The Sharing Economy: A Geographically Weighted Regression Approach to Examine Crime and the Shared Lodging Sector

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Abstract

The sharing economy has gained great market share within the lodging sector by offering cost-effective accommodation solutions. However, it is also troubled by increasing criminal incidents. This study examined the global relationship between the density of Airbnb and crimes in Florida, explored how the relationships vary at the county level. The results suggested that crime-lodging associations vary by listing types but not crime types. Only the Shared Room type consistently exhibited positive associations with both property and violent crimes, while Private Room and Entire Home exhibited negative associations. Local variations were identified by geographically weighted regression, which could be explained by the local tourism development and ethnic diversity degree. We suggested equal efforts in preventing both property and violent crimes in home sharing business. Also regional differences need to be considered when responding to shared lodging crimes.

Introduction

The sharing economy, defined as "the sharing of access to goods and services from peer-to-peer" (Kester 2017), has become an indispensable part of the lodging industry in many major destinations (Biswas and Pahwa 2015). One of the leading lodging service providers of the sharing economy, Airbnb, has an expected global market share of 10% within the lodging industry over the next five years (Winkler and MacMillan 2015). Unfortunately, along with this rapid expansion, there is a wide concern for security issues. Heightened media attention has shown that guests of Airbnb rentals have been the target of a variety of criminal acts, particularly stealing of valuables during their staying (McPadden 2016; Brown 2015; Fox News 2014). Growing concern over the policies and procedures required by renters within the sharing economy's lodging sector has emerged (TravelMole 2017).

In shared lodging businesses, the adoption of security policies over and above the provision of fire extinguishers, or information on how to evacuate the property are rare. Most third-party booking agents (e.g., Travelocity, Expedia, and Agoda) tend to avoid posting information related to many aspects of security precautions or risk management regulations of the accommodation. Consequently, this might lead the guest to believe in a similar standard of security as in a large hotel chain (Priporas et al. 2017), thereby largely averting their awareness toward crime.

Given the relatively new phenomenon of the sharing economy, few studies have examined the relationship between crime and the sharing economy. Specifically, the nuances of this relationship have largely been ignored. Understanding the locational differences (spatial effects) of crime in relation to site locations of the sharing economy's lodging properties is an interesting gap that exists in the literature; a thorough understanding of this may reveal crucial policy and administrative guidelines for the industry.

The purpose of this study was therefore to understand the spatial relationship between the shared lodging sector and crime. To explore spatial heterogeneity in the model, geographically weighted regression (GWR), a spatially explicit regression technique was implemented in a case study in Florida. To achieve the research purpose, this study (1) identified the factors that could potentially alter this relationship and (2) explored spatially varying relationships between shared lodging and crime across the study area. The findings of this study help to understand the local correlation between

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Airbnb and crime, which is a critical step to facilitate spatial planning and strategy in tourism development and planning.

Tourism-Related Crime

Tourism is susceptible to criminal activities (Brunt, Mawby, and Hambly 2000). A line of studies have shown tourism assets with higher crime rates (McPheters and Stronge 1974; Fujii, Mak, and Nishimura 1978; Mawby 2014; Walmsley, Boskovic, and Pigram 1983; De Albuquerque and McElroy 1999). Crime can impose significant negative impacts on tourist destinations, including the decline in the number of tourist arrivals and hotel occupancy rates. Pizam and Mansfeld (1996) conducted a study on international tourists and found that criminal activities may result in a 10% decline in tourist arrivals. Tourists are an easy target for crime (Brunt, Mawby, and Hambly 2000; De Albuquerque and McElroy 1999). In modern times, social networking and media have increased the rate at which news related to crimes have spread, thus deterring tourists from traveling to certain destinations. Having a reputation as a high-crime destination can result in a negative impact on lodging businesses, such as reduction in rental prices and thus profitability (Pope 2008; Linden and Rockoff 2008).

While the tourism and lodging industry is concerned with the negative impact of crime, a number of studies argued that the increased development of tourism could give rise to criminal activities, and suggests that crime can be a by-product of tourism (McPheters and Stronge 1974; Biagi and Detotto 2014). One of the major topics within the tourism-related crime literature is what types of crime may be associated with the tourism and lodging industry. For example, McPheters and Stronge (1974) used multivariate regression to investigate the relationship between tourism and crime in Miami, Florida. They suggested that the local crime rates are seasonally influenced by the influx of tourists. Specifically, there is a positive correlation between the rate of robbery, larceny, and burglary with the number of incoming tourists. Similarly, Fujii, Mak, and Nishimura (1978) used time series and cross-sectional analysis to study tourism and crime in Hawaii. They found tourism is related to robbery, burglary, and rape. Baker and Stockton (2014) analyzed the data from Honolulu and Las Vegas and found that Honolulu has a negative correlation between the number of visitors and violent crimes while Las Vegas has significant positive correlation between the tourist number and crimes.

The impact of crime has also been discussed within the lodging literature. The lodging industry over time has been affected by a wide range of property crimes such as robbery, burglary, and theft (Ho, Zhao, and Brown 2009; Mawby and Jones 2007). These crimes have targeted both hosts and guests (Gill et al. 2002). C. Jones and Mawby (2005) found significant evidence of repeated levels of victimization in burglary among guests residing in professional hotels in southern England.

Ho, Zhao, and Brown (2009) analyzed the effects of hotel guests' characteristics on criminal victimizations. They found that most crimes committed at hotels were property-related, including burglary and theft. This conclusion was further examined by Ho, Zhao, and Dooley (2017) with the Miami-Dade hotel-related crime report, where vehicle theft was added as the third major crime in hotels (Ho, Zhao, and Dooley 2017). Hua and Yang (2017) found that violent crimes have a greater negative impact on a hotels' well-being than property crimes. Although it is contended that hotel guests are more exposed to property-related crimes (De Albuquerque and McElroy 1999), they are still subjected to various types of crime. For example, case studies of burglary in Sunnybay (Mawby and Jones 2007), robberies in Miami (Zhao, Ho, and Chen 2004), and rape in Hawaii (Chesney-Lind and Lind 1986) all discussed the major types of crime related to tourists.

Crime in the tourism literature is often categorized as property/violent crime or single criminal activities. A growing amount of literature has charted the lodging sector and criminal activity. Areas covered in the literature include cities, communities, or hotels for analysis. Interestingly, the findings are often hard to generalize. Alleyne and Boxill (2003) suggested the impact of crime in Jamaica's tourism market is small because the growth of hotels surpasses the negative impact of crime. Most studies have shown the major crime types which impact the tourism and lodging vary case by case, and the pattern of association between lodging and crime is difficult to depict and generalize in a larger study area. This study tried to apply a geographic approach to explore the overall geographic association between the shared lodging sector and crime in different counties in Florida.

Shared Lodging and Crime

Shared lodging, as a major contributor to the sharing (shadow) economy (Kester 2017), has been discussed in terms of governance (Elgin and Oztunali 2012; Din et al. 2016), economic benefits (Gibbs 2016), and legitimization (Friedrich and Williams 2013). In a wider body of literature, the relationship between crime and the lodging sector, in general, has received some attention (P. Jones and Groenenboom 2002; Zhao, Ho, and Chen 2004). However, the current literature related to the shared lodging economy and crime is mostly documented in the popular culture literature. Safety issues surrounding the shared lodging sector have mostly eluded academic examination.

