From Medical to Recreational Marijuana Sales: Marijuana Outlets and Crime in an Era of Changing Marijuana Legislation

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Abstract

Objectives.—A movement from medical to recreational marijuana use allows for a larger base of potential users and easier access to marijuana as a user does not have to talk to a physician before using marijuana. This study examines whether changes in the density of marijuana outlets were related to violent, property, and marijuana-specific crimes in Denver, Colorado during a time in which marijuana outlets began selling marijuana for recreational (not just medical) use.

Methods.—Data were collected on locations of crimes, marijuana outlets and covariates for 481 Census block groups over 34 months (N = 16,354 space-time units). A Bayesian Poisson spacetime model assessed statistical relationships between independent measures and crime counts within "local" Census block groups. Spatial "lag" effects were examined to assess whether crimes in Census block groups adjacent to locations of outlets were also affected.

Results.—Independent of effects for covariates, densities of marijuana outlets were unrelated to property and violent crimes in local areas. Density of marijuana outlets in spatially adjacent areas were positively related property crime in spatially adjacent areas over time. Density of marijuana outlets in local and spatially adjacent blocks groups were related to higher rates of marijuana-specific crime.

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This article does not contain any studies with human participants or animals performed by any of the authors.

Conclusions.—This study suggests that the effects of the availability of marijuana outlets on crime do not necessarily occur within the specific areas within which outlets are located, but are occurring in adjacent areas. Thus studies assessing the effects in local areas are underestimating their true effects.

Keywords

Marijuana Outlets; Violent Crime; Property Crime

The legalization of marijuana for medical or recreational use continues to generate controversy, particularly around potential adverse effects related to crime (California Police Chief's Association, 2009). The changing norms around marijuana use have culminated, most recently, in the legalization of cannabis for recreational use in four states: Colorado, Washington, Alaska and Oregon. Law enforcement officials continue to cite concerns about the increases in crime rates due to the rising number of dispensaries, although limited empirical evidence suggests that this might not be the case in the local areas in which marijuana outlets are located (measured within Census tracts; Kepple & Freisthler, 2012), but may be true in adjacent neighborhood areas (measured within smaller Census block groups (Freisthler, Ponicki, Gaidus, & Gruenewald, 2016). The passage of medical marijuana laws does not appear to have increased crime at the state level in at least one study (Morris, TenEyck, Barnes, & Kovandzic, 2014). However, the concerns around possible deleterious effects of marijuana distribution on communities are magnified as access to marijuana for the general population continues to increase due to legalization, and more people report being in favor of legalization (54%) than not (Pew Research Center, 2014). Hence, the increased commercial sales of marijuana will further fuel the controversy surrounding whether there are more marijuana-related crimes.

In November 2000, Colorado became the fourth state to allow marijuana use for specified medical conditions with the passage of Amendment 20, known as the "Medical Use of Marijuana Act". Amendment 64 "Use and Regulation of Marijuana" was enacted twelve years later (in 2012) making Colorado the first state to legalize marijuana for recreational use. On January 1, 2014, the first outlets began selling marijuana for recreational use. The effects of this changing legislation on social problems, including in crime is unknown. However, as three additional states also allow recreational sales and public support for marijuana legalization is increasing (Pew Research Center, 2014), a better understanding of the relationship between marijuana availability and outcomes such as crime is important for assessing the public health costs of such legislation. Information obtained from such assessments can be used to inform policy as additional states consider allowing marijuana for medical or recreational use.

Marijuana Outlets and Crime

Current concerns about links between marijuana sales and crime are motivated by community and police concerns that this largely for-cash market with high demand will increase criminal activity. Greater numbers of suitable targets of crime, motivated offenders, and limited enforcement resources combine to lead to greater crime rates (routine activity

theory, Cohen & Felson, 1979). Medical marijuana dispensaries are said to be magnets for crime as they are largely a cash-and-carry business selling a substance considered illicit for non-medical users (California Police Chief's Association, 2009).

While there is a paucity of research on the association between marijuana retail outlets and crime, it is possible that marijuana consumers are likely to become targets of crime. Recent studies suggest that offenders will travel some distance to participate in crime at locations (Tita & Griffiths, 2005) such as medical marijuana dispensaries, and surges in violence, particularly in relatively safe areas, will create adverse effects on businesses in the area (Greenbaum & Tita, 2004). Colorado is currently seeing an influx of marijuana-related tourism adding to the number of customers largely unaware of local neighborhood conditions (Blevins, 2015). Jean (2008) observed that crime pockets are often located in and adjacent to places that support cash economies (e.g., liquor stores, check-cashing outlets), where oftentimes individuals patronize while distracted. These tourists may be suitable targets as the may carry more cash than the average customer and may not be focused on their surroundings, which may make them "easy marks" for those wishing to perpetrate crime (Glesnor & Peak, 2004).

