Crime Hot Spots & Spatial Regressions (Eau Claire County, Wisconsin)

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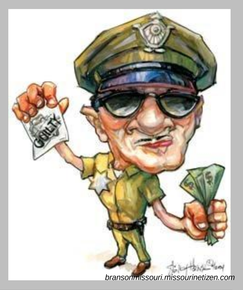
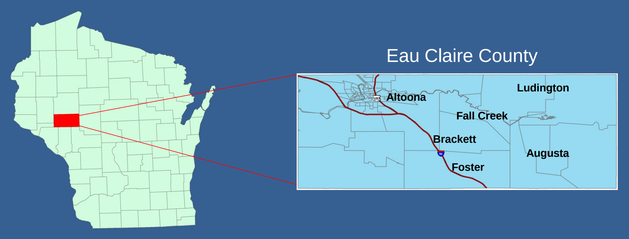


Abstract

General Information
The purpose of this study is to run multiple regression models for different crime categories in Eau Claire County to explore the geographic relationship between crime and a suite of explanatory variables. Crime was categorized by year (2003-2009) and type for a total of 63 datasets including the following: sex offense, drugs, burglary, personal/violent, disturbances, traffic-OMV, property crimes, and OWIs. Each record in the dataset includes the crime, geographic location, liquor outlets, and 2000 census data. All of the crimes and liquor outlets were geocoded by street address, and then the crimes were separated into the different classifications that where joined to the 2000 census block groups. Geocoding rates were very high in each of the years ranging between 95% and 96%. Independent variables include percent white, percent no education, number of liquor outlets, percent unemployed, median household income, and percent higher education (post high school). Our results will compare the difference between ordinary least squares regressions and spatially lagged regressions, and potentially indicate a spatial relationship between crime and the suite of explanatory variables.

MATERIALS AND METHODS

Study Site
The sample for this study is comprised of 66 census block groups. A total of 42,060 recorded crimes took place in Eau Claire County, Wisconsin between the years of 2003 and 2009. According to the US Census Bureau, Eau Claire County has a 2009 population estimate of 99,409.



Graph 1 shows the number of mappable crimes has on average increased annually, but the percent of recorded mappable crimes has also increased. Only 65 percent of recorded crimes in 2003 had mappable address which increased to 100 percent in 2009 when it became standard practice for police to record addresses.

Graph 1: Crimes with Addresses, Absolute and Percent

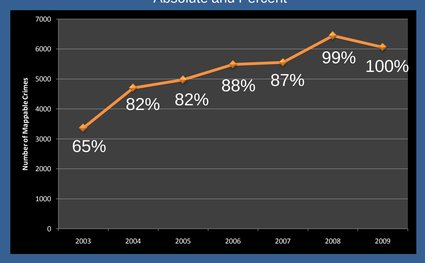


Table 1 shows the number of crimes per year for each crime classification.
Table 2 shows the percent of crimes per year for each crime classification.

Table 1: Number of Mappable Crimes Classifications per Year

	2003	2004	2005	2006	2007	2008	2009
Sex Offense	17	32	0	3	3	27	42
Drugs	193	238	402	421	438	427	337
Burglary/Theft	128	186	116	125	130	197	563
Personal/Violent	199	279	28	18	9	274	279
Disturbance	807	1311	1477	1571	1656	1729	1625
Traffic-OMV	101	94	82	84	138	85	87
Property	69	80	91	105	152	84	90
OWI	275	328	325	341	447	503	435
Total	1789	2548	2521	2668	2973	3326	3458

Table 2: Percent of Crimes per Year

	2003	2004	2005	2006	2007	2008	2009
Sex Offense	1%	1%	0%	0%	0%	1%	1%
Drugs	11%	9%	16%	16%	15%	13%	10%
Burglary/Theft	7%	7%	5%	5%	4%	6%	16%
Personal/Violent	11%	11%	1%	1%	0%	8%	8%
Disturbance	45%	51%	59%	59%	56%	52%	47%
Traffic-OMV	6%	4%	3%	3%	5%	3%	3%
Property	4%	3%	4%	4%	5%	3%	3%
OWI	15%	13%	13%	13%	15%	15%	13%
Total	100%	100%	100%	100%	100%	100%	100%

Concerns about the list of crimes available from the police department included that some addresses were not recorded after a crime occurred, and some addresses were recorded incorrectly and were unable to be geocoded. **Table 3** shows the number of crimes with incorrectly recorded addresses.