Being a sub-section of the lodging industry, shared lodging is embedded with fundamental features of hospitality service. Although disputable, the shared lodging sector has had a measurable impact on accommodation market share (Lane and Woodworth 2016). However, the security issue in the shared lodging economy may differ from traditional hotels. Shared lodging is typically more prevalent in tourism-related communities, which accommodate higher crime

rates (Brunt, Mawby, and Hambly 2000; Altindag 2014; Adam and Adongo 2016; Mehmood, Ahmad, and Khan 2016; Montolio and Planells-Struse 2016). As tourists are easy targets for criminals (Ryan 1993; Dimanche and Lepetic 1999), the shared lodging economy that houses tourists is not immune from the impact of criminal activities.

Compared to hotels, there is an expressed concern with low levels of security in family-host accommodations. Interestingly, whether there is an association between the sharing of homes and crimes has not been statistically examined yet. An approach to inspecting this relationship is to look into the community environment where shared lodging is located. Ellen, Mertens Horn, and Reed (2017) found that a decrease in crime rate is the most powerful factor to attract new residents to urban neighborhoods, especially for Americans with higher levels of education and income. Based on this, Quattrone et al. (2016) cited crime rate as a major control variable in the regression model of predicting Airbnb rental price. In this study, Airbnb density was found to raise the rent while crime rate was of no significance in the regression to rent. Although being regarded as the control variable, we still see crime rate and Airbnb density both appeared in the predictors' group. The evidence shows a paucity of Airbnb listing in areas with high violent crime rates (Wegmann and Jiao 2017), which raised an interesting question: What is the association between crime rate and Airbnb density?

Another issue surrounding crime and the shared lodging sector pertains to the differences in policies that oversee a property's adherence to legislated or mandated safety and security rules (Coldwell 2014). These policies should be set out by either the government, the accommodation's parent company, or both.

To conclude, there is a dearth of literature on the association between shared lodging and crime. Studies in crime and relevant concepts like community or neighborhoods have been discussed yet have not specifically focused on the home sharing business. Also, from a policy-making perspective, we should not be satisfied with just knowing the magnitude of the negative impact of the tourism business on crime, but also which types of crime are mostly committed (Biagi and Detotto 2014). By understanding this, we can scrutinize the security of the home-sharing business with the same level of detail as the hotel industry.

Based on the discussions above, the following research questions are raised:

Question 1: What is the relationship between shared lodging density and overall crime index?
Question 2: What is the relationship between shared lodging density and property/violent crime index?

Patterns of Crime

Crime pattern theory. Crime does not happen randomly. Criminologists believe crime rates depend on time, space, and society. Crime pattern theory explains why crimes occur in certain areas. Criminals tend to follow a "crime template" to commit crimes. The template consists of critical places that intersect the activity path of both criminal and victim (Brantingham and Brantingham 1993). Victims are more likely to be attacked as a result of being exposed to a "bad" environment or unsafe areas (Seigel 2006).

Theories in victimization also explain the frequency of crime occurrence per location. According to the assumption of routine activity theory (Cohen and Felson 1979; Felson 1986, 1994), the chance for the crime depends on three factors: an attainable target, absence of a guardian and a motivated offender. For example, Harper, Khey, and Nolan (2013) explored the different spatial patterns of robbery between tourists and local residents and found that robbery toward tourists was more concentrated around attractions, while aggravated tourist robbery was concentrated primarily in residential places without tourist attractions or police presence.

As crime pattern theory is broadly applied in the scholarly research related to crime prevention (Maxfield 1987; Eck and Weisburd 2015; Sherman, Gartin, and Buerger 1989), several assumptions of this study were also built on crime pattern theory. Firstly, the absence of guardianship from janitors, apartment managers, and lifeguards (Eck 1996) in transient rentals (Townsley et al. 2014) are expected to increase the opportunity for crime. In this regard, shared lodging properties with less surveillance are more likely to attract offenders. Secondly, according to the assumption from Brantingham and Brantingham (1993), the larger the common space that guests share with others, the higher exposure they have toward offenses. Generally, a shared lodging property is categorized into one of three different types: Shared Room (entire space shared with others), Private Room (public space shared with others), and Entire Home (no space shared with others). The level of interaction between hosts and guests decreases by type in the above sequence; thus, the presumable exposure to crimes declines in the same order. However, compared with Shared/Private Room, Entire Home has less third-party supervision, which should thereby trigger more crime, as indicated in the theory. This setting of "Entire Home" type will be tested in this study.

Etiology of Crime in Lodging Business. In a literature review about the etiology of urban crime, Beasley and Antunes (1974) sum up three factors that give rise to crimes: socioeconomic, population density, and ethnic segregation problems. The following studies continuously verified this argument. The empirical study from Beasley and Antunes (1974) found that population density and medium income consistently explained most of the variance in crime, and are also the most frequently cited incentives of crime in later studies.

Patterns of hotel crimes have been studied specifically in travel and hospitality research, and there are two general factors which may stimulate hotel crime. External factors including location, proximity to other hotels, transportation

convenience, overall safety image (Huang, Kwag, and Streib 1998; P. Jones and Groenenboom 2002; Rephann 2009) are recognized as significant factors which are related to criminal activity. Internal factors like hotel rental features like the number of rooms, length of stay (Hendri 2012), and security design (Huang, Kwag, and Streib 1998) have also affected the crime rate. Factors such as market mix and hotel grade are found to have disproportionate effects on crime (P. Jones and Groenenboom 2002).

Unlike hotels/resorts lodging, home sharing businesses mostly operate in residential communities. The shared lodging economy's combination of business and community make for a unique situation when home-sharing businesses are faced with crime. The patterns of association may not just follow traditional hotel crimes, but also may be subject to community crimes. Crimes occur in communities for a variety of reasons and reveal certain patterns.

The high association between the tourism lodging community and crime could be partially explained under social disorganization theory (Sampson and Groves 1989). Scholars believe that community is "a complex system of friendship and kinship networks, formal and informal associations rooted in families and socialization process" (Kasarda and Janowitz 1974), and crimes happen in this social network linked with communities' ecological characteristics, such as high level of ethnic heterogeneity, immigration, and residential mobility, which are believed to weaken social monitoring and thereby increase community crime rates (Bursik 1988; Sampson and Groves 1989; Martinez and Valenzuela Jr 2006; Lee and Martinez Jr 2002).

Unveiling the common socioeconomic factors associated with crime is the level of social interaction that pulls the string. To study the associations between social interaction and crimes, Bellair (1997) constituted 10 social interaction measures for 60 urban neighborhoods in the United States. By conducting ordinary least squares (OLS) regression, he found that both frequent and infrequent getting-together meetings among neighbors are important for implementing community controls, thus yield stronger constraints on crime rates. According to Messner et al. (1999), less affluent areas are hotbeds for homicide and violent crimes. Similarly, studies in Australia (Hogg and Carrington 2006) and Canada (Lithopoulos and Ruddell 2011; Ruddell, Lithopoulos, and Jones 2014) have indicated above-average crime rates in rural communities, which often is attributable to low economic status.

