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A Micro-Temporal Geospatial Analysis of Medical Marijuana Dispensaries and Crime in Long Beach California

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Abstract

Aims—To determine whether the density of marijuana dispensaries in California, USA, in 2012-2013 was related to violent and property crimes, both locally and in adjacent areas, during a time in which local law enforcement conducted operations to reduce the number of store-front medical marijuana dispensaries.

Design—Data on locations of crimes and medical marijuana dispensaries as well as other covariates were collected for a sample of 333 Census block groups. .

Setting—Long Beach, California, USA from January 2012 through December 2013.

Observations—A total of 7,992 space-time observations (from 333 Census block groups over 24 time points).

Measurements—Outcome measures focused on block-group counts of violent and property crimes. Predictors were numbers of local and adjacent-area medical marijuana dispensaries. Covariates included markers of alcohol availability as well as area demographic and economic characteristics.

Findings—After adjustment for covariates, density of medical marijuana dispensaries was unrelated to property and violent crimes in local areas but positively related to crime in spatially adjacent areas [IRR = 1.02, CI (1.01, 1.04) for violent crime, IRR = 1.02, CI (1.01, 1.03) for property crime].

Conclusions—Using law enforcement to reduce medical marijuana dispensaries in California appears to have reduced crime in residential areas near to, but not in, these locations.

Keywords

Medical Marijuana Dispensaries; Violent Crime; Property Crime

Medical marijuana dispensaries continue to attract attention by the popular press for their perceived effects on local communities. As cities and countries decriminalize, legalize, or consider whether or not to change policies around marijuana use and their availability[1], one lingering concern is whether greater availability of marijuana through store-front dispensaries will increase crime. Law enforcement officials regularly point to crimes that occur in and around dispensaries as one of the reasons they should be regulated or banned[2]. However, crude assessments conducted by local police departments in Los Angeles, Denver, and Colorado Springs suggest that areas in which dispensaries are located do not have more crime than banks, liquor stores, or other businesses[3-5]. Advocates of medical marijuana and dispensaries point to these numbers as proof that crime is not an issue around dispensaries and speak of the need of having marijuana easily accessible to populations who need it[6]. In reality, very few studies exist that rigorously test the relationship between dispensaries and crime. As more states continue to consider legislation to legalize medical or recreation marijuana, understanding how access to marijuana through these dispensaries affects changes in crime rates is an important consideration for public health, city zoning and planning departments.

Routine activities theory and environmental criminology provide frameworks that could explain why crime may increase when dispensaries are introduced into neighborhood areas. According to routine activity theory, the necessary conditions for crime to occur are a motivated offender, a suitable target, and an absence of capable guardians who may server to deter violent or criminal behaviors[7]. Motivated offenders might choose dispensaries or their customers as targets of crime because dispensaries continue to be primarily cash businesses and carry an attractive illicit substance (marijuana) which can be re-sold fairly easily. Suitable targets may be the dispensaries or patients who use dispensaries who may be carrying large amounts of cash before the purchase and marijuana products after their purchase. Since it appears that dispensaries are located in higher poverty areas[8] and areas with higher percent of retail employment[9], both aspects of neighborhoods indicative of low guardianship, crimes may be more likely to occur in these areas. Crime also occurs around high activity nodes based on the travel patterns of offending populations or along edges of neighborhood areas as they transition from commercial to residential[10-11]. As it appears that dispensaries are located adjacent to residential areas, crimes in those nearby areas (known as edges) may be more frequent, especially property crimes associated with residential areas[10].

Recent empirical evidence at the state-level, however, found no changes in Part I FBI crime arrests in states that had laws legalizing the use of medical marijuana[12]. Although this study did examine changes in crime longitudinally, it did so at the state level, providing no guidance for policymakers and public health officials on whether or how to regulate local marijuana outlets (e.g., storefront dispensaries). Since the theoretical framework employed here suggests that changes in crime should be seen in proximity to the actual sites of dispensaries, aggregation bias may have dampened observed effects at the state level. More

locally, one cross-sectional study in Sacramento, California also found no relationship between dispensary densities and property or violent crimes at the Census tract level. However, other indicators related to routine activities theory were statistically significant and in expected directions (e.g., percent of commercial zoning related to higher levels of property and violent crime)[13]. This lack of a relationship suggests that either one of the necessary conditions needed for crime to occur may not be met or the effects of dispensaries on crime may be at a smaller spatial scale than Census tracts.

