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Associations between socioeconomic status and hunting license sales among census tracts in Cook County, Illinois

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ABSTRACT

Hunting license sales have declined in many U.S. states over recent decades, and efforts are underway to recruit new hunters. Research suggests socioeconomic status influences hunting participation and license sales. A limited number of studies, however, actually connect socioeconomic status and license sales on an aggregated community level or spatial context. This article examined relationships between socioeconomic factors and hunting license sales in Cook County, Illinois. A principal component analysis is used to create indices aggregating census tract socioeconomic indicators. Spatial and statistical analyses using both linear regression and multinomial logistic regression explored relationships between indices and percentage of license sales for each census tract. Spatial correlation and quantitative relationships were found between the indices and hunting license sales. Models developed through this study may provide current state hunter recruitment programs with an understanding of the interaction of socioeconomic factors and hunting license sales.

KEYWORDS

Hunting license sales; hunter recruitment; socioeconomic indices; regression; spatial analysis

Introduction

Hunting is a traditional recreational activity in the USA. An estimated 11.5 million Americans aged 16-years old and older hunted during 2016 (U.S. Fish and Wildlife Service, 2016). This figure indicates a decline of 2.2 million licensed hunters from 2011 (U.S. Fish and Wildlife Service, 2011). Licensing is an effective way to manage and regulate wildlife populations while generating funding to support wildlife management and conservation (Floyd & Lee, 2002) and contribute to rural economies. During 2016, hunting was estimated to generate 25.6 billion dollars (USD) in economic activity (U.S. Department of the Interior, U.S. Fish and Wildlife Service, and U.S. department of Commerce, U.S. Census Bureau, 2016). In Illinois, for example, waterfowl hunting alone contributed $264 million USD in direct and indirect expenditures during 2012, mostly through rural economies (Williams, Miller, & Campbell, 2013). Maintaining or increasing hunting license sales will enhance state agency efforts to manage wildlife populations, habitat, and support rural economies. State wildlife agencies could benefit by understanding factors influencing hunting license sales, and therefore maintain necessary funding for wildlife conservation.

Numerous studies have focused on the significance of social (Ryan & Shaw, 2011), demographic (Frawley, 2004; Schultz, Millspaugh, Zekor, & Washburn, 2003), attitudinal (Daigle, Hrubes, & Ajzen, 2002), and motivations/satisfaction (Brunke & Hunt, 2008; Mehmood, Zhang,

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& Armstrong, 2003) dimensions to hunter participation. The objective of this article was to contribute to this past research by offering spatial models that determine the probability of hunting license sales through the use of socioeconomic data.

Previous studies have suggested that socioeconomic status affects participation in recreational activities, as it influences social capital, availability and accessibility of recreation resources, and other constraints (Estabrooks, Lee, & Gyurcsik, 2003; Lee, Cubbin, & Winkleby, 2007; Lindström, Hanson, & Östergren, 2001; Moore, Diez Roux, Evenson, McGinn, & Brines, 2008; Powell, Slater, Chaloupka, & Harper, 2006; Wilson, Kirtland, Ainsworth, & Addy, 2004). As a recreation activity, it is reasonable to assume that participation in hunting will also be affected by socioeconomic status. For example, initiation into hunting is profoundly influenced by culture and family (usually father or other leading male figures) (Duda, Bissell, & Young, 1996). Age, gender, education, and urban socialization all determine trends in hunting participation (Bissell, Duda, & Young, 1998; Duda et al., 1996). Age, gender and race are considered important predictors for hunting participation (Tsachalidis & Hadjisterkotis, 2008). Ethnic background (e.g., Hispanic, African-American) may limit the purchase of licenses in some regions of the USA, and these ethic and racial factors are usually correlated with other socioeconomic factors (e.g., gender, education) (Floyd & Lee, 2002). The public space and travel distances needed for hunting may constrain some individuals from participation (Mehmood et al., 2003; Tsachalidis & Hadjisterkotis, 2008).

Hunters must undergo training and certification before buying a license to legally participate. In addition to the license, hunters are often required to purchase tags or permits to hunt specific species (e.g., deer, turkey, waterfowl). Access to public and private lands open to hunting requires a private vehicle, travel time, and incurs additional costs (Miller & Vaske, 2003). Therefore, hunting is sensitive to market conditions and economic environments.