In line with the routine activity theory, the increased presence of dispensaries becomes targets for motivated offenders. The increased availability of marijuana through dispensaries (in states allowing medical use) and in retail outlets (in states allowing recreational use) has been a concern of police officials who worry about higher crime in these areas due to the increased traffic in and around the dispensaries (California Police Chief's Association, 2009). In particular, as marijuana use remains illegal at the federal level the outlets that sell marijuana have few banking options; thus many marijuana outlets continue to rely primarily on cash sales (California Police Chief's Association, 2009). Because the majority of transactions in medical marijuana centers involve cash, they become attractive targets for violent crime such as robberies (Wright & Decker, 2011). Add to that a product attractive for possible re-sale on the streets (i.e., marijuana), dispensaries and their patients appear to be a prime target for crime.

In reality, very few studies have assessed the relationship between these marijuana outlets and crime. Kepple and Freisthler (2012) found that density of medical marijuana dispensaries in Census tracts for Sacramento, California were not related to rates of property or violent crimes. Yet this study had a small sample size, used Census tracts (a unit of analysis that may be too large to assess this relationship), and cross-sectional limiting its power to fully assess a dispensary and crime link. However, using data from smaller geographic units (Census block groups) tracked over a time when marijuana dispensaries were rapidly opening and closing, Freisthler and colleagues (2016) found that having higher densities of medical marijuana dispensaries in adjacent areas was related to higher rates of both violent and property crime in Long Beach, California. These results suggest geographic scale may be an important consideration for the study of effects of medical marijuana dispensaries on crime. Notably, the latter study was conducted over the course of 24 months when police in Long Beach increased enforcement efforts aimed at ensuring dispensaries complied with a local ban on storefront dispensaries within city limits.

Finally, no studies have examined how marijuana-specific crime is related to the density of these outlets. Marijuana-specific crimes may be those crimes that involve marijuana and licensed marijuana outlets such as those committed against the licensed outlets or where marijuana is the primary target in the commission of these crimes but the marijuana was not related to a specific outlet. These may include street-dealers purchasing large enough quantities of marijuana (e.g., quarter of a pound) and re-selling on the streets or burglary attempts at the outlets. Areas of communities with more of these drug market activities have been related to higher rates of assault independent of many other environmental, social and demographic characteristics (also at the Census block group level, Banerjee, Gruenewald, Freisthler, Treno, & Remer, 2008).

The observation that some state-level studies of laws that decriminalize marijuana sales do not indicate relationships with crime and other health outcomes does not, at this time, support the argument that marijuana decriminalization is without community impacts. Measured at the state level one study of changes in medical marijuana laws found lower rates of arrests for homicides and assaults after the enactment of medical marijuana laws (Morris et al., 2014). However, at these large geographic units aggregation bias generally leads to deflation of effects (e.g., averaging across areas with and without greater access to marijuana) making detection of the resulting effect sizes statistically difficult (and, of course, local effects impossible). In addition state level arrest records do not fully capture all crime reported to the police and a general assessment of the passage of laws does not provide information on how aspects of those policies or features of implementation may affect crime (Pacula, Powell, Heaton, & Sevigny 2015). These individuals may also be committing other crimes in the areas adjacent to where dispensaries are located.

To date, no studies have assessed the effects of the physical availability of marijuana on crime for areas that have legalized marijuana for recreational use. A movement from medical to recreational marijuana use allows for a larger base of potential users and easier access to marijuana as a user does not have to talk to a physician before using marijuana. In sum, the current policy context of changing availability of marijuana from only medical to recreational purposes changes the physical availability of marijuana through outlets and the likely clientele of those outlets. Similar to previous work, we hypothesize that density of marijuana outlets in adjacent Census block group areas will be related to higher rates of violent, property, and marijuana-specific crimes.

Methods

The study analyzes data from 481 Census block groups that comprise the city of Denver over 34 months (January 2013 to October 2015). In January 2014, the first marijuana outlets were able to sell marijuana to the general public throughout the city. Thus, the current study covers the transition from when marijuana could only be sold to medical users to the ability to sell to those who use marijuana recreationally. The sample size is 16,354 space-time units (481 Census block groups x 34 months).

Crime incident data were obtained from the city of Denver police department data. These data include location, dates, and types of crime. Data were geocoded using x, y coordinates

provided in the data files. Due to the largely cash nature of marijuana outlets, we examined three types of crime in the current study: (1) violent crime, (2) property crime, and (3) marijuana outlet-specific crime. Violent crime refers to those incidents that involve force or the threat of force and included murder, rape, robbery, and aggravated assaults. Property crime is defined as those events that involve the taking or damage of property and includes burglary, larceny, automobile theft and arson.