In a pilot study examining the first supposition, dispensaries which had security cameras or door men stationed outside had lower levels of violent crime within 250 feet of the dispensary[14]. The security measures dispensaries take may act as capable guardians which prevent crime but only in relatively local areas. As these security measures are fairly visible, they may serve to lessen criminal behaviors within the immediate vicinity of the dispensaries and possibly displace crime to nearby areas. In addition to examining the relationships of dispensaries to crime in local areas, the current study will assess whether dispensaries in local areas affect crime in adjacent areas.

Policy Context

California voters approved the use of marijuana for medical purposes in 1996 via Proposition 215 leaving regulation of production and distribution to local city and county governments. In 2003 additional legislation was passed that allowed greater access to medical marijuana through dispensaries but again created no specific guidelines for regulation; most localities also made no immediate provisions for regulation. In 2010 the city of Long Beach enacted Ordinance 10-007 that placed restrictions on where dispensaries could be located and mandated a variety of security features, including the use of security cameras. Since quite a few dispensaries had opened by this time, a lottery was held to identify those dispensaries within 1000 feet of each other which would remain open. However, a resulting lawsuit (Pack vs. City of Long Beach) ruled that cities cannot limit medical marijuana dispensaries using lottery or city zoning ordinances since they are banned at the federal level. The City of Long Beach responded by phasing in a ban of all dispensaries in February 2012; those dispensaries that had previously been given permits under the lottery system had an additional six months (by August 2012) to comply. This set up the natural experiment exploited by the current study.

The current study examines whether changes in dispensaries over a 24 month time period (2012-2013) affected violent and property crimes in Long Beach, California. During this time, local law enforcement conducted a series of operations designed to reduce or eliminate the number of store-front medical marijuana dispensaries in the city. We hypothesize that density of dispensaries will be related to rates of crime in local and adjacent areas.

METHODS

Study Sample

Crime and Census data were collected over 24 months (January 2012 to December 2013) for 333 Census block groups wholly within Long Beach, California, a total sample size of 7,992

space-time units. Long Beach is a city of about 470,000 individuals in which over 29% of the residents are white, 13.5% are Black, 12.9% are Asian, and 40.8% are Hispanic. The median household income is over $52,000 and 1 in 5 residents live in poverty[15]. Block groups had an average of 1,389 residents, 0.15 square miles, and 6.1 neighboring block groups.

Measures

Dependent Variable—Crime was measured using incident data obtained from the Long Beach Police Department. 99% of the crimes were geocoded to point locations of occurrence (either street address or intersections). Data were coded to represent monthly counts of Part I property and violent crime using definitions from FBI Uniform Crime Reports. Property crimes are defined as those that take property away from an individual, but where no harm to the person occurs. Examples of property crimes include burglary, larceny, and theft. Violent crimes are those crimes where a person has been harmed during the commission of the crime and include homicide, assault, and robbery.

Independent Variables—Store-front medical marijuana dispensaries were obtained by premise survey in January, 2012 using locations of dispensaries from the official Long Beach city list and websites that list locations of dispensaries (e.g., weedmaps, CANORML, puffpuff411, medicalmarijuanalocators, thcfinders, and Yelp). Each site on the city list was visited by a research assistant to determine whether or not the dispensary was open and operating as a dispensary. Dispensary lists were collected again for March, April, June, and November of 2012 and February, May, August, September, October, November, and December 2013. Premise visits also occurred during those time periods to assess open or closure of the dispensaries. A variable representing the density of dispensaries was calculated by taking the number of dispensaries per area (measured by square miles). Local (within Census block group) and spatially-lagged (averaged across 1 to 12 immediately adjacent Census block groups) dispensary density variables were created for each block group. For months where direct observations were not conducted, we used the most recently reported number of dispensaries. At the beginning of the study period, 37 dispensaries were identified as open and operating whereas only 5 dispensaries were open at the end of the study, an 83% reduction.

Control Variables—Control variables included many that relate directly to the assessment of routine activity theory: percent of a Census block group zoned for commercial use, presence of a highway ramp, and percent of youth aged 15 – 24. Data on commercially zoned land use for 2013 was obtained from the City of Long Beach technology services and GIS was used to calculate the percent of block group area that is zone commercially. 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. Annual data on a variety of neighborhood sociodemographics were obtained from Geolytics for 2012 and 2013. These included population density (per square mile), the percent of one person households, the 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. Given the relationship of alcohol outlets to crime, measures of area densities of off-premise alcohol outlets (e.g., liquor and convenience stores), restaurants that serve alcohol, and bars/pubs were also included (available annually for 2012 and 2013 from the Department of Alcoholic Beverage Control).