Few studies have examined connections between socioeconomic status and license sales; of those, most were conducted at the individual scale (e.g., Floyd & Lee, 2002; Heberlein & Ericsson, 2005). Recent studies examined relationships between license sales and the socioeconomic context in which these relationships are embedded (e.g., Karns, Bruskotter, & Gates, 2015; Larson, Stedman, Decker, Siemer, & Baumer, 2014). A recent study by Robison and Ridenour (2012) examined the influence of indoor electronic entertainment on hunting participation declines. Karns et al. (2015) explored the effect of electronic entertainment and other social and demographic factors on hunting participation and found correlations for county-level factors. Previous studies have focused primarily on state-level factors and few studies have considered spatial or geographically based models assessing recreation demand (see, for example, Lee & Schuett, 2014). Studies centered on community-level influences on hunting participation are needed to: (a) understand the impact of the socioeconomic environment on license sales; (b) identify areas with high potential for license sales; (c) lay a foundation for increasing license sales.

The objectives of this article were two-fold: (a) examine relationships between socioeconomic factors and hunting license sales, and (b) compare outcomes of linear and multinomial logistic regression models to denote optimal results. This article was centered on census tracts, which were proxies of communities. For this purpose, the socioeconomic context was measured by indexing aggregate census tract socioeconomic indicators (race, education, age, gender, the proportion of single mothers, income, unemployment, and poverty rate) using Principle Component Analysis (PCA). License sales were measured by the percent of license holders (i.e., number of license holders divided by population in different census tracts). There were two primary analyses: (a) local indicators of spatial association and (b) establishment of regression model. This article used socioeconomic factors and hunting license sales data from Cook County, Illinois, USA. Cook County lies in the northeastern part of Illinois, with its county seat in the city of Chicago. This highly developed region was selected for two reasons. First, the Cook County accounts for over 40% of the state's population; yet contains only 6% of hunting license holders in Illinois. Second, the county has a heterogeneous socioeconomic profile that allows for comparing hunting activities and license sales across varied socioeconomic contexts within the same county.

Methods

Establishing Socioeconomic Index

Socioeconomic status involves multidimensional variables. Based on prior empirical research (Floyd & Lee, 2002; Lalloué et al., 2013; Meijer, Engholm, Grittner, & Bloomfield, 2013; Osborn & Morris, 1979), 14 variables were considered to depict the socioeconomic characteristics of census tracts (U.S. Census Bureau, American Community Survey, 2016a and 2016b, pg. 48). Specifically, median household income and poverty rate were used to depict economic characteristics; unemployment rate was used to depict occupation; percentage of high school graduate or higher and percentage of bachelor's degree or higher were used to depict education; percentage of Hispanic or African Americans was used to depict ethnic groups; median age, old-dependency ratio, and age-dependency ratio[1] were used to depict age structure (U.S. Census Bureau, 2016a); percentage of single mothers, number of cars—1, 2, ≥3 per household were used to depict household characteristics. All socioeconomic data were collected and reorganized from the U.S. Census Bureau 2010 ACS 5-year estimates on the census tract level. Considering its flexibility in the choice of scale, PCA was selected to aggregate those variables and establish the socioeconomic index at the census tract level. Quartimax rotation was selected as it makes the components more interpretable over other options for rotation. Three orthogonal components were extracted to represent different dimensions of the socioeconomic context.

Mapping License Sales

Hunting license sales data were collected from the Illinois Department of Natural Resources and included the names and addresses of every license holder in Cook County. The ArcGIS 10 (ESRI, 2011) Geocoding was used to project all the records into maps (shapefiles) whereby each license holder appeared as a point at their address location. To measure residence of license holders on the aggregated level, ArcGIS 10 (ESRI, 2011) spatial join was applied to the shapefiles of license purchasers and the boundary of census tracts. The count of license holders was computed in each census tract, and the percentage of license sales was determined by dividing the number of license holders by population size within each census tract. The unit for the percentage of hunting license sales was the number of license per 1,000 people. Percentages were mapped with ArcGIS 10 (ESRI, 2011), and the classification method was the quantile. Quantile classification means each group has the same number of observations, which avoids empty classes or classes with too few or too many observations. The disadvantage of a quantile is that widely different values may fall into the same class (Ayalew, Yamagishi, & Ugawa, 2004).