Marijuana-specific crimes were identified by the Denver Police Department in an effort to identify whether or not crimes committed around marijuana outlets could be attributed to the marijuana establishment (Reed, Hilkey, Smith & English, 2016). According to documentation by the police, marijuana-specific incidents were determined to have a clear connection or relation to marijuana, but did not include those violations due to restrictions on the possession, sale, or cultivation of marijuana. These crimes include those that involve marijuana and licensed marijuana facilities such that the crime incident (1) was committed against the licensed industry or by the industry itself or (2) where marijuana is the primary target in the commission of these crime but the marijuana was not related to a specific outlet. In 2014, 64% of marijuana-specific crimes were related to the industry (e.g., burglary of a marijuana outlet). The remaining 34% were not related to the industry. Burglaries made up 66% of industry related marijuana-specific crimes but only about 40% of non-industry related marijuana-specific crime. In contrast, robbery comprised more than 25% of non-industry marijuana-specific crime compared to only about 4.0% of industry marijuana-specific crime.

Data on marijuana outlets was obtained from a variety of sources. Licensed outlets, medical and recreational, were obtained from the Colorado Department of Revenue Enforcement Division which licenses all outlets for the state of Colorado and reports those data monthly. These data were supplemented with monthly downloads of data from several websites where outlets advertise their location, hours of operation, and products available. These included Weedmaps, Medical Marijuana Locators, Sticky Guide, Puffpuff411, Yelp, and Weedtracker. Using data from weedmaps.com, we confirmed that the dispensaries were largely cash only businesses. During the study period, only 25% of Denver marijuana outlets report accepting credit card payments in February 2014 and less than 20% accepted credit cards in October 2015. These data were geocoded to a street address, files were de-duplicated across location and month to provide monthly numbers of marijuana outlets in Denver. Density of marijuana outlets was created by aggregating the point-located addresses to Census block groups and dividing by area. We use outlet density per square mile because it is a better measure of physical availability of outlets to residents. Adding more people to an area would not decrease the availability of outlets to the existing population, but spreading the same number of outlets over a larger physical area would generally reduce availability by increasing the average resident's travel distance to reach an outlet. This study does not differentiate between recreational or medical marijuana licenses. Over 90% of recreational marijuana outlets share an address with a medical marijuana outlet, due to initial licensing requirements which allowed existing medical marijuana outlets to obtain recreational marijuana licenses first.

Over half (53%) of all Denver marijuana retailers have a geocoded location within 50 feet of an adjacent block group's boundary; thus a crime happening across the street is likely to be in an adjacent spatial unit. Given that some stores employ security personnel, crimes might be more common some distance from the store itself. Therefore, spatially lagged variables were creating by averaging the densities of marijuana outlets for all adjacent block groups.

Sociodemographic estimates for the 481 Census block groups was obtained yearly from Geolytics for 2013, 2014 and 2015. These data include block group estimates for a variety of control variable used in our analyses. The variables included in the current study are population density (per square mile), percent of one person households, male to female ratio, median household income, percent of families in poverty, percent of adults unemployed, percent of owner-occupied housing units, percent of vacant housing units, percent of residents who are Asian, percent of residents who are Black, percent of residents who are Hispanic, and percent of residents between the ages of 15 and 24.

Parcel level land use data was obtained from the City of Denver. Parcels with a commercial land use were identified as those that had one of the following land use descriptions: commercial, retail, restaurant, shopping, gas station, supermarket, and hotel / motel. GIS was used to overlay this data with block groups to calculate the percent of block group area in a commercial land use. Presence of a highway ramp was calculated by extracting highway ramp road segments from the Census TIGER/Line roads Shapefile (Feature Class Code S1630) and overlaying these ramp locations with Census block groups.

Alcohol license data for 2015 was obtained from the city. Data included location of the alcohol outlets, type of alcohol license and x, y coordinates. License categories were classified into off-premise outlets (e.g., liquor and convenience stores), restaurants that serve alcohol, and bars/pubs. Block group area densities were calculated in each of these three categories.

Variables were chosen to loosely represent the tenets of routine activities theory where a suitable target is represented by percent of adult males aged 15 – 24 and percent single person household as it may indicate neighborhood areas where people spend more time outside the home (Cohen & Felson, 1979). Guardianship is represented by vacant housing, owner-occupied housing and population density. Motivated offender is measured using percent poverty and percent unemployment (Cohen & Felson, 1979). Finally we include structural characteristics of neighborhoods (e.g., alcohol outlet density, presence of highway ramps) shown to be related to crime in previous studies of medical marijuana dispensaries and crime (Kepple & Freisthler, 2012; Freisthler et al., 2016).