Previous studies in tourism, hospitality, or criminal justice show that the association between crime and local community follows basic crime pattern rules, based on the above discussion, the following research question was raised:

> *Question 3*: How is the spatial structure of the shared lodging (Shared Room, Private Room, Entire Home) associated with crime?

Exploring Spatial Heterogeneity with GWR

According to the First Law of Geography (Tobler 1970), adjacent objects carry similarities and closer distances, therefore, would result in higher spatial dependency between objects. This requires a spatial analysis method to address the important locational information carried by each data case (Goodchild and Haining 2004). Spatial data displays spatial heterogeneity, which refers to the varying relationships between objects over space (Mennis and Jordan 2005; Jang, Kim, and von Zedtwitz 2017; Kim and Nicholls 2018). So, spatial heterogeneity should be explored when modeling spatially referenced data (Kim and Nicholls 2016). If only a nonspatial method (e.g., linear OLS regression) is applied, large residuals occur and thus cause biased evaluations (Anselin 2013).

From multiple case studies, we see the association patterns between shared lodging and crime may be unified in the general research areas but may differ from place to place (Messner et al. 1999; Huang, Kwag, and Streib 1998; Xu and Pennington-Gray 2017). Failure to focus on important local variations may lead to deceptive estimates if they are extrapolated to the local environment (Fotheringham, Brunsdon, and Charlton 2003; Gutiérrez-Posada, Rubiera-Morollon, and Viñuela 2017). However, to date, few studies have focused on the locational relationship between lodging and crime from a spatial approach.

Geographically weighted regression (GWR) is a way of exploring spatial nonstationary relationships by calibrating multiple regression models that allow different relationships to exist at each observation point in the studied area (Zhang et al. 2011; Leung, Mei, and Zhang 2000; Brunsdon, Fotheringham, and Charlton 1996). It can explore spatially varying relationships between variables with better model performance compared to the linear OLS regression by estimating local regression coefficients (Kim and Nicholls 2016). In this study, both lodging property and crime are spatial data embedded with specific locations. Thus, GWR was employed to explore the spatially varying relationships between lodging properties and crime since it has been proven to be a more effective method to explore spatial heterogeneity (Gilbert and Chakraborty 2011).

In the area of criminology, spatial factors and mapping skills are often applied (Hiropoulos and Porter 2014; Maltz, Gordon, and Friedman 1991). Although GWR is gradually being applied in exploring spatially varying relationships in the context of hospitality and tourism (Deller 2010; Zhang et al. 2011; Kisilevich, Keim, and Rokach 2013), shared lodging has not been addressed in spatial heterogeneity. From previous research, we see that the association between lodging businesses and types of crime vary within each sample; therefore, it is possible that spatial heterogeneity may exist. However, most studies in hospitality and crime have only examined locational difference; that is, the geographic

patterns of the associations in macro have not yet been studied, nor have the factors that contribute to them, or the factors explaining the local patterns. In this study, the GWR was used to explore the association between shared lodging and crime at both the local and global levels.

From the spatial perspective, the last research question was raised:

Question 4: What are the spatial heterogeneous patterns regarding the relationship between shared lodging and crime?

Research Methods

Study Area

Florida is one of the top tourist destinations in the U.S., and the local economy largely relies on tourism. By 2016, Florida had more than 412,000 hotels and 112 million tourist arrivals (VisitFlorida 2017). According to the statistics from the Visit Florida website, 1.4 million jobs are supported by visitors statewide, and the average hotel/motel occupancy rate was 71.6%. The shared lodging business is also large, taking up 10% of the Airbnb listing. Meanwhile, the crime rate (number of crimes per 1,000 population per year) in Florida was 28.13 in 2016, higher than the national median of 24.9. With a high volume of tourist flows and home sharing facilities and high crime rates, Florida served as a good example for the study. In this study, 67 counties in the state of Florida were used as units of analysis. Figure 1 illustrates the distribution of Airbnb (n=63,446) and the county boundaries in the state of Florida.

Conceptual Model

The overall research design is based on the assumption of shared lodging as a connection to crime. According to the space structure and the level of accessibility to crime, the shared lodging sector is divided into three room types: Shared Room, Private Room, and Entire Home. This was done so as to test the different associations with crime per the crime pattern theory (Brantingham and Brantingham 1993). According to the definition of crime (FBI 2000), two types of crime will be examined: (1) property crime, including the offenses of burglary, larceny-theft, and motor vehicle theft (the objective of the theft-type offenses is the taking of money or property, without force or the threat of force), and (2) violent crime, including murder, rape, robbery, and aggravated assault (these offenses involve force or the threat of force). What is more, when evaluating the relationships between lodging density and crimes, external factors can lead to biased model estimations. In this study, there are external social factors other than the density of shared lodging that may influence the crime rate. To extract the authentic
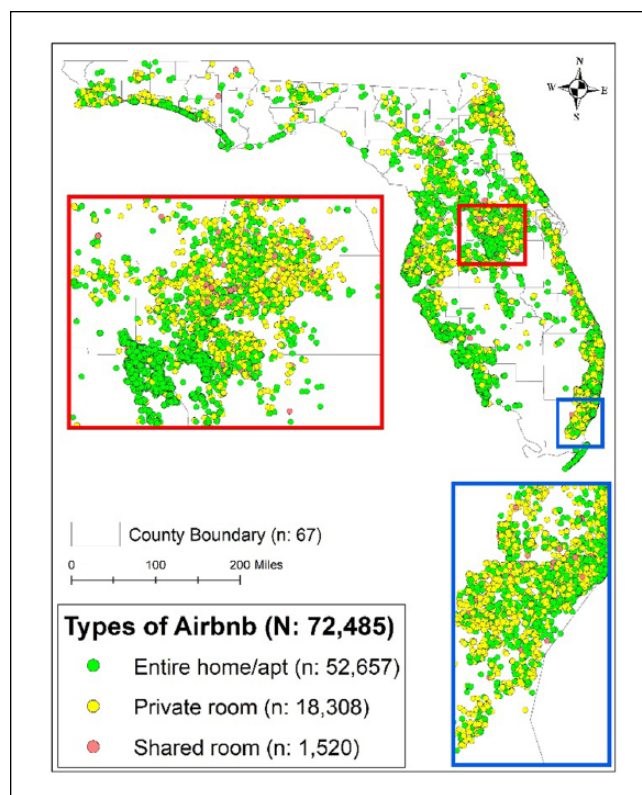

Figure 1. Distribution of Airbnb by listing type.

associations between shared lodging and crime, we chose to examine the tourism industrial scale and ethnic diversity to represent the community features that may incur crimes and set them as control variables. By introducing control variables into the model, inconsistencies can be ameliorated (Clarke 2005). Prior research on crime and tourism/lodging industry identified 3 major factors to control: population density, tourism scale, and ethnic diversity (see Figure 2).