To better measure spatial correlations between license data and the indices, Local Indicators of Spatial Association (LISA) method was used. Using the LISA method, cluster maps were made to examine how the percentage of license sales in a given census tract correlates with socioeconomic indices of surrounding census tracts (Anselin, 1995).

Regression Models

Two models, linear regression and multinomial logistic regression, were selected to measure the quantitative relationships between the socioeconomic indices and license sales. The dependent variable for linear regression was the percentage of hunting license sales and predictors were the three orthogonal components from PCA. To further explore the relationships detected in linear regression, a multinomial logistic regression model was employed to predict how changes in each socioeconomic index influenced the probability of the license sales. Percentage of hunting license sales was classified into three groups: low, medium and high with the quantile method (i.e., each group has the same number of census tracts). The dependent variable was the classified percentage of license sales, the reference is the low license percentage group, and the predictors were the three components from PCA.

Moran's I values of the residuals were calculated for the two models to measure the spatial autocorrelation between the residuals. Moran's I value is the slope of the Moran scatter plot. The x-axis of the Moran scatter plot represents the residuals of the regression model and the y-axis is the spatially lagged transformation of residuals (i.e., a variable that essentially averages the neighboring residuals of a location) (Moran, 1950). A large Moran's I value means that the residual is highly correlated with its neighbors and some spatial factors are missing in the model. The two models were then compared based on the accuracy of their estimations and autocorrelation of the model residuals.

Results

Socioeconomic Indices

The PCA provided three principal components (indices) and accounted for 38%, 23%, and 14% of the variance, respectively, and 75. of the total variance (Table 1). All variables in the categories for economic (median household income and poverty rate), occupation (unemployment rate), education (percentage of high school graduate or higher and percentage of bachelor's degree or higher), and ethnic groups (percentage of Hispanic/Latino or African-American) as well as one variable in the dimension of household (percentage of single mothers) loaded highest (>.6) on the first component. The first component covered most of the dimensions and pictured the overall socioeconomic status of each census tract. Given the variables comprising this component, it was labeled Socioeconomic Status (SES). The remaining four variables (households with none, one, two, or three or more cars) in the category household had higher factor loadings (>.6) on the second component, which measured the number of cars in each household and was labeled as "Household Mobility (HM)." The third

Table 1. Factor loadings of socioeconomic variables.

	Race/ Economic	Mobility	Age	Variance	Alpha
Percent Hispanic and African-American	.887			378%	.918
Percent bachelor's degree or higher	−.875				
Percent Female with child	.825				
Unemployment Rate	.773				
Median Income	−.766				
Percent high school graduate or higher	−.750				
Poverty Rate	.720				
Household with 3 or more cars		−.878		23%	.845
Household with 2 cars		−.855			
Household with no car		.749			
Household with 1 car		.664			
Old Dependency Ratio			.949	14%	.742
Median Age			.757		
Age Dependency Ratio			.611		

component, with all variables in the age structure (median age, old dependency ratio, and age dependency ratio), were labeled as Age Index (AI). To verify the reliability of the indices, the standardized Cronbach's alpha reliability coefficient (Vaske, 2008) was calculated for each component and results were .918, .845 and .742, respectively (Table 1).

Scores for each index were then mapped (Figure 1). Score values for SES and HM were negatively correlated with actual socioeconomic status and household mobility; therefore, the inverse of the two score values was taken to allow for easier interpretation (i.e., the greater the value, the greater Socioeconomic Status or Household Mobility for a specific census tract). All three components were mapped with ArcGIS 10 (ESRI, 2011). The classification method was also the quantile, with the same number of census tracts in each group.

