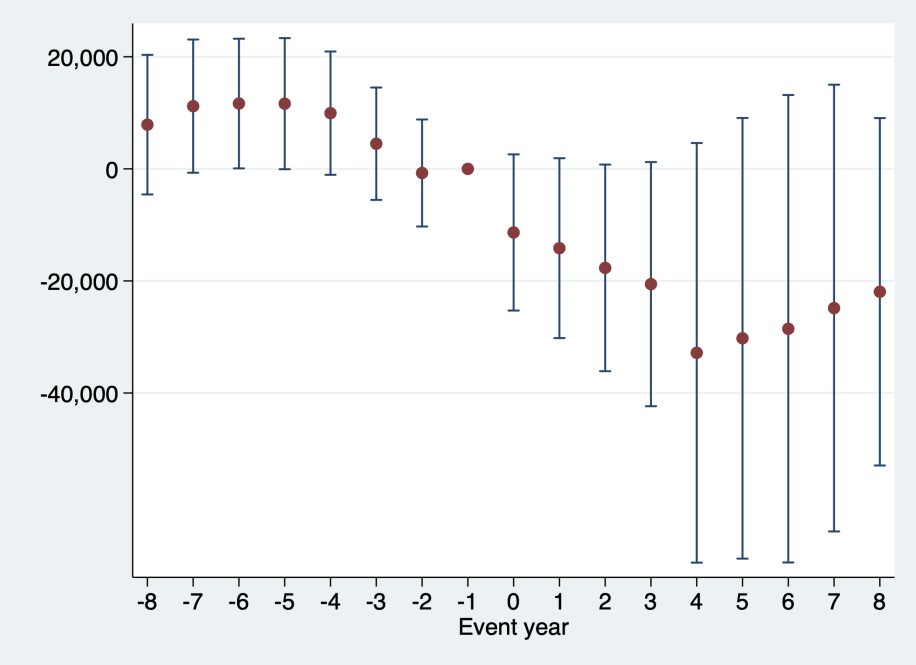

Figure 2. Effect of statewide medical marijuana legalization on home values

4.2 Effects on Statewide Legalization on Housing Prices

The results of the regressions of statewide legalization on home values (as described in section 3.2.3) are presented in the following figures. Figure 2 displays the coefficients of interest with their 95% confidence intervals, for legalization of medical marijuana, while Figure 3 displays the results for legalization of recreational marijuana.

From Figure 2, we can conclude that housing prices decrease in the first four years following legalization of medical marijuana. However, this decrease is likely a byproduct of the already-decreasing values, as observed in the pre-trends. The coefficients are negative, yet increasing, for years 4 through 8 following legalization.

From Figure 3, we can conclude that housing prices increase in the years following legalization of recreational marijuana. From the pre-trends, we observe that the housing prices were roughly constant in the years leading up to legalization, so we are able to assume that the parallel trends assumption holds. Thus, we can interpret the positive coefficients with confidence intervals above zero for years 4 through 8 following treatment as evidence that legalization of recreational marijuana increases that state's average home value, and this increase is experienced 4 to 8 years following legalization.