Table 3: Number of Crimes with Incorrectly Recorded Addresses

	2003	2004	2005	2006	2007	2008	2009
Number of Addresses Recorded Incorrectly	157	182	205	285	228	234	245

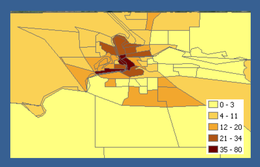
Regressions

Data Analyses
Multiple regression models were run for different crime categories per census block in Eau Claire County to explore the geographic relationship between crime and the suite of explanatory variables.
The crime data was separated into eight categories: sex offense crimes, drug crimes, burglary/theft crimes, personal/violent crimes, disturbance crimes, traffic-OMV crimes, property crimes, and OWI.

- All R^2s increase from OLS regression to spatially lagged regression
  - Average increase in R^2 was 0.08
  - R^2 increased the most in property crimes
  - R^2 increased the least in sex offense

	OLS R^2	Spatially Lagged R^2	Increase
Property Crimes 03-10	0.4326	0.6388	0.2062
All Crimes 03-10	0.4713	0.5952	0.1239
OWI 03-10	0.398	0.5135	0.1155
Burglary 03-10	0.4012	0.5155	0.1143
Drugs 03-10	0.4583	0.5155	0.0572
Traffic-OMV 03-10	0.492	0.5442	0.0522
Disturbance 03-10	0.1561	0.2036	0.0475
Personal/Violent 03-10	0.4327	0.451	0.0183
Sex Offense 03-10	0.1008	0.1134	0.0126

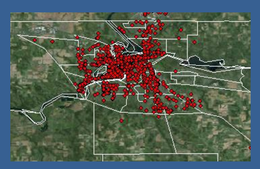
Property Crimes
- R^2 increased the most in this crime classification
- R^2 increased from 0.4326 to 0.6388 which is an increase by 0.2026
- Property crimes are spatially pegged to median household income, liquor outlets, and percent no education (all explanatory variables are significant)

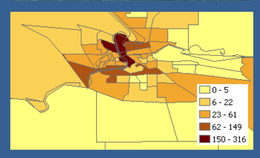


Dependent Variable	Independent Variable	Std. Error of Est.	B	Std. Error	t	Probability	R^2	Log Likelihood	Akaike	Schwarz
Property Crimes 03-10 OLS	Constant	9.9151	29.017	5.3575	5.4162	0	0.4326	-245.058	498.115	506.874
	Median Household Income		-0.0005	0.0001	-4.4933	0				
	Liquor Outlets		1.2708	0.2929	4.3387	0				
	Percent No Education		-255.3561	106.2439	-2.4035	0.0192				

Dependent Variable	Independent Variable	Std. Error of Est.	B	Std. Error	z	Probability	R^2	Log Likelihood	Akaike	Schwarz
Property Crimes 03-10 Spatial	Count	7.9115	0.6007	0.1032	5.8194	0	0.6388	-233.078	476.156	487.104
	Constant		11.6875	4.8898	2.3902	0.0168				
	Median Household Income		-0.0002	0	-2.6913	0.0071				
	Liquor Outlets		1.3462	0.227	5.9292	0				
	Percent No Education		-169.0187	83.0562	-2.035	0.0419				

Drug Crimes
- This crime classification had an average increase in R^2
- R^2 increased from 0.4583 to 0.5155 which is an increase by 0.0572
- Drugs are spatially pegged to liquor outlets and percent white (they are significant variables)
- Percent unemployed was not a significant variable