Variables and Data Source

In accordance with the industrial census data, zonal based data were applied. All variables were organized at the county level, 67 cases (counties) were included. Geographic data and base maps of county boundaries were acquired from the Florida GIS data library (http://www.fgdl.org/metadataexplorer/explorer.jsp). The standardized crime index was utilized to represent the level of crimes, where a 100 points stand for average crime level, points above 100 stands for above average and vice versa (Scott and Marshall 2009). Data of the criminal activity counts of the year 2016 in the state of Florida were collected from the Florida Department of Law Enforcement (FDLE). Crime index was calculated based on crime counts, and then justified with the database from the Simply Map database (http://geographicresearch.com/simplymap).
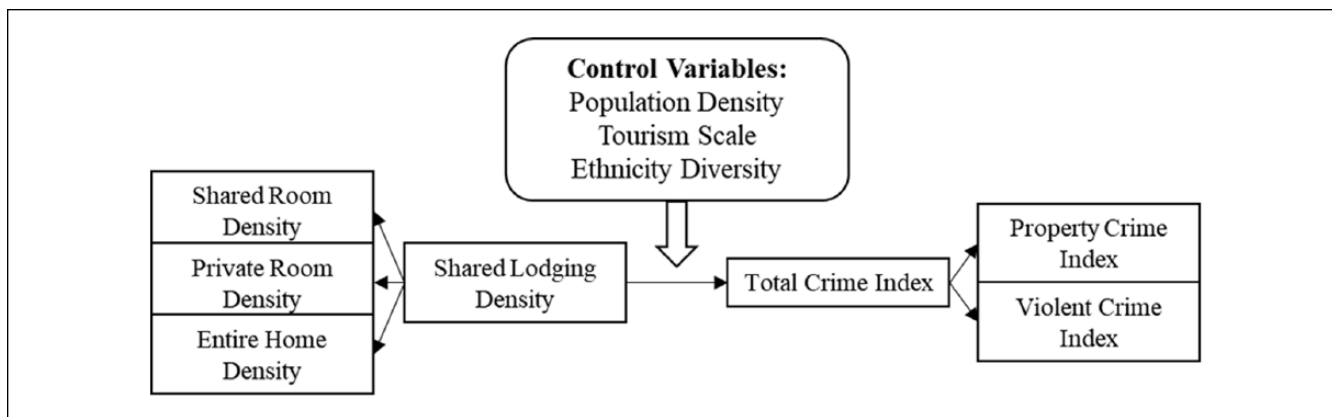
Figure 2. Conceptual model.

The shared lodging density was measured using Airbnb properties. Considering that many shared lodging facilities are posted on multiple platforms, to avoid duplicated sampling, we took the number of Airbnb properties in representation for the shared lodging, because it has an absolute predominant market share of the shared lodging economy. All listed Airbnb properties were collected from the AIRDNA (https://www.airdna.co/) by October 2016. To consider the condition of Airbnb clustering across the county, kernel density estimations (KDE) were calculated according to the geographic location (latitude, longitude) of all Airbnb properties, as well as properties by each listing type. This was operationalized by the average kernel densities of each type of Airbnb properties in each county. As a nonparametric density based on the concept of spatial dependence (Jang, Kim, and von Zedtwitz 2017), kernel density has been used to estimate the level of geographic clusters of urban parks (Moore, Roux, and Brines 2008; Maroko et al. 2009) and supermarkets (Thornton et al. 2012). While applying KDE method, bandwidth will largely impact the results (Silverman 2018). The average size of Florida counties is 805 square miles (2,085 km²), conforming to a mean diameter of 27 miles (45 km). Based on former studies (Desmet and Fafchamps 2006; Li, Goodchild, and Xu 2013), a 13-mile radius was adopted as the measure of bandwidth. To avoid multicollinearity, the log of the KDE of Airbnb sites were used as surrogates.

Population density (POPD) indicates the amount of county population per square mile, obtained from the Office of Economic and Demographic Research.

Tourism development tax (TOUR) represents the tourism/lodging industry scale, refers to the tax collected on any unit rented or leased for 6 months or less. The data were obtained from the *2016 Local Government Financial Information Handbook* published by the Florida Legislature's Office of Economic and Demographic Research.

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Accommodation and food industry payroll (PAYR) represents the tourism/lodging industry scale. The data was collected from the North American Industry Classification System, coded as NAICS_72.

Ethnic fractionalization index (EF) represents the aggregated ethnic diversity. According to previous researches (Bursik 1988; Sampson and Groves 1989), the more diversified the ethnic groups are, the higher crime risk the region might experience. The original ethnicity data were collected from the United States 2010 Census Data. The calculation of the index follows the formula developed by Fearon (2003) as below:

$$F = 1 - \sum_{i=1}^{n} P_i^2$$

where P_i stands for the population shares of ethnic group i. F denotes the probability that two randomly selected persons will be from different ethnic groups, which indicates the level of fractionalization of the local ethnic composition.

Model Building

The study firstly uses OLS regression model to explore the global relationships that shared lodging density might exert on crime, then applies GWR to capture the local varying relationships across 67 counties. Based on previous literature, it is assumed that (1) shared lodging density is positively associated with total crime index; (2) shared lodging density is positively associated with both property and violent crime index; (3) the correlation between shared lodging density and crime index differs by lodging listing type (Shared Room, Private Room, Entire Home); and (4) spatial varying relationships exist in all the associations above.

Table 1. Model Building.

	Dependent Variable	Independent Variable	Control Variable
MODEL1	Total crime	ALL	POPD, TOUR, PAYR, EF
MODEL2	Property crime	ALL	
MODEL3	Violent crime	ALL	
MODEL4	Total crime	SRD, PVD, ETD	
MODEL5	Property crime	SRD, PVD, ETD	
MODEL6	Violent crime	SRD, PVD, ETD	

Note: SRD = Share Room density; PVD = Private Room density; ETD = Entire Home density.

Table 2. OLS and GWR Results of Model 1.

Model 1 Dependent Variable: Total Crime; n = 67; Neighbors = 12

	OLS Coefficients			GWR Coefficients			Rho (Spatial Variability)	Range
Variable	β	SE	p	Minimum	Mean	Maximum		
ln_All	−7.341	2.219	0.002	−0.0003	−0.0002	0.001	<0.05	0.0013
CV1_POPD	−0.015	0.008	0.054	−0.043	0.016	0.029	0.41	0.0013
CV2_TOUR	0.206	0.155	0.187	−0.0013	0.0003	0.0007	<0.05	0.002
CV3_PAYR	−1.16E−05	0	0.348	−0.091	−0.036	−0.011	0.22	0.08
CV4_EF	45.46	24.183	0.065	32.18	67.38	97.65	<0.05	65.47
Adjusted R^2	0.302			0.25	0.34	0.53		0.28
Condition index	423.538			11.15	12.47	19.73		8.58

Note: OLS = ordinary least squares; GWR = geographically weighted regression; SE = standard error.

Table 3. OLS and GWR Results of Model 2.