Spatial Comparison of Socioeconomic Status and License Sales

The spatial patterns of the license sales are presented in Figure 2. Comparisons of Figures 1 and 2 showed spatial patterns (spatial distribution of Low, Medium and High

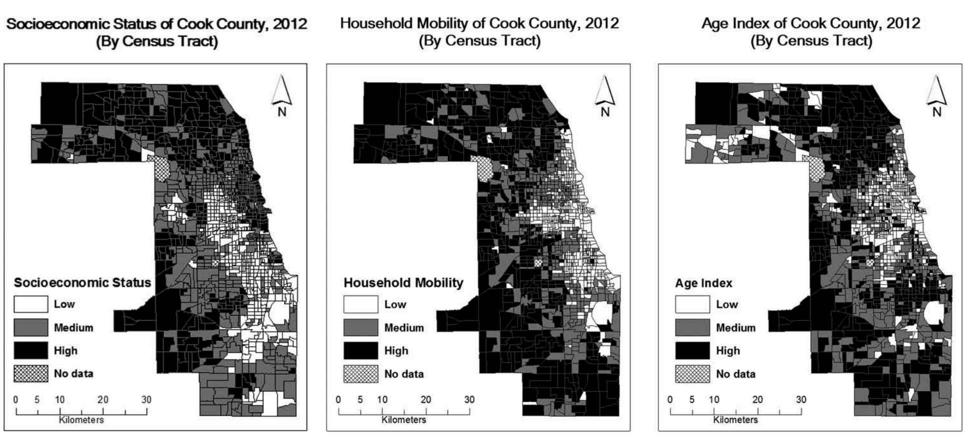

Figure 1. Spatial distribution of the socioeconomic indices.

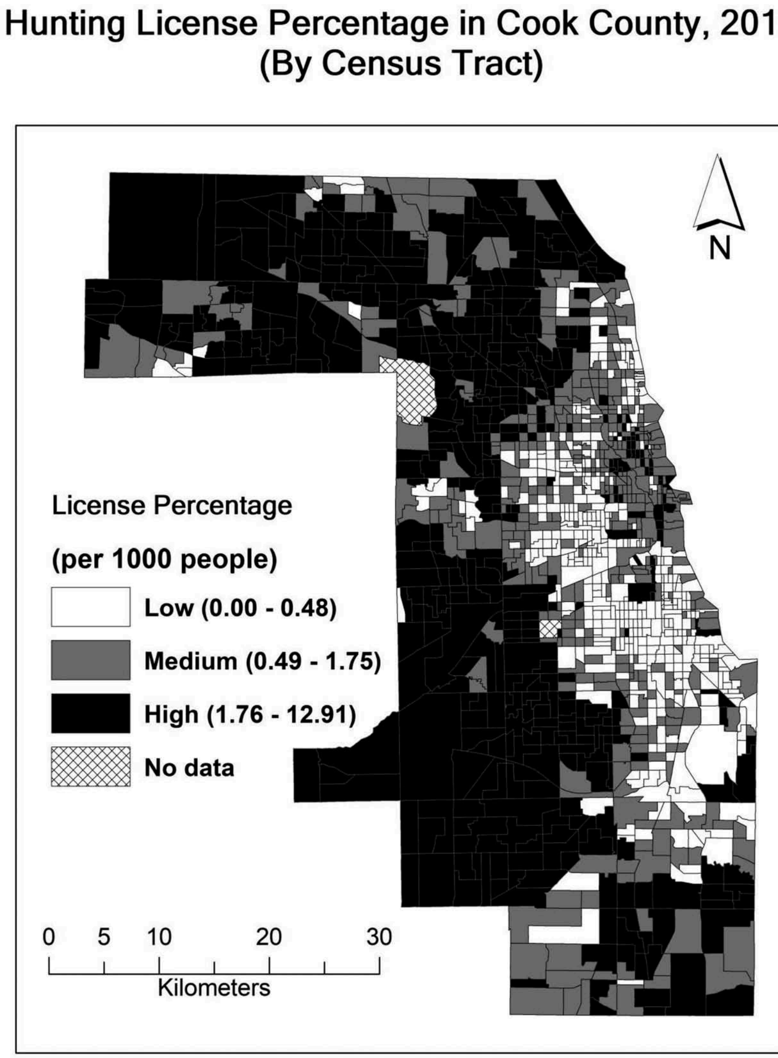

Figure 2. Spatial distribution of the hunting license sales (low: 0.00–0.48, medium 0.49–1.75, high 1.76–12.91).

group) of hunting license sales were quite similar to the patterns of the three indices. Specifically, a greater proportion of census tracts in the northern and western portions of the county fell into both the High indices for Socioeconomic Status, Household Mobility and Age Index and the High hunting license sales group, whereas many in the central portion fell into both the Low indices group and the Low hunting license sales group, although patterns in the east and south part were complex and relatively different from the other regions of the county.