Data Analysis Procedures

Data were analyzed using Bayesian Conditional Autoregressive (CAR) Poisson models to assess statistical relationships between density of marijuana outlets and monthly counts of violent, property, and marijuana crime incidents in each Census block group in Denver, Colorado. The use of the CAR procedures adjusted for the loss of statistical independence among adjacent spatial units due to spatial autocorrelation (Besag, York, & Mollie, 1991; Carlin & Louis, 2004). In addition to the random effect related to spatial similarity (i.e.,

correlated heterogeneity), a second random effect accounted for non-spatial block group differences (i.e., uncorrelated heterogeneity). The Bayesian approach helps to deal with small area problems by allowing estimates in each region to borrow strength from those of neighboring areas, and have also been shown to allow for overdispersion (Waller & Gotway, 2004; Lord, Washington, & Ivan, 2005). The model is specified as follows:

$$Y_{i,t} \mid \mu_{i,t} \sim Poisson(E_{i,t} \exp(\mu_{i,t}))$$

where $Y_{i,t}$ represents the observed count of crimes in block group i during month t and $E_{i,t}$ denotes the expected number of the crimes under the assumption that study-wide criminal incidents are distributed in direct proportion to block group population. $Exp(\mu_{i,t})$ may be interpreted as the relative crime risk of residing in spatial unit i at time t such that regions with $\exp(\mu_{i,t}) > 1$ will have greater crime counts than expected based on their population, and regions with $\exp(\mu_{i,t}) < 1$ will have fewer crime incidents than expected.

The log-relative risk, $\mu_{i,t}$, is modeled as a linear combination of fixed covariate effects and random effects take into account spatial correlation:

$$\mu_{i,t} = \alpha + \lambda \bullet t + X'_{i,t}\beta + \theta_{i,t} + \varphi_{i,t} + \omega_t$$

Parameter α is an intercept, and $\lambda \bullet t$ is a city-wide linear time trend across the 34-month period. Matrix $X'_{i,t}$ contains space- and time-specific independent variables (local and spatially-lagged marijuana outlet densities) as well as control variables, and β is a vector of fixed-effects estimates of the impacts of those covariates. $\theta_{i,t}$ and $\varphi_{i,t}$ denote the pair of random effects capturing spatially unstructured heterogeneity and CAR spatial dependence, respectively. A temporal random effect ω_t allows for unexplained variance in risks across months. Models were estimated using WinBUGS 1.4.3 software (Lunn, Thomas, Best, & Spiegelhalter, 2000). Non informative priors were specified for all fixed and random effects. Analyses were allowed to burn-in for 40,000 Markov Chain Monte Carlo (MCMC) iterations. Posterior estimates were then sampled for an additional 40,000 iterations.

Results

Table 1 presents the descriptive statistics for all the study variables. On average, each Census block group has .48 violent crimes, 3.0 property crimes, and .04 marijuana-specific crimes per month. Block groups also have about 2.5 marijuana outlets per square mile in local and spatially lagged (adjacent) areas.

Violent crime.

Density of marijuana outlets (local or spatially lagged) were not related to rates of violent crime during the 34 month study period. Density of bars and off-premise alcohol outlets were related to higher rates of violent crimes. Census block groups that had lower population densities, median household incomes, percent of owner-occupied housing, percent of unemployed adults, and percent of young adults aged 15 to 24 had higher rates of violent crime. Having a higher percent of vacant housing and percent of land zoned for

commercial uses was related to higher rates of violent crime. Violent crime also had a statistically significant positive linear time trend. The Moran's I coefficient was measured at .813 (z-value = 29.99, p < .001) indicating the presence of significant positive spatial autocorrelation.

Property crime.

The number of marijuana outlets per square mile within the Census block group was not related to rates of property crimes. However, the density of marijuana outlets in spatially adjacent block groups was positively related to property crime. Off-premise alcohol outlets, percent of vacant housing, percent of area commercially zones and the presence of highway ramps was positively related to property crime rates. Population density, median household income, percent of owner-occupied housing, and percent of Hispanic residents was negatively related to rates of property crime. The linear time trend was also positive and statistically significant. Spatial autocorrelation was positive and statistically significant (Moran's I: .890, z-value = 32.79, p < .001). Figure 1 shows the model obtained posterior estimates by Census block group for the effects of lagged marijuana outlets on property crime. Using these estimates, marijuana outlets are related to 84.81 more property crimes per year.

Marijuana-specific crime.

Having higher densities of marijuana outlets within the Census block group and in spatially adjacent block groups was related to higher rates of marijuana-specific crime. Similar to both violent and property crime, higher rates of marijuana-related crime occurred in block groups with lower population densities and lower household incomes. A higher percent of families living in poverty was related to higher rates of marijuana-specific crime. Unlike violent and property crime, the linear time trend was not significant. Significant positive spatial autocorrelation was present as evidenced by the Moran's I statistic equaling .922 (z-value = 33.78, p < .001). The posterior values for the local and spatially-lagged marijuana outlets on crime can be found in Figure 2. These outlets are related to 12.2 higher marijuana-specific crimes in each year.