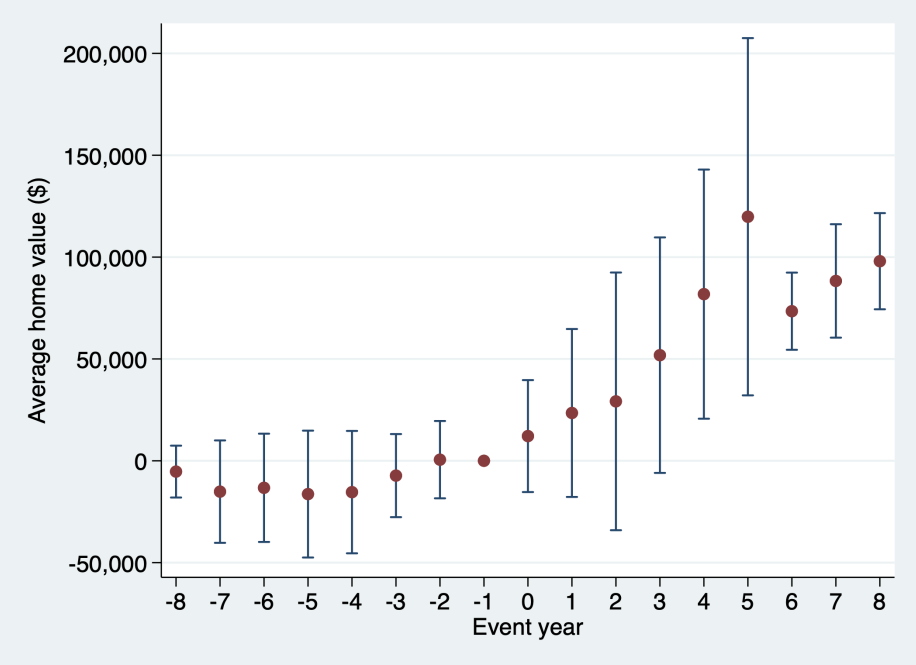

Figure 3. Effect of statewide recreational marijuana legalization on home values

5 Conclusions

In the analysis of individual dispensaries on surrounding property values (Section 4.1), we found that there was no significant effect, as all confidence intervals spanned zero. I argue that this is likely due to two factors. The first is that dispensaries in the Greater Boston Area are recent and a small sample size. There are only eleven dispensaries in the GBA and the first opened in 2019, so we can only examine $2-3$ years of effects on housing prices. The second reason is that the location information for the property-level dataset only included the property's zipcode. To calculate the distance between a property and a dispensary, I used the geographic centroid of the zipcode that the property was located in. Because of this, I was unable to capture any localized effects, such as an increase/decrease of home values for properties within a few blocks, which is more than likely the case.

In the state-level analysis, we found that home values decrease in the years immediately following the legalization of medical marijuana; however, this may be due to spillover pre-trends. For recreational marijuana, however, housing prices increase in the years following legalization. Specifically, the average home value in a state is over $\$80,000$ higher 4 years after legalization, and $\$100,000$ higher 8 years after legalization.

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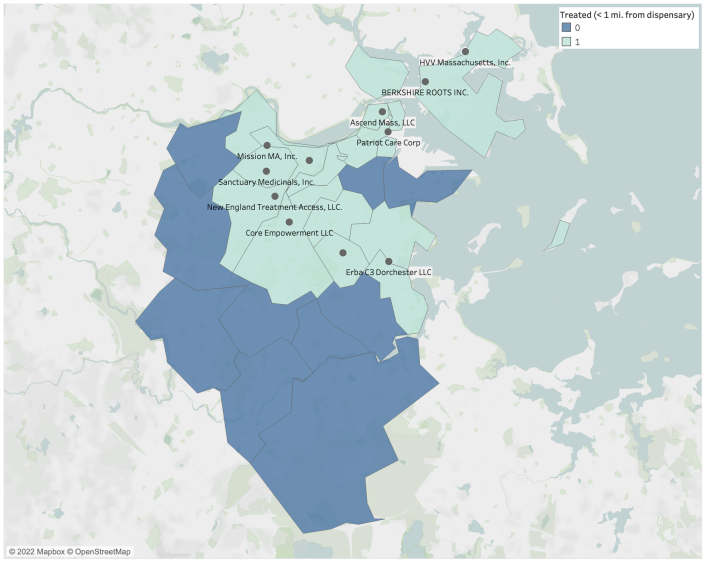
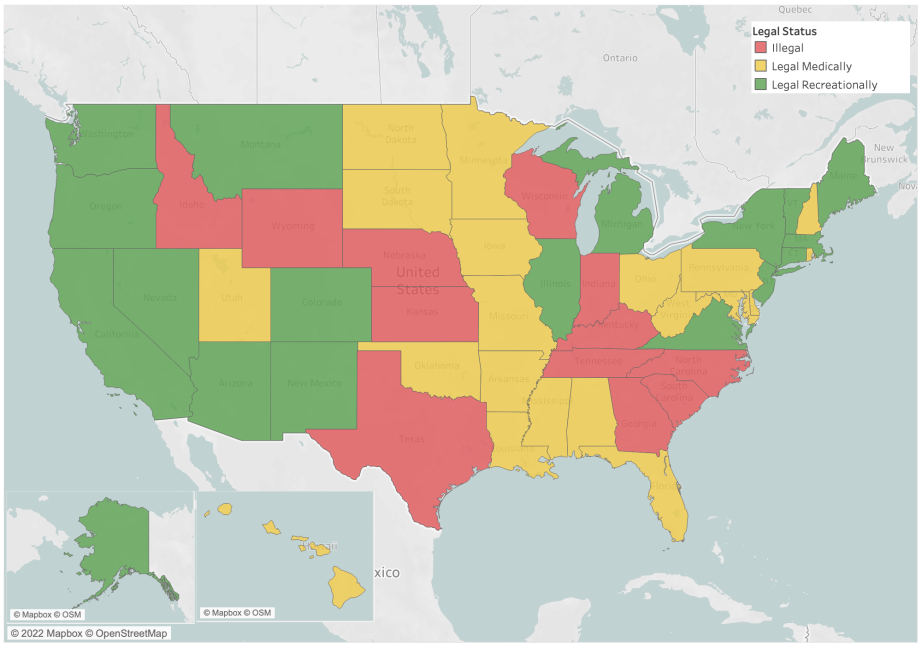
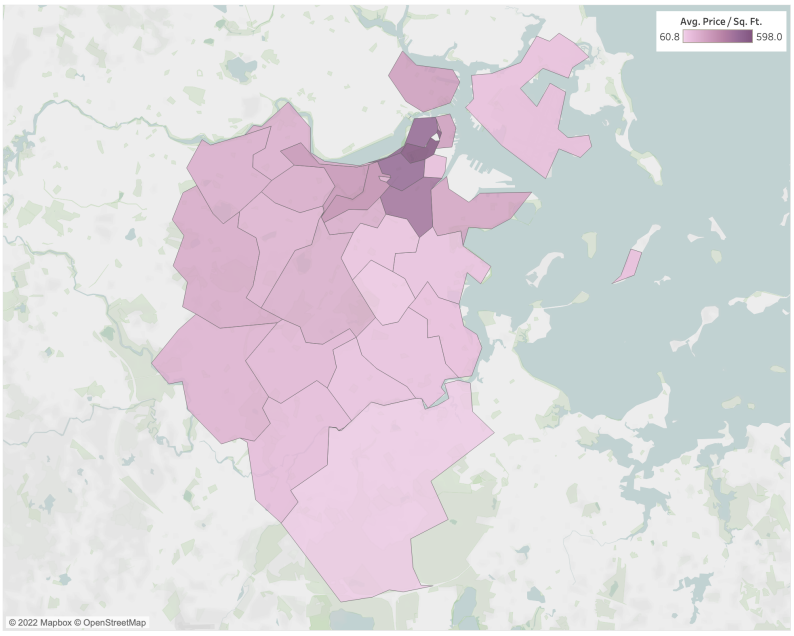
A Appendix Tables and Figures