Model 2 Dependent Variable: Property Crime; n = 67; Neighbors = 12

	OLS Coefficients			GWR Coefficients			Rho (Spatial Variability)	Range
Variable	β	SE	p	Minimum	Mean	Maximum		
ln_All	−3.826	1.627	0.022	−0.00017	−0.00008	0.00009	<0.05	0.00026
CV1_POPD	−0.004	0.006	0.438	−0.019	−0.006	−0.002	0.46	0.017
CV2_TOUR	0.152	0.113	0.186	−0.00091	0.00013	0.00027	<0.05	0.00118
CV3_PAYR	−3.4E−06	0	0.705	−0.014	−0.006	0.025	0.14	0.039
CV4_EF	48.995	17.731	0.008	30.18	59.52	73.17	<0.05	42.99
Adjusted R^2	0.164			0.14	0.24	0.32		0.18
Condition index	381.9524			11.22	11.95	15.83		4.61

Note: OLS = ordinary least squares; GWR = geographically weighted regression; SE = standard error.

According to the research question and assumptions 1, 2, and 3, six OLS models (see Table 1) were developed to explore the overall correlations between all types of Airbnb and each type of crimes. To answer question and assumption 4, relationships in each county will be assessed from the local coefficients from GWR. Maps are also generated to aid with the local pattern analysis.

Results

Relationships Vary by Crime Type

Three OLS regressions were performed to separately assess the impact of Airbnb density on total/property/violent crime.

Results of the model are presented in Tables 2–4. All VIF values and were below the cut-off point of ten (Cornell 1987), and Condition Index was below 30, indicating that the models did not have collinearity issues and the results are reliable. All three models are statistically significant from ANOVA. The value of the adjusted R^2 (0.302, 0.164, 0.325) indicates a moderate model fit.

As Table 2 shows, the independent variable ln ALL (density of all Airbnb) was significant at the 0.05 level in three models with negative β values, which means Airbnb density has a negative global correlation with crime index.

For the local relationship, the Rho (spatial variability value) in Table 2 was insignificant, which indicates equitable

Table 4. OLS and GWR Results of Model 3.

Model 3 Dependent Variable: Violent Crime; N = 67; Neighbors = 12

Variable	OLS Coefficients			GWR Coefficients			Rho (Spatial Variability)	Range
	β	SE	p	Minimum	Mean	Maximum		
In_All	−8.064	2.133	0	−0.00033	−0.00017	0.00026	<0.05	0.00059
CV1_POPD	−0.014	0.007	0.066	−0.0251	−0.0142	−0.0084	0.38	0.021
CV2_TOUR	0.19	0.149	0.207	−0.001	0.0002	0.0007	<0.05	0.0016
CV3_PAYR	−8.24E−06	0	0.485	−0.103	−0.032	−0.005	0.21	0.098
CV4_EF	54.278	23.243	0.023	54.8	80.44	107.31	<0.05	0.0167
Adjusted R^2	0.325			0.26	0.34	0.55		0.29
Condition index	418.2213			11.15	12.47	19.73		8.58

Note: OLS = ordinary least squares; GWR = geographically weighted regression; SE = standard error.
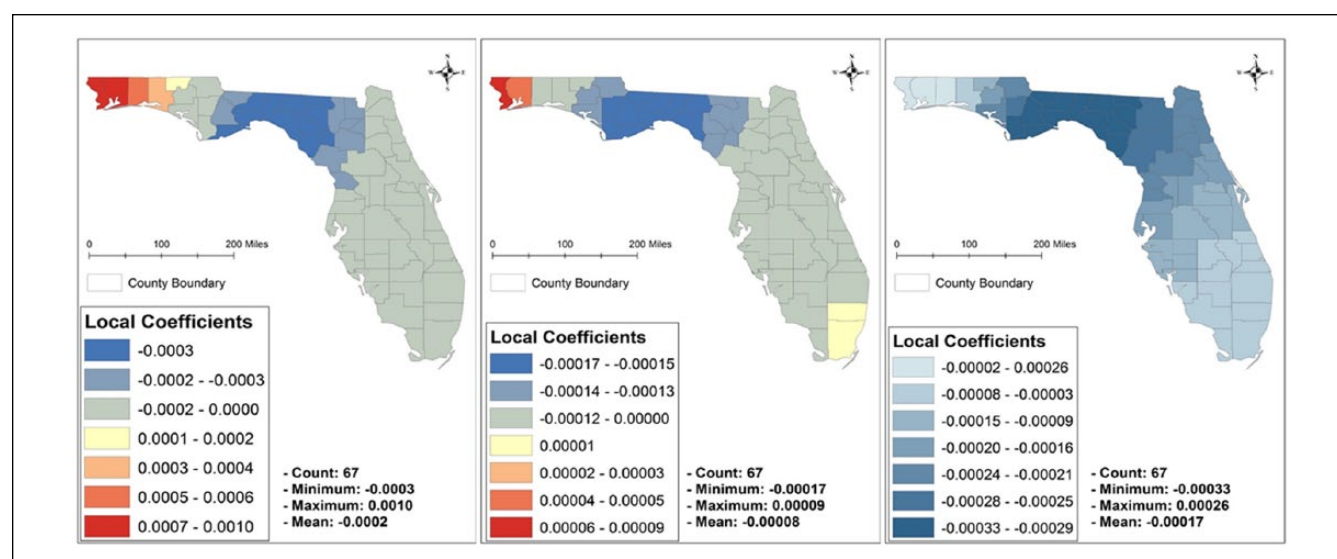
Figure 3. Local coefficients for models 1–3.
Note: Independent variable: All Airbnb density; dependent variables from left to right: total crime, property crime, violent crime.

negative correlations between all Airbnb and crimes across the 67 counties. However, the Rho in Table 3 and Table 4 were significant, which means if we divide crime into property/violent types, the negative correlations between Airbnb and each type of crime vary by county. Specifically, the GWR local coefficients show how strong the relationship is in each local estimation within a certain geographic bandwidth. The minimum and maximum GWR coefficients in models 1–3 show that there is a diversified association between Airbnb and crime in each count from negative to positive.

From Figure 3, we could see that the local patterns of association between Airbnb–total crime and Airbnb–property crime were similar. Property crime was found to have the maximum correlation between property crime and Airbnb in Northwest Florida, while mid–North Florida was found to have the minimum correlation. For violent crime, the

majority of the state exhibited negative correlations, while the strongest negative correlation remained confined to the mid-North. Interestingly, given the overall negative coefficients in violent crime, we still found a slight positive correlation in the northwest, where Airbnb was also positively correlated with property crime. This shows that Airbnb in northwest Florida is associated with all types of crimes. But still, in most of the southern counties, Airbnb has a weak association with the total amount of crime.

Relationships Vary by Listing Type

As Tables 4–6 show, when divided by listing type, the Shared Room displays a significant positive impact (β = 17.163, 13.012, 21.725) on all types of crimes. Conversely, Private Room displayed a negative impact (β = −0.046) on all crimes. The Entire Room only showed significant negative

Table 5. OLS and GWR results of Model 4.