Several specification tests were conducted. In the first we added a dummy variable that indicated the change from medical to recreational availability. This was done to assess whether or not crimes increased with the opening of recreational marijuana outlets. This variable was not supported in any of our models. The findings related to marijuana outlets did not change. In the second specification test, we included the rate of other drug crimes as a control variable in the analysis. We found that the variable was well supported and positive for property and violent crimes, but was not related to marijuana-specific crimes. The inclusion of this variable did not change the findings related to marijuana outlets.

Discussion

Across the United States, individual states are debating and considering legislation that will legalize medical or recreational marijuana use. Yet the long term consequences of such legislation remain largely unknown. Policy researchers are attempting to assess the early

impacts of marijuana legalization upon public health outcomes related to marijuana use. These outcomes go far beyond crime to include rising levels of marijuana dependence and related hospitalizations (Mair, Freisthler, Ponicki, & Gaidus, 2015). One big concern is that state level studies are too global and imprecise to identify public health impacts. Simple measures of legalization that do not recognize critical elements of the social mechanisms by which problems related to marijuana sales and use arise founder on imprecision; the critical measure is availability, where and how easily consumers can obtain the good. Global measures of crime and other health outcomes are noisy in the extreme and poorly represent the great heterogeneity in risks related to marijuana outlets experienced at the local level. The current study assesses the relationship between the densities of marijuana outlets and violent, property, and marijuana-specific crime in Denver, Colorado using very highly resolved spatial and temporal units. The study period covers the time during which marijuana moved from being sold only for medical purposes to being sold for recreational purposes. It is at this level of resolution that we are most likely to see effects.

Similar to previous longitudinal work, our study found that density of marijuana outlets was related to higher rates of property crime in spatially adjacent areas (Freisthler et al., 2016), neighborhoods around those where marijuana outlets opened in Denver. However, unlike our previous work, the current study found no relationship of local marijuana outlets to violent crime. Density of medical marijuana outlets in local and spatially adjacent areas were related to higher rates of marijuana-specific crime. These types of crimes may represent an opportunity for place management around marijuana outlets and be of concern for neighborhood residents.

This study (along with previous research) suggests that the effects of the physical availability of marijuana outlets on crime do not necessarily occur within the specific block groups within which outlets are located, but are occurring in adjacent areas. Thus studies assessing the effects in local areas are underestimating their true effects. Colorado legislation specifies security measures dispensaries must take in order to reduce crimes. These measures may mitigate any problems related to crime close to the dispensaries (Freisthler, Kepple, Sims, & Martin, 2013).

The effects of outlets on crime may be occurring in adjacent areas as people move in and out of the areas where these marijuana outlets are located. Interpreting these findings within the framework of routine activities theory, the property (e.g., automobiles) of dispensary customers, particularly those who may be tourists, may be suitable targets for those wishing to commit crimes (Glesnor & Peak, 2004) as their owners may not secure their belongings before visiting a dispensary. Properties in surrounding areas may also prove to be ideal targets as they may have less security (e.g., lack of suitable guardians) than the areas local to the marijuana outlets. Motivated offenders may also be those who use these marijuana outlets who become familiar with the adjacent areas as they pass through them regularly to and from the outlet.

Interestingly, density of marijuana outlets in local or spatially adjacent areas was not related to rates of violent crime. As marijuana markets move from illegal to legal in Colorado, less 'enforcement' may be needed to ensure illegal drug transactions occur (Goldstein, 1998). In

other words, the presence of retail marijuana markets may obviate some violence used to ensure that illicit drug market transactions occur (e.g., buyer pays the seller for the purchase of illegal drugs).

The study does have limitations. As an ecological population-level study, we are unable to assess the exact social mechanisms by which the density of marijuana outlets is related to crime. Density of marijuana outlets does not provide information about how much marijuana is being sold or is available on the streets. Having data on sales by each outlet would provide a better estimate of the effects of these outlets on crime as they would allow us to distinguish before more or less highly trafficked venues. We chose Census block groups because, in part, because of the availability of demographic and economic data. However, these administrative units may not be ideal for linking marijuana availability to crime. Other studies should examine this relationship using different geographic specifications to see if these findings occur at other spatial scales.

Our study only assessed crime rates in relation to marijuana outlets. Marijuana is currently also available through individual cultivation and delivery services. These other forms of physical availability of marijuana were not assessed here; thus their relationship to crime remains unknown. Finally, the marijuana-specific crimes were identified by the Denver police department. We are unable to independently verify whether or not these crimes were actually related to marijuana outlets. Police officials may be biased when determining these marijuana-specific crimes. For example, higher marijuana-specific incidents may allow the police department to advocate for more resources to combat crime or advocate against legalization. Thus it would be in the department's interest to identify marijuana-specific crimes. However, in each year of the study, fewer than 300 crimes were classified as marijuana-specific indicating this may be a conservative estimate. Finally, the study only includes spatially-lagged variables in our analysis and not temporal lags. The level of collinearity between current and prior month density of marijuana outlets is quite high (.982) which would like adversely affect model fit.