Statistical Analysis

A Bayesian spatial Poisson model was used to assess statistical relationships between independent measures and monthly counts of violent and property crimes in each Census block group; a Conditional Autoregressive (CAR) process accounted for loss of statistical independence among adjacent spatial units due to spatial autocorrelation[16-17]. These models split unexplained block group differences into two random effects: a CAR process that accounts for similarity among adjacent spatial units, and an unstructured random effect that accounts for block group differences that are not spatially correlated. 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[18-19]. The model is specified as follows:

$$Y_{i,t}|\mu i,_{t}\text{Poisson}\ (E_{i,t}\exp(\mu_{i,t}))$$

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 events are distributed in direct proportion to block group population. Hence $\exp(\mu_{i,t})$ may be interpreted as the relative crime risk of residing in spatial unit i at time t: 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 than expected.

Following standard generalized linear models, the log-relative risk, $\mu_{i,t}$, is modeled linearly as:

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

This is a linear combination of fixed covariate effects and random effects which may take account of spatial correlation. Parameter α is an intercept, and λ•t is a city-wide linear time trend across the 24-month period. Matrix $X'_{i,t}$ contains space- and time-specific independent variables (local and spatially-lagged dispensary 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 $\phi_{i,t}$ 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[20]. Uninformed priors were specified for all fixed and random effects. Analyses were allowed to burn-in for 20,000 Markov Chain Monte Carlo (MCMC) iterations, which were sufficient for all parameter estimates to stabilize and converge between two chains with different initial values. Posterior estimates were then sampled for an additional 40,000 iterations.

RESULTS

Table 1 presents descriptive statistics for all model variables. Averaged across all months, each Census block group had an average of 1.31 violent crimes and 3.21 property crimes, 0.704 dispensaries per square mile with .721 dispensaries per square mile in adjacent block groups, and were racially and ethnically diverse with 11.24% Asian residents, 11.07% Black residents, and 39.73% Hispanic residents. As shown in the table these values ranged greatly across block group areas and time. Figure 1 shows the temporal change in dispensaries.

Model 1 in Table 2 presents the results of the Bayesian analyses for violent crime. Controlling for all other covariates in the model, the overall effect of densities of marijuana dispensaries across local and adjacent areas was positive and well supported with a relative rate of RR=1.0310 and a 95% credible interval of CI=1.0146 to 1.0478. Across local and adjacent areas, an increase of one dispensary per square mile was related to a 1.5% to 4.8% increase in violent crime. However, as detailed in the table, local medical marijuana dispensaries (within a Census block group) were unrelated to rates of violent crime while densities of dispensaries in adjacent block groups were related to a 2.5% increase of violent crime (CI=1.0097,1.0402. Using these estimates, Figure 2 presents model-predicted annual numbers of violent crimes attributable to dispensaries observed at their greatest (March 2012) and least (August 2013) points.

Several other variables reflecting routine activities were also related to violent crime. These included positive relationships with percent single person households, percent young people aged 15 to 24 years, the presence of highway ramps within a block group, percent families in poverty, and greater male to female population ratios. Combined densities of all alcohol outlets, regardless of type, were related to violent crime (RR=1.0130, 95% CI=1.0049, 1.0211) with that for off-premise outlets most well supported. Greater median household income (in 2013 dollars), percent ownership of occupied housing, and greater population densities were related to lower rates of violent crime.

Model 2 in Table 2 presents the results for property crime. Here the overall effect of densities of marijuana dispensaries across local and adjacent areas was positive and well supported (RR=1.0156, 95% CI=1.0048 to 1.0264). Across local and adjacent areas, an increase of one dispensary per square mile was related to a 0.4% to 2.6% increase in property crime. However, as detailed in the table, local medical marijuana dispensaries were unrelated to rates of property crime while densities of dispensaries in adjacent block groups were related to a 1.7% increase in property (CI=1.0071, 1.0268). Using these estimates, Figure 3 presents model-predicted annual numbers of property crimes attributable to dispensaries observed at their greatest (March 2012) and least (August 2013) points. The combined effects of all alcohol outlets were positively related to property crime (RR=1.0338, 95% CI=1.0263, 1.0412), separate densities of bars, restaurants, and off-premise alcohol outlets positively related to crime, with effects related to bars exceeding all others. Areas with higher population density, median household income, and percent of owner-occupied housing were related to lower rates of property crime. More unemployment and Hispanic residents were related to more property crime.