Dependent Variable: Total Crime; N = 67; Neighbors = 12

Variable	OLS Coefficients			GWR Coefficients			Rho (Spatial Variability)	Range
	β	SE	p	Minimum	Mean	Maximum		
SRD	17.163	6.39	0.009	−1.35	0.31	1.09	<0.05	2.44
PVD	−30.344	6.935	0	−0.123	−0.046	−0.02	<0.05	0.103
ETH	−1.679	2.599	0.521	−0.0009	0.0001	0.0005	0.12	0.0014
CV1_POPD	−0.006	0.007	0.408	−0.106	0.001	0.008	0.2	0.098
CV2_TOUR	0.165	0.139	0.239	−0.0016	0.0002	0.0007	<0.05	0.0023
CV3_PAYR	−9.6E−06	0	0.406	−0.08	−0.036	0.027	0.35	0.107
CV4_EF	57.061	21.479	0.01	21.023	62.758	97.709	<0.05	76.686
Adjusted R^2	0.462			0.42	0.45	0.51		0.09
Condition index				3.53	5.49	21.87		18.34

Note: OLS = ordinary least squares; GWR = geographically weighted regression; SE = standard error.

Table 6. OLS and GWR Results of Model 5.

Model 5 Dependent Variable: Property Crime; n = 67; Neighbors = 12

Variable	OLS coefficients			GWR Coefficients			Rho (Spatial Variability)	Range
	β	SE	p	Minimum	Mean	Maximum		
SRD	13.012	4.875	0.01	0.056	0.236	1.108	<0.05	1.052
PVT	−19.875	5.29	0	−0.101	−0.022	−0.006	<0.05	0.095
ETH	−1.175	1.983	0.556	−0.0007	−0.0001	0.0002	<0.05	0.0009
CV1_POPD	0.001	0.005	0.823	−0.022	0.006	0.01	0.68	0.021
CV2_TOUR	0.138	0.106	0.198	−0.001	0.0001	0.0006	<0.05	0.0012
CV3_PAYR	−3.94E−06	0	0.654	−0.017	−0.006	0.029	0.42	0.046
CV4_EF	57.095	16.386	0.001	21.704	57.974	70.764	<0.05	49.06
Adjusted R^2	0.302			0.27	0.32	0.36		0.09
Condition index	371.6217			5.97	13.6	23.85		17.88

Note: OLS = ordinary least squares; GWR = geographically weighted regression; SE = standard error.

correlations (β = −0.0001) with Property Crime. The adjusted R^2 for models 4, 5, and 6 are 0.45, 0.32, and 0.51, which indicated a decent goodness of model fit.

However, when we look into local GWR coefficients, the local patterns are diverse as Figure 4-6 shows. First, the coefficients between Shared Room and Total Crime varied from positive to negative across the state, which means Shared Room is only conditionally associated with crimes. Second, counties in the northwest exhibited uniqueness: Shared Room showed the strongest positive associations with both property and violent crimes, while reversely, Private Room showed the strongest negative associations. In the northwest, Entire Home displayed the same association pattern as Private Room with property crime, while in most eastern coastal counties, Entire Home has significantly positive correlations with property crimes.

To answer questions 1 and 2, OLS regression was conducted and it was found that the global relationship between

shared lodging and crimes are negative. This conclusion is consistent when we divided crimes into property crime and violent crime. Guided by question 3, we divided Airbnb into different room types. Shared Room exhibited significant positive correlations with all types of crimes, while Private Room exhibited significant negative correlations with them. Entire Home was only found to have significant negative correlations with property crime.

For question 4, the relationships between Airbnb density and crime counts did vary across the study area, as the Rho values (<0.05) showed significant spatial variations in the correlations in all the models at a 0.05 level. Also, as the minimum/maximum GWR coefficients show from Table 2 to Table 7, the local correlations between different types of Airbnb and crime types vary from negative to positive, indicating that the relationship is not stationary at the county level. When local coefficients were examined, various spatial patterns were observed in each model. Generally, the northwest counties
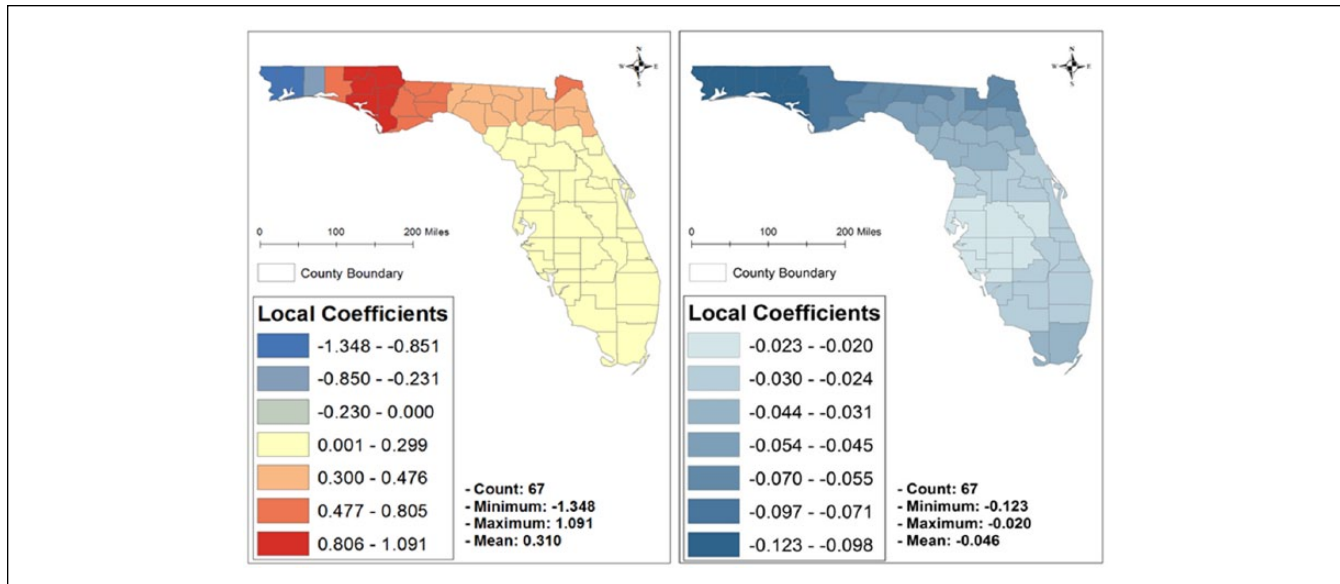
Figure 4. Local coefficients for model 4.
Note: Independent variables from left to right: Share Room, Private Room; dependent variable: Total crime.
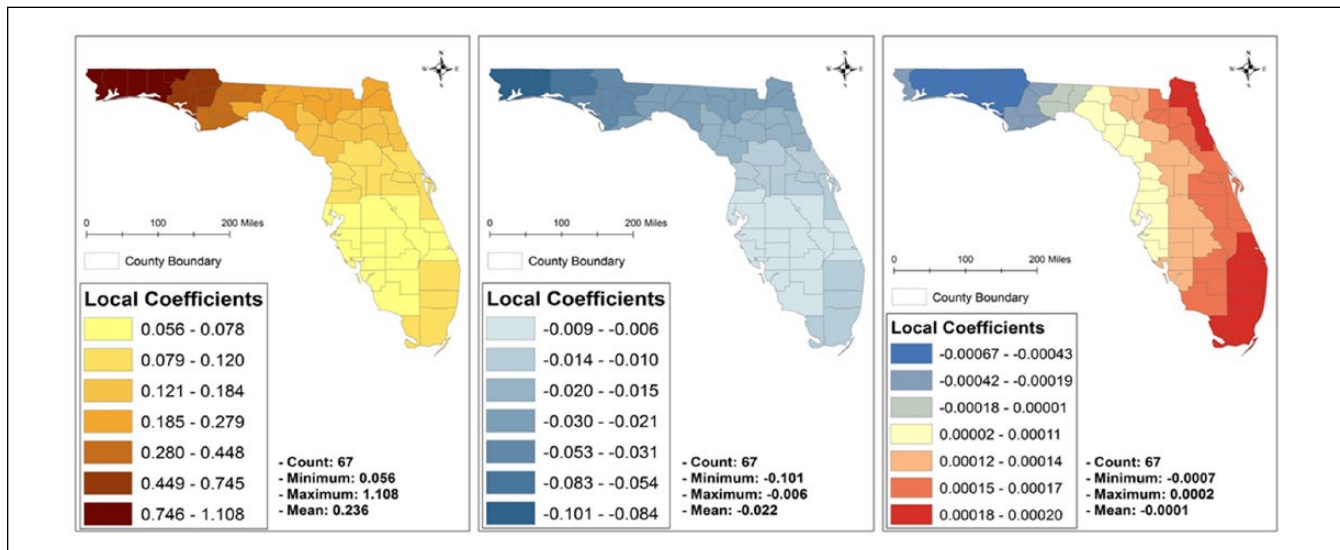