Conclusions and Implications

The regulation, location, and marketing of marijuana through marijuana outlets remains a controversial topic and practice, particularly for those living near the outlets. The findings from this current study have important implications for debates around legalization across the country. In particular, as states legalize marijuana for recreational use, property crime in adjacent areas may increase. Studies that only assess local impacts of marijuana outlets may miss the actual relationship of these outlets to crime. As marijuana increases in popularity and use, research needs to continue to assess and understand how greater availability may affect crime rates and other public health problems.

Acknowledgments

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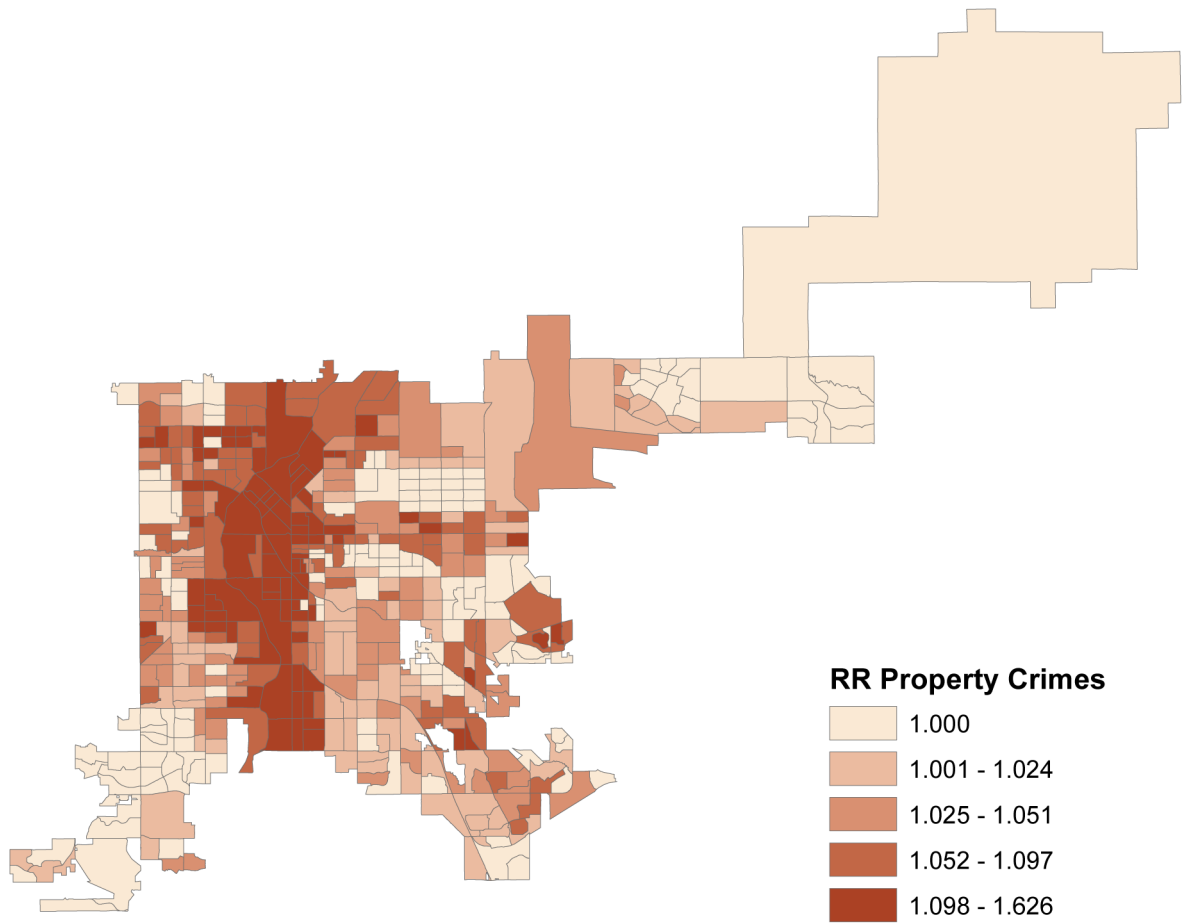**Figure 1:**
Posterior relative incidence rates of property crimes in Denver, October 2015 due to
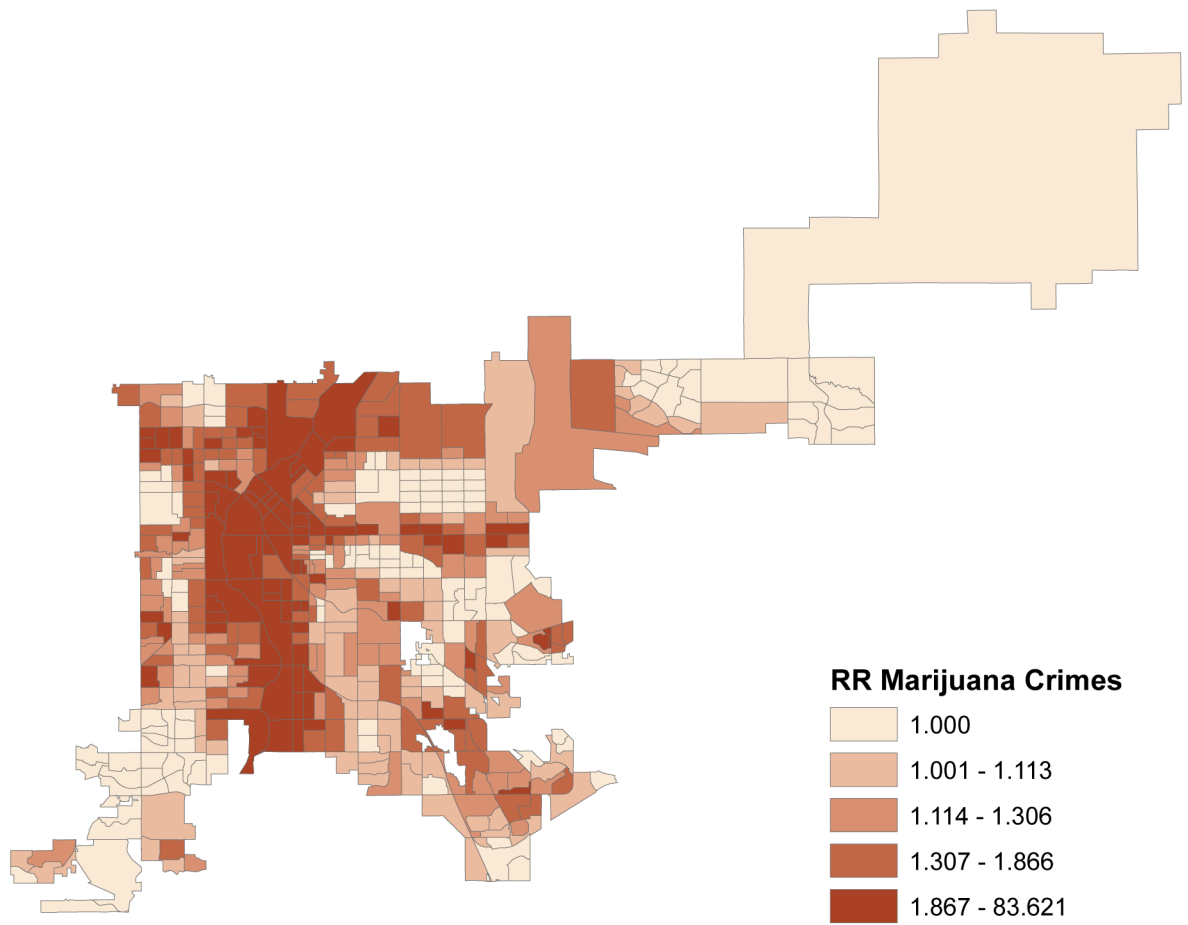Marijuana Outlet Effects