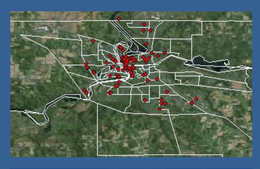


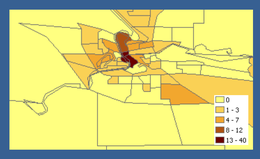


Dependent Variable	Independent Variable	Std. Error of Est.	B	Std. Error	t	Probability	R^2	Log Likelihood	Akaike	Schwarz
Drugs 03-10 OLS	Constant	40.8588	375.4658	99.4822	3.7742	0.0004	0.4583	-336.455	680.91	689.668
	Liquor outlets		4.8383	1.1064	4.379	0				
	Percent White		-390.0154	100.7445	-3.8713	0.0003				
	Percent Unemployed		570.3779	331.8139	1.719	0.0906				

Dependent Variable	Independent Variable	Std. Error of Est.	B	Std. Error	z	Probability	R^2	Log Likelihood	Akaike	Schwarz
Drugs 03-10 Spatial	Count	37.4532	0.3426	0.1396	2.453	0.0142	0.5155	-333.609	677.218	688.166
	Constant		287.6439	92.6889	3.1033	0.0019				
	Liquor outlets		5.1307	1.0153	5.0536	0				
	Percent White		-306.6567	93.2817	-3.2874	0.001				
	Percent Unemployed		307.5758	307.5758	1.2049	0.2282				

Sex Offenses
- R^2 increased the least in this crime classification
- R^2 increased from 0.1008 to 0.1134 which is an increase by 0.0126
- Percent white and percent no education were not significant variables in describing the locations of sex offenses
- Sex offense crimes happening in 2005-2007 had addresses redacted by the police department.





Dependent Variable	Independent Variable	Std. Error of Est.	B	Std. Error	t	Probability	R^2	Log Likelihood	Akaike	Schwarz
Sex Offense 03-10 OLS	Constant	5.0078	19.0886	11.8995	1.6042	0.1137	0.1008	-198.44	402.88	409.449
	Percent White		-19.5497	12.1694	-1.6065	0.1132				
	Percent No Education		72.6628	50.082	1.4509	0.1578				

Dependent Variable	Independent Variable	Std. Error of Est.	B	Std. Error	z	Probability	R^2	Log Likelihood	Akaike	Schwarz
Sex Offense 03-10 Spatial	Count	4.8582	0.144	0.1778	0.8095	0.4182	0.1134	-198.112	404.225	412.983
	Constant		15.1111	11.6382	1.2985	0.1941				
	Percent White		-15.812	11.8683	-1.3323	0.1828				
	Percent No Education		80.4047	48.5907	1.6547	0.098				

Conclusion

This research concludes that spatially lagged regressions are better at predicting the locations of crime because they take into account the distance between the polygons and assumes that touching polygons are more similar than polygons separated by other polygons. In another words, if one census block group has a higher rate of crime the adjacent block groups would also have higher rates of crime (Crime Cluster). The regressions show that socio-economic and other variables can explain the approximate locations of crime in Eau Claire county. Hot spot analysis provided for a few different crime classifications show that the majority of crime happens in the city of Eau Claire with crime reducing with increasing distanced from the city. This research will be formatted into a professional article and published later in the year.

Hot Spots

Hot spot analysis gives a set of weighted features and identifies statistically significant hot spots and cold spots. In order for a value to be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values.

All Crimes

Drugs

Disturbances

References

Ackerman, W. V. "Socioeconomic Correlates of Increasing Crime Rates in Smaller Communities." *Professional Geographer* 50, no. 3 (1998): 372-87.
Baum Rebekah. "Examining the Relationship between Alcohol Outlets and Crime in Eau Claire County, WI." 15 December 2009: 1-17
Cahill, M., and G. Mulligan. "Using Geographically Weighted Regression to Explore Local Crime Patterns." *Social Science Computer Review* 25, no. 2 (2007): 174-93.
Chainey, Spencer. GIS and Crime Mapping. John Wiley and Son, 2005.
"Geography for Life: National Geography Standards 1994." National Geography Standards. August, 1998. Hawaii Geographic Alliance. 20 