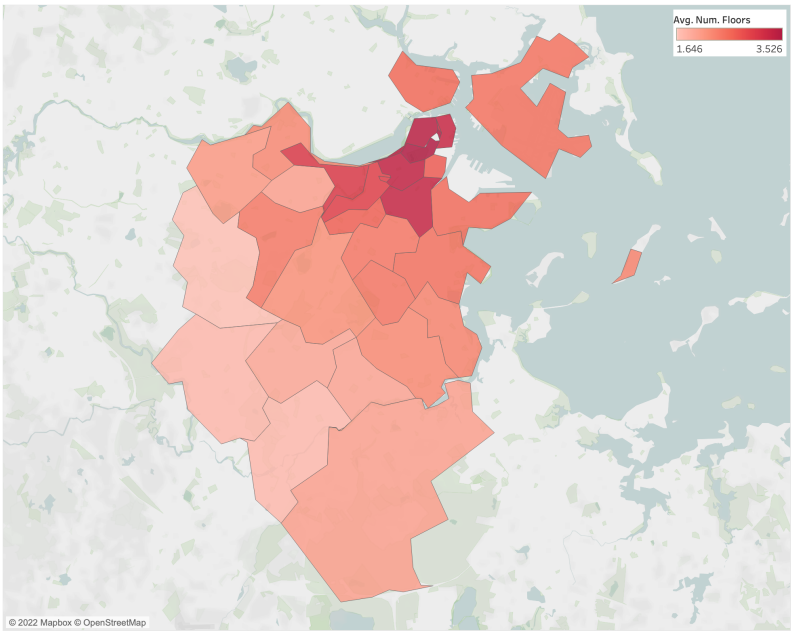
Appendix Figure A1. Recreational Cannabis Dispensaries in the Greater Boston Area



Appendix Figure A2. Legal Status of Cannabis, by U.S. State



Appendix Figure A3. Average Assessed Price per Square Foot of Properties in the Greater Boston Area



Appendix Figure A4. Average Number of Floors of Properties in the Greater Boston Area

	Mean	SD	Obs
Apartment/dorm			
Assessed value	202,706.7	202,225.1	1,114
Price per square foot	61.3	51.8	1,114
Living area	3,316.6	1,142.8	1,114
Number of floors	2.7	0.5	1,114
Condominium			
Assessed value	782,549.0	851,343.6	64,354
Price per square foot	699.6	331.8	64,354
Living area	1,084.4	582.0	64,354
Number of floors	1.3	0.8	64,354
Essential			
Assessed value	439,434.7	287,248.8	1,410
Price per square foot	175.8	97.4	1,410
Living area	2,808.6	1,366.8	1,410
Number of floors	2.1	0.7	1,410
Residential			
Assessed value	401,870.6	396,935.0	494,676
Price per square foot	172.0	100.4	494,676
Living area	2,406.1	1,035.2	494,676
Number of floors	2.2	0.6	494,676
Total			
Assessed value	445,195.5	486,778.2	561,554
Price per square foot	232.3	223.2	561,554
Living area	2,257.4	1,081.8	561,554
Number of floors	2.1	0.7	561,554

Appendix Table A1. Summary statistics of assessed property values, by type of property