RR Marijuana Crimes

1.000

1.001 - 1.113

1.114 - 1.306

1.307 - 1.866

1.867 - 83.621

Figure 2:
Posterior relative incidence rates of marijuana crimes in Denver, October 2015 due to
Marijuana Outlet Effects

Table 1:

Descriptive Statistics for Study Variables

Variable Name	Mean	SD	Min	Max
Violent Crimes per month	0.480	1.036	0.000	16.000
Property Crimes per month	2.999	5.259	0.000	102.000
Marijuana Crimes per month	0.043	0.249	0.000	5.000
Marijuana Outlets per square mile	2.465	6.087	0.000	57.693
Spatially-lagged Marijuana Outlets per square mile	2.500	3.103	0.000	24.165
Bars & Pubs per square mile	4.192	14.464	0.000	204.810
Restaurants (that serve alcohol) per square mile	14.216	44.626	0.000	687.576
Off-Premise Alcohol Outlets per square mile	5.301	9.699	0.000	87.776
Population Density (1000s per square mile)	8.622	5.618	0.000	38.789
% One-Person Household	36.463	16.780	7.862	82.397
Male / Female Ratio (x 100)	100.936	17.545	36.590	192.727
HH Income ($1000s in 2015)	5.490	3.237	0.000	21.901
% Families in poverty	17.798	17.580	0.000	92.566
% Unemployment	7.783	8.416	0.000	100.000
% Owned housing	48.710	23.549	0.000	94.143
% Vacant housing	12.940	7.716	0.000	96.012
% Asian	1.834	3.332	0.000	40.242
% Black	7.611	12.526	0.000	67.054
% Hispanic	32.058	29.229	0.072	97.384
% Age 15-24	10.022	4.461	0.000	24.699
% Zoned Commercial	4.268	6.592	0.000	67.336
Any Highway Ramps	0.189	0.392	0.000	1.000
Block group population	1352.896	887.425	0.000	12950.000
Block group area (square miles)	0.321	1.949	0.028	42.286