Figure 5. Local coefficients for model 5.
Note: Independent variables from left to right: Share Room, Private Room, Entire Home; dependent variable: Property crime.

have the strongest positive relationships between Airbnb and total crimes, and the northern counties displayed the strongest negative correlations. The southernmost parts of Florida showed moderate coefficients. When evaluating property crime, Shared Room had positive correlations and Private Room negative, but their strength and distribution patterns were similar. For Entire Home, both negative and positive correlations existed, while negative in the northwest and positive in the eastern coastal counties. When evaluating violent crimes, shared and Private Room presented significant

coefficients. They also showed similar patterns of direction and strength as they were predicting property crime.

Conclusion and Discussions

In order to answer the question "Is shared lodging safe?" this study applied traditional OLS regression and geographically weighted regression to explore the global and local relationships between shared lodging and crime. As a result, we found high crime rates usually occur in shared lodging properties
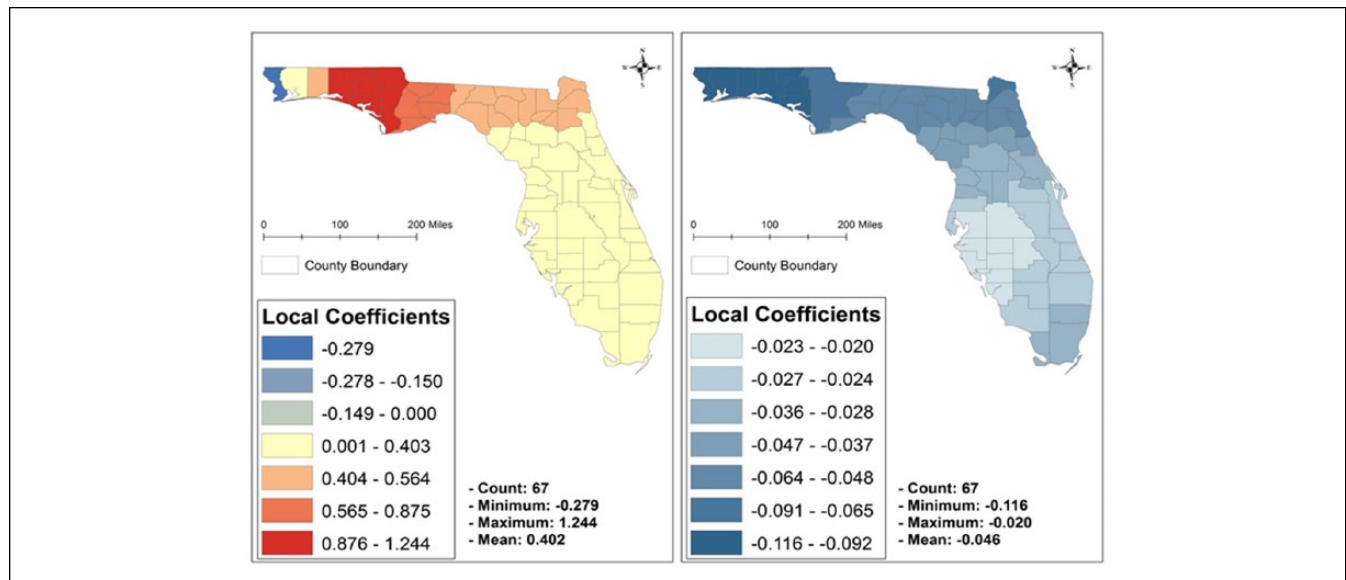
Figure 6. Local coefficients for model 6.
Note: Independent variables from left to right: Share Room, Private Room; dependent variable: Violent crime.

Table 7. OLS and GWR Results of Model 6.

Model 6 Dependent Variable: Violent Crime; n = 67; Neighbors = 12

Variable	OLS Coefficients			GWR Coefficients			Rho (Spatial Variability)	Range
	β	SE	p	Minimum	Mean	Maximum		
SRD	21.725	5.905	0.001	−0.279	0.402	1.244	<0.05	1.523
PVT	−33.26	6.408	0	−0.116	−0.046	−0.02	<0.05	0.096
ETH	−3.461	2.402	0.155	−0.0015	−0.0002	0.0004	0.17	0.0019
CV1_POPD	−0.005	0.007	0.491	−0.032	0.015	0.083	0.62	0.025
CV2_TOUR	0.167	0.128	0.198	−0.0011	0.0002	0.0006	0.23	0.0017
CV3_PAYR	−9.27E−06	0	0.386	−0.111	−0.036	−0.004	0.16	0.107
CV4_EF	67.825	19.849	0.001	49.118	78.02	104.717	< 0.05	55.599
Adjusted R^2	0.519			0.45	0.51	0.57		0.1
Condition index	397.3145			13.45	20.23	27.74		14.29

Note: OLS = ordinary least squares; GWR = geographically weighted regression; SE = standard error.

that possess: Shared Room listing type, highly tourism-dependent economy, and diverse ethnicity.

To explore the general relationship between shared lodging density and crimes, OLS regression model was applied, which assumes that the relationships between Airbnb and crime are consistent over all the census tracts. As a response to questions 1 and 2, the findings suggest that there is a globally negative correlation between shared lodging density and any type of crime. However, as an answer to question 3, when the shared lodging economy was divided by listing type, Shared Room showed a greater likelihood of crime, while Private Room tended to indicate less crime.

Furthermore, when the relationships were evaluated by both listing type and crime type, Shared Room consistently exhibited greater chance in associating with property and violent crimes, whereas Private Room negatively related to both, and Entire Home only negatively related to property crime. This suggested that crime-lodging associations vary by the spatial structure of the lodging facility, which has not been discussed by previous studies yet.

The findings also validate the crime pattern theory (Brantingham 2010), which claims that places with more human interaction are more likely to generate crime. Also, the conclusion remains consistent with both property and violent crime. This seems unique when compared with hotel crime, which always appears to be property-related. This might be explained by the shared lodging's dual feature of being both commercial and community-based. Thus, we suggest that

equal efforts are needed to prevent both property and violent crimes in home sharing properties.

Although there was a lack of significance between Entire Home and violent crime, more research should be conducted that examines the relationship between the size of homes, whether the home is in a gated community, whether the home has a security system or service, and frequency of rental time. One would hypothesize that those that are rented out more frequently in less safe neighborhoods would be more likely to exhibit higher levels of criminal activities, because of weaker social network and surveillance (Bellair 1997).

To answer question 4, GWR was then applied to calibrate local regression results (Fotheringham, Brunsdon, and Charlton 2003). The variability in the model parameters suggested that the relationship between shared lodging density and crime index are not stationary. Although the overall correlation was negative, the conclusion of "more shared lodging, less crime" may not be drawn. Essential factors, including listing type, which indicates the level of shared public space (Brantingham and Brantingham 1993), crime type (Ho, Zhao, and Brown 2009), social (ethnicity diversity), economic (tourism development), and geographic feature (county) were all considered in the relationship.

In this study, the obtained crime data were all-inclusive, meaning the host or the outsiders are counted as criminals or victims. As previously stated, it is more common that outsiders commit crimes against shared lodging guests. However, our data do not reveal this. All we know is the relationship. However, it is recommended that shared lodging platforms such as Airbnb offer hosts protection insurance to cover damage to their lodging properties should they occur. On the flip side, access to background checks of renters or guests should be part of the check-in and rental process. From a traveling safety perspective, the host and guest should both take extra precautions when renting properties in touristy areas.

Past studies on lodging and crime were impeded by limitations of the type of data and methodologies. A large number of researchers have focused on hotel crimes, ignoring shared lodging that might also be associated with crime risks. Studies measuring lodging crime were mostly based on conventional statistical methods, thus failing to uncover local variations. This would generalize the conclusions and show that places within the same study area might differ from each other with regard to the nature and extent of external factors (Gilbert and Chakraborty 2011). This study specifically explored the spatial relationship between shared lodging and crime. The findings revealed a comprehensive local relationship pattern, where shared lodging in counties located in the northwest region of Florida had a solid positive correlation with both property crime and violent crime; while northern counties proved to be safer places. This may make sense because these locations in the northern counties are more rural and less populated. Further as Bellair (1997) suggested, affluent communities with greater social and economic resources are more likely to build and maintain stronger social networks that can strengthen the surveillance toward crimes.

In addition, when examining by room listing type, the northwest area was only dangerous for Shared Room. However, Entire Home along the eastern coastal counties of Florida need to pay more attention to preventing property crimes. This finding suggests that different levels of crime risk could exist within a state. Based on the spatial variation, pertinent precautionary measures could be taken in different regions. As the trend for shared lodging continues to develop and increase, more investigations in different destinations will be necessary, so as to better understand the laws of shared lodging crimes and safety.

Among the results, two of the control variables Ethnic fractionalization index (EF) and Tourism Development Tax (TOUR) consistently display significant β values when correlated with the dependent variables. It is not surprising to witness these two influential indicators, that have been proved by previous literature (Beasley and Antunes 1974), actively impacting the shared lodging location with crime. In model 1, Figure 3, contrary patterns toward the main effects in northern Florida were presented, this indicated that counties with more tourism tax and ethnic diversity had less association with Airbnb crime. However, when the indicators were separated into type of property, the situation was reversed. The patterns of association between property crime and ethnic diversity and tourism tax were similar to the patterns of property crime and all types of shared lodging. This effect, to some extent, lends reference to the explanation that relationships between Airbnb and crime vary by area.

Implications

This study shows that shared lodging can be associated with crime in a variety of ways. To better protect personnel and property, shared lodging properties should set up a specific security system. Hobica (2016) suggests that there is a lack of systematic security precautions and safety legislations undertaken by the shared lodging sector. In recent years, the leading company of shared lodging, Airbnb has taken endeavors to adjust safety-related regulations. In addition, various governments have grappled with how to enforce greater regulations for the sharing economy and Airbnb specifically (Gibbs 2016). Unfortunately, practices tend to fall behind policies because of a lack of thorough understanding of the importance of the issues.

According to the findings from this study, shared lodging properties experience the same type of crime risks as hotels, but the safety requirements are much different. The current safety practices engaged in by most shared lodging properties tend to only protect against unintentional risks (e.g., mandatory fire extinguisher) or compensation for loss from the third parties (e.g., Airbnb host protection insurance). These policies should be market-driven and demanded as well as legally enforced.

The spatial effects detected in this study indicated that different levels of policing may be required in different census tracts. Places with higher level of associations between location and crime should burden reasonably higher costs of public security service. Although the results of this study are organized at the county level, there is a reasonable assumption that associations between shared lodging sector and crime can vary by even smaller tracts of geography (i.e., streets, municipalities, zones). If there is an increase in the Shared Room type of rental, it is important to increase safety and security programs to protect the visitor. In this case, the discussion of "discriminated lodging security cost" should be applicable in smaller administrative regions as well.

The study also explained that all shared lodging properties experience unequal levels of crime risk. As McPheters and Stronge (1974) suggested, it is the local residents that will bear the cost of additional crimes resulting from increased tourism activity. To build a safer tourism community, the destination management organization (DMO) should be more aware of the impact of the shared lodging economy, particularly in relation to criminal activities, and increase the availability of training for shared accommodation operators.

From this study, the DMO had the opportunity to gain greater insight into varying levels of crime among different geographical areas within the destination. This can help guide the destination in situating and creating targeted tourism security programs throughout the destination, such as tourism police stations. In addition, programs could be created and managed by the DMO for renters, and executed on a regular basis for more highly engaged shared lodging entrepreneurs. The information garnered from this study has also provided the industry with empirical support to demonstrate the need for greater caution in running home-sharing businesses and protect the safety of their visitors.

Limitations and Future Studies

This is an exploratory study guided by advanced geographic methods with a background of destination management. As a promising research in the interdisciplinary area, this study may have several limitations to consider. First, to test a solid causal relationship between shared lodging and crimes, chronological data should be gathered. Second, in this study tourism development tax and ethnic fractionalization index are the only two factors that can explain the spatial heterogeneity, there are more factors that may be associated with the rate of crime as well as the density of shared lodging sector. To obtain a pure relationship between shared lodging and crime, additional relevant indicators should be introduced as control variables into the model. A linear combination of tourism tax percentage, rent rate, disparity in tourism sales, and percentage of hotel rooms to residential rooms can be introduced in future studies. This will also help to interpret the strength of spatially varying relationships.

Third, this study has demonstrated the relationships between shared lodging and crime, and within this relationship, there could be mediation/moderation effect from related factors. Inferring from previous research, tourism intensity level may have a mediation effect on crime's impact on Airbnb lodging. Finally, although this study has discussed some inherent differences between shared lodging and hotel businesses, there is still a need to compare some criminal indicators between shared and regular lodging facilities. The industry cannot definitively conclude that the hotel lodging sector is safer than the shared lodging sector based on this study alone, and further research is necessary to determine this. Based on this, the original conceptual model could be optimized.

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