DISCUSSION

This study examined the relationship between densities of marijuana medical dispensaries and levels of violent and property crime in Long Beach, California, during a time period when most dispensaries were forced to close. Greater densities of medical marijuana dispensaries were related to higher rates of property and violent crimes in areas adjacent to dispensary locations. However, densities of dispensaries in local areas alone were not related to crime. These results differ from those observed in a cross-sectional study using Census tract data from Sacramento, California[13]. That study did not assess the role of densities of dispensaries in adjacent areas on crime and used larger spatial units. Geographic scale may play an important role in the detection of medical marijuana dispensaries on local crime rates. Our results also differ from state level studies of medical marijuana laws and regulations on crime using arrest (rather than incident) data[11]. The very large geographic scale of state level studies may also mitigate efforts to detect effects on crime, but more importantly the focus on legal and regulatory change without assessments of impacts on availability (especially through storefront dispensaries) leaves out the critical intervening variable that may mitigate regulatory effects. The current study was able to take advantage of the efforts to enforce a ban on dispensaries by the Long Beach Police Department, an important difference when compared to studies examining changes in legislation where implementation and enforcement are unknown.

One explanation for adjacent dispensaries' positive association with crime may lie in dispensaries' use of security measures to mitigate extremely local crime[14]. Thus those wishing to prey on users of medical marijuana dispensaries may be going outside of the watch area of these security measures[10]. A related possibility is that dispensaries' own security efforts may cause police to shift their enforcement activities, leading to more crimes detected in nearby areas. Other variables representing routine activities theory (such as highway ramps and percent of one person households) were also related to crime rates. These findings suggest that the location of dispensaries may contribute to one of the three necessary conditions for crime to occur as described by that theory.

An unintended consequence of a reduction in dispensaries may be that as patients of these dispensaries change their travel patterns to go to these different neighborhood areas where medical marijuana remains available through storefront dispensaries, they may also find opportunities to participate in various crimes (e.g., burglarizing a home)[10]. Property crime, a crime of opportunity, may increase as offenders use different activity nodes (in this case to obtain medical marijuana) increasing familiarity with new neighborhoods. This familiarity provides information on when guardians are around and what homes might have valuables worth stealing[10]. Reducing the density of storefront dispensaries, but not eliminating them altogether, may increase crime through movement of people through this movement through these neighborhoods.

To put these findings in perspective, the citywide decline in dispensaries from the March 2012 peak to the August/September 2013 minimum (a decline of 32 dispensaries from 37 to 5) was associated with a decline of 182.5 Long Beach violent crimes per year (3.49% of total), while they were associated with a decline of 219.3 property crimes per year (1.71% of

total). An equivalent drop of 32 citywide alcohol outlets (representing a 3.97% decline in total alcohol outlets) was associated with a decline of 26.2 Long Beach violent crimes per year (0.50% of total), while they were associated with a decline of 113.9 property crimes per year (0.89% of total).

These results suggest that local agencies who enact and enforce bans on dispensaries (i.e., reducing the number of dispensaries to 0) will reduce crime in neighborhoods next to where the dispensaries are located. Enforcement efforts and patrols by police may be better served in those neighborhoods next to where dispensaries are rather than where the dispensaries are located given the security measures taken by these businesses. This regulation and enforcement needs to occur at the local, not state, level to effect change in crime rates. More importantly, public health, local government and police officials should consider these secondary costs of opening dispensaries when deciding to enable storefront sales of marijuana in their cities.

This study adds to the growing literature assessing how medical marijuana dispensaries affect crime. However, the current study was conducted in one mid-sized city in California and may not generalize to other cities and local jurisdictions. The use of crime incidents may undercount actual crime rates, particularly those that occur on the premises of dispensaries themselves as dispensaries may choose not to report crimes so as not to draw extra attention to themselves. As a population-level study, we are unable to assess the exact mechanisms by which dispensaries may be affecting crime. The distribution of medical marijuana in California has been changing such that many dispensaries have converted from store-fronts to delivery only services. Given that the addresses of these delivery services are unknown (usually listed as post office boxes), we were unable to assess how this changing mode of distribution may be affecting crime rates.