Table 2:

Bayesian Space-Time Models of Relationship between Medical Marijuana Dispensaries and Crime (n = 16,354)

Variable Name	Model 1: Violent Crime		Model 2: Property Crime		Model 3: Marijuana-Specific Crime	
	Relative Rate	95% Credible Interval	Relative Rate	95% Credible Interval	Relative Rate	95% Credible Interval
Intercept	1.851	(0.556, 6.404)	1.365	(0.446, 2.429)	0.449	(0.023, 14.531)
Marijuana Outlets per square mile	1.007	(0.999, 1.015)	1.001	(0.997, 1.006)	1.080	(1.057, 1.103)*
Spatially-lagged Marijuana Outlets per square mile	1.001	(0.979, 1.024)	1.021	(1.010, 1.032)*	1.078	(1.022, 1.137)*
Bars & Pubs per square mile	1.010	(1.000, 1.019)*	1.004	(0.998, 1.011)	1.008	(0.986, 1.031)
Restaurants (that serve alcohol) per square mile	0.999	(0.996, 1.002)	0.999	(0.997, 1.001)	0.995	(0.988, 1.003)
Off-Premise Alcohol Outlets per square mile	1.013	(1.005, 1.022)*	1.010	(1.004, 1.017)*	1.014	(0.992, 1.036)
Population Density (1000s per square mile)	0.927	(0.910, 0.944)*	0.952	(0.941, 0.963)*	0.868	(0.827, 0.908)*
% One-Person Household	0.996	(0.985, 1.007)	1.001	(0.995, 1.010)	1.005	(0.971, 1.035)
Male / Female Ratio (x 100)	1.003	(0.998, 1.009)	1.002	(0.998, 1.006)	1.008	(0.996, 1.019)
HH Income ($1000s in 2015)	0.918	(0.882, 0.959)*	0.954	(0.930, 0.977)*	0.841	(0.750, 0.938)*
% Families in poverty	1.001	(0.995, 1.007)	0.999	(0.994, 1.003)	1.015	(1.002, 1.030)*
% Unemployment	1.003	(0.995, 1.011)	1.003	(1.000, 1.007)	1.002	(0.983, 1.021)
% Owned housing	0.987	(0.981, 0.993)*	0.992	(0.988, 0.996)*	0.996	(0.982, 1.011)
% Vacant housing	1.010	(1.002, 1.018)*	1.012	(1.008, 1.017)*	0.990	(0.969, 1.012)
% Asian	1.016	(0.992, 1.041)	0.997	(0.979, 1.016)	0.978	(0.927, 1.030)
% Black	1.009	(0.997, 1.020)	0.994	(0.987, 1.002)	0.990	(0.966, 1.012)
% Hispanic	1.005	(0.997, 1.012)	0.993	(0.988, 0.998)*	1.003	(0.990, 1.019)
% Age 15-24	0.951	(0.912, 0.992)*	0.999	(0.979, 1.020)	1.016	(0.909, 1.122)
% Zoned Commercial	1.030	(1.018, 1.043)*	1.031	(1.023, 1.041)*	1.010	(0.980, 1.039)
Any Highway Ramps	1.204	(0.978, 1.482)	1.345	(1.154, 1.555)*	1.465	(0.947, 2.302)
Linear time trend	1.010	(1.004, 1.016)*	1.007	(1.002, 1.012)*	1.004	(0.994, 1.014)
SD (correlated heterogeneity/CAR random effect)	1.013	(0.728, 1.388)	0.520	(0.364, 0.693)	0.803	(0.083, 1.605)
SD (uncorrelated heterogeneity/non-spatial random effect)	0.458	(0.232, 0.581)	0.473	(0.417, 0.525)	1.043	(0.742, 1.292)
SD (month random effect)	0.141	(0.103, 0.195)	0.131	(0.103, 0.174)	0.059	(0.022, 0.152)

Variable Name	Model 1: Violent Crime		Model 2: Property Crime		Model 3: Marijuana-Specific Crime	
	Relative Rate	95% Credible Interval	Relative Rate	95% Credible Interval	Relative Rate	95% Credible Interval
Proportion Spatial	0.830	(0.627, 0.972)	0.546	(0.341, 0.725)	0.369	(0.005, 0.804)

*
Credible interval does not include 1;

**
To be compared with an expected value of 0.0000.