Results of the LISA method for hunting licenses (Figure 3) showed that the higher percentage of hunting license sales was mostly clustered with high Socioeconomic Status, high Household Mobility and high Age Index, and low percentage of hunting license sales clustered with low indices values. In general, the indices and percentage of hunting license sales were positively correlated with each other spatially. The

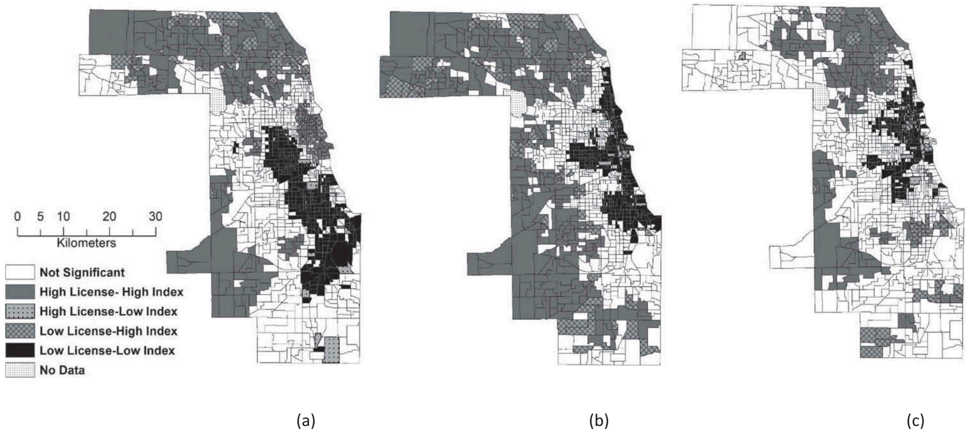

Figure 3. Spatial correlation between the density of hunting license sales and socioeconomic indices (a) correlation between density and socioeconomic status; (b) correlation between density and household mobility; (c) correlation between density and age index.

High-High (high sale/high index values) pattern fell on the northern and south-western part of Cook County, whereas the Low-Low (low sales/low index values) pattern was located primarily in the central part of the county.

Quantitative Relationships between Socioeconomic Status and License Sales

Based on the linear regression estimate of the parameters (Table 2), the percentage of hunting license sales was positively influenced by all three indices. Using the Low category as the reference, estimates of the multinomial logistic regression model parameters showed the relative importance of SES (Table 3). Increases across all three indices resulted in an increased probability of higher license percentage. Generally, the findings from both models were similar to each other and consistent with the pattern of the cluster maps from LISA. Comparisons of observed and predicted license percentage of different models showed the overall percentage correctly predicted in the linear model was .65, whereas in the multinomial logistic model the percentage was .68. For the three hunting license groups (low, medium and high), the linear model correctly predicted .47%, .58%, and .89%, respectively, whereas the multinomial model correctly .73%, .52%, and .80% (Table 4).

In terms of residuals, the linear regression model produced a Moran's I value of .40, whereas the multinomial logistic regression resulted in a Moran's I value of .80. Therefore, according to Moran's I value, spatial autocorrelation was rare among residuals for the linear regression model. However, there was a clear spatial autocorrelation within the residuals of the multinomial logistic regression model (i.e., obvious linear correlation with the lagged residual).

Table 2. Parameter estimates for linear regression model of hunting license sales.

Hunting	Coefficients	Std. Error	*t*	*p*-value	*R*-square
Constant	1.64	0.04	44.30	<.001	.48
Socioeconomic Status	0.37	0.02	16.78	<.001	
Household Mobility	0.46	0.03	17.04	<.001	
Age Index	0.21	0.03	7.92	<.001	

Table 3. Parameter estimates for multinomial logistic regression model of hunting license sales.