The regulation and marketing of marijuana through store-front dispensaries remains a controversial topic and practice, particularly for those living near the dispensaries. Our results suggest that these dispensaries may increase crime rates in adjacent areas. As dispensaries are not allowed in purely residential areas, these results suggest those areas could see increases in crime if they are located next to areas with high densities of dispensaries. These findings clearly are in need of replication across multiple cities. Further research is needed to determine whether or not these effects of crime are different for medical vs. recreational dispensaries, and whether or not place-based security measures of dispensaries could be modified to reduce crime in adjacent areas.

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Figure 1.

Monthly variation in number of medical marijuana dispensaries from January 2012 to December 2013 in Long Beach, CA

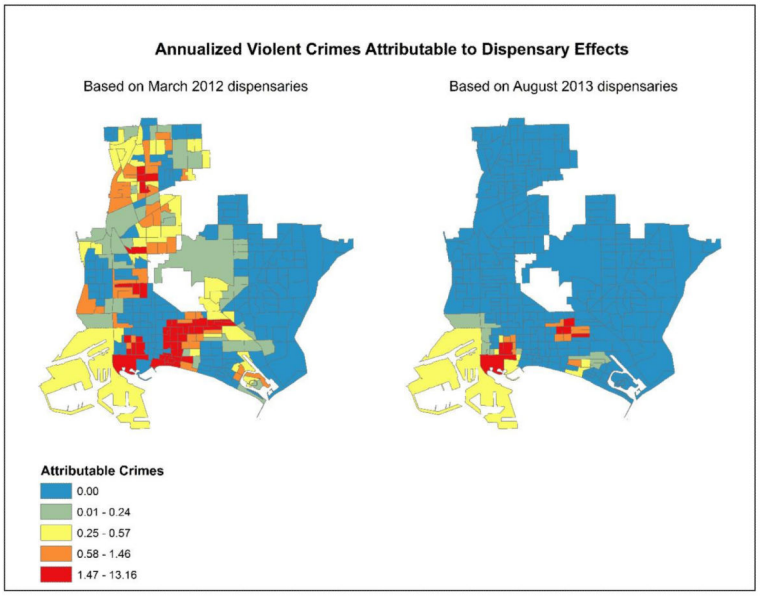

Figure 2.

Predicted annualized violent crimes per block group attributable to dispensary densities at two time points.

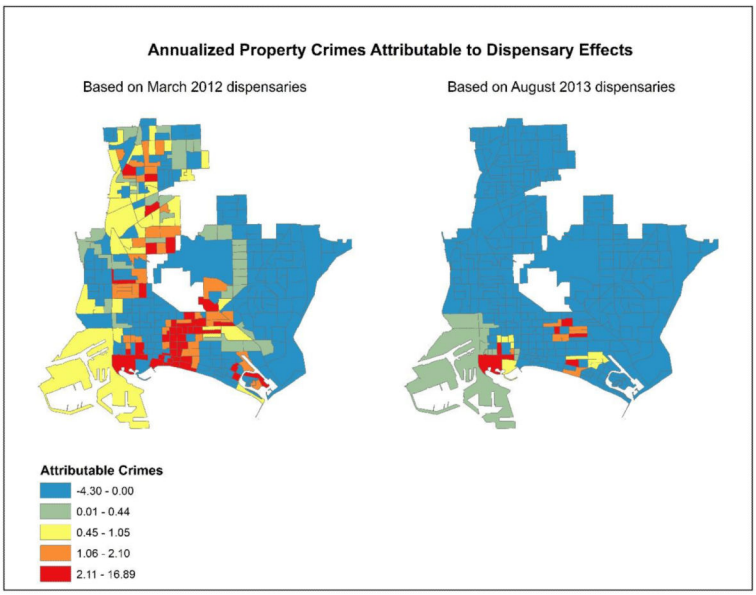

Figure 3.
Predicted annualized property crimes per block group attributable to dispensary densities at two time points.

Table 1

Descriptive Statistics for Study Variables

Variable description	Mean	SD	Min	Max
Violent Crimes per month	1.308	1.830	0	23.000
Property Crimes per month	3.205	3.284	0	45.000
Medical Marijuana Dispensaries / sq. mile	0.704	3.649	0	59.698
Adjacent Medical Marijuana Dispensaries / sq. mile	0.721	1.857	0	27.387
Bars & Pubs / sq. Mile	3.486	8.630	0	60.213
Restaurants / sq. Mile	11.181	15.438	0	89.599
Off-Prem. / sq. Mile	10.762	23.743	0	177.150
Population Density (1000s / sq. mile)	16.089	11.223	0	52.988
% One-Person Household	26.347	13.978	0	106.667
Male / Female Ratio (x 100)	99.798	21.076	43.188	337.500
HH Income ($1000s)	60.396	30.441	0	190.683
% Families in poverty	16.921	16.329	0	75.000
% Unemployment	14.103	13.051	0	100.000
% owned housing	43.535	27.839	0	91.446
% vacant housing	6.304	4.489	0	50.000
% Asian	11.241	9.891	0	63.821
% Black	11.066	10.282	0	74.946
% Hispanic	39.727	23.828	0	95.544
% age 15-24	13.270	4.522	0	21.979
% Zoned Commercial	0.086	0.094	0	0.428
Any Highway Ramps	0.132	0.339	0	1
Block group population	1389.317	607.844	0	3448
Block group area (square miles)	0.151	0.320	0.018	4.895
Count of adjacent block groups	6.060	1.862	1	12

N = 7,992 monthly block-group observations (333 block groups over 24 months from January 2012 to December 2013). Block group data on alcohol outlets and demographic variables were available annually, and were assumed to remain unchanged across all months of each year.

Table 2

Bayesian Space-Time Models of Relationship between Medical Marijuana Dispensaries and Crime (n = 7,992)

	Model 1: Violent Crime		Model 2: Property Crime	
Variable description	**Relative Rate**	**95% Credible Interval**	**Relative Rate**	**95% Credible Interval**
Intercept	0.3160	(0.0907, 0.8314) *	2.3854	(0.7048, 7.8877)
Medical Marijuana Dispensaries / sq. mile	1.0061	(0.9997, 1.0124)	0.9984	(0.9940, 1.0027)
Adjacent Medical Marijuana Dispensaries / sq. mile	1.0248	(1.0097, 1.0402) *	1.0169	(1.0071, 1.0268) *
Bars & Pubs / sq. Mile	1.0031	(0.9949, 1.0112)	1.0238	(1.0160, 1.0324) *
Restaurants / sq. Mile	1.0028	(0.9993, 1.0061)	1.0032	(1.0000, 1.0065) *
Off-Prem. / sq. Mile	1.0071	(1.0017, 1.0124) *	1.0067	(1.0016, 1.0118) *
Population Density (1000s / sq. mile)	0.9659	(0.9546, 0.9769) *	0.9579	(0.9471, 0.9695) *
% One-Person Household	1.0166	(1.0066, 1.0273) *	1.0102	(1.0014, 1.0191) *
Male / Female Ratio (x 100)	1.0042	(1.0001, 1.0086) *	1.0042	(0.9992, 1.0087)
HH Income ($1000s in 2013)	0.9925	(0.9878, 0.9969) *	0.9881	(0.9838, 0.9926) *
% Families in poverty	1.0060	(0.9963, 1.0172) *	1.0057	(0.9971, 1.0144)
% Unemployment	1.0008	(0.9930, 1.0084)	0.9892	(0.9808, 0.9964) *
% owned housing	0.9869	(0.9808, 0.9935) *	0.9916	(0.9857, 0.9972) *
s% vacant housing	1.0218	(0.9966, 1.0461)	1.0015	(0.9763, 1.0258)
% Asian	1.0016	(0.9929, 1.0112)	0.9923	(0.9839, 1.0010)
% Black	1.0065	(0.9968, 1.0175)	0.9941	(0.9848, 1.0028)
% Hispanic	1.0037	(0.9969, 1.0116)	0.9900	(0.9845, 0.9959) *
% age 15-24	1.0646	(1.0233, 1.1050) *	1.0371	(1.0082, 1.0708)
% Zoned Commercial	1.0086	(0.9989, 1.0182)	1.0037	(0.9948, 1.0132)
Any Highway Ramps	1.4290	(1.1204, 1.8098) *	1.5509	(1.2186, 2.0012) *
Linear time trend	0.9975	(0.9920, 1.0030)	0.9989	(0.9933, 1.0044)
SD (CAR random effect)	0.2791	(0.0469, 0.5532) *	0.2617	(0.0464, 0.5093) *
SD (non-spatial random eff.)	0.5687	(0.4975, 0.6392) *	0.6547	(0.5950, 0.7191) *
SD (month random effect)	0.0641	(0.0374, 0.1005) *	0.0809	(0.0587, 0.1160) *

Variable description	Model 1: Violent Crime		Model 2: Property Crime	
	Relative Rate	95% Credible Interval	Relative Rate	95% Credible Interval
Moran Coefficient	0.9442	(0.9120, 0.9764)**	0.9715	(0.9393, 1.000)**

*Credible interval does not include 1;

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