Hunting		Coefficients	Std. Error	*Wald*	*p*-value
Medium	Intercept	0.61	0.10	41.30	<.001
	SES	0.65	0.05	157.03	<.001
	HM	0.23	0.06	13.85	<.001
	AI	0.11	0.06	3.63	.057
High	Intercept	−0.17	0.12	2.10	.147
	SES	1.22	0.08	248.41	<.001
	HM	0.99	0.08	148.64	<.001
	AI	0.36	0.07	25.60	<.001

Table 4. Prediction accuracy of linear regression and multinomial logistic regression models for hunting license sales.

		Predicted			
	Observed	Low	Medium	High	Percent Correct
Linear Regression	Low	207	184	47	47
	Medium	47	254	137	58
	High	3	46	389	89
	Percent Correctly Classified				65
Multinomial Logistic Regression	Low	319	93	26	73
	Medium	121	228	89	52
	High	12	77	349	80
	Percent Correctly Classified				68

Discussion

Model Comparison

The two regression models provided similar results (i.e., the percentage of hunting license sales was positively influenced by these indices). In terms of model accuracy, the multinomial logistic regression model provided a more accurate prediction than the linear regression model. The multinomial logistic regression model provided better predictions for both the Low group and High group. The relatively poor performance in the medium percentage group may have been caused by classification. The percentage of license sales were manually classified into three groups: low, medium and high. There were inevitable overlaps between groups, such as medium-low and medium-high. Data in the overlap areas were quite close to each other, and as the model cannot differentiate slight differences it may lead to misclassification. Observations in the medium group have a higher probability to fall in the overlapping areas than the other two groups, and as a result, the medium group has the lowest predictive accuracy of the three groups. Predictive accuracy for the linear regression model increased with an increased percentage of license sales, and therefore the High group received the best predictions.

It is apparent that when comparing the observed and predicted percentage of license sales, the multinomial logistic regression models have higher prediction accuracy. However, given the residuals, the linear regression model (i.e., smaller Moran's I) was more properly defined than the multinomial logistic regression model. These findings suggest the logistic model failed to explain some spatial factors that also influence license sales.

Multinomial logistic regression generated better predictions, but the linear regression was more statistically correct. One possible way to improve the logistic regression model is to use a logistic mixed model and a geographically weighted logistic model, as both of these models include spatial variables that may reduce the spatial autocorrelation of the residuals (Wu & Zhang, 2013). The model with the smallest spatial autocorrelation and heterogeneity in the residuals best fits the data set. Moreover, data over different time periods will also help to further validate the model. Specifically, data from a single period of time can be used to create the model and serve as a baseline, and data from different periods will be used to test the model by comparing the predicted percentage of license sales compared with the initial period.

Interactions between both socioeconomic and cognitive factors may help to improve sales of licenses by improving understanding of market segmentation. A greater understanding of market segmentation will allow for the development of recruiting programs focused on those socioeconomic constraints that predominate among specific populations in a given area.

Methods used for this article were applied in the context of a large metropolitan region. This same approach is applicable for rural and suburban regions, however the relative importance of the individual variables may change. Developing models for other regions will improve understanding of the complexities contributing to license sales and help state wildlife agencies develop targeted approaches to hunter recruitment.

Management Implications

Hunter recruitment programs have applied similar approaches in urban to rural areas across states, and do not take into consideration differences in populations, constraints, or socioeconomic factors. These programs would benefit by incorporating modeling approaches that address specific population variables in conjunction with other market-based methods, such as promoting hunting among locavores (Steadman, Larson, Tidball, Tidball, & Curtis, 2017). Identifying factors that increase probabilities of license sales among spatially defined areas will enable greater precision in identifying areas to target recruiting efforts (e.g., training workshops). This article provided an example of such an approach through the use of spatial models incorporating socioeconomic data available via the U.S. Census. Further refinement of this approach by applying it in differing regions (suburban, rural) will enable state agencies to develop programs directed toward local factors that will introduce more people to hunting, enhance conservation values, and increase the funding base necessary to further conservation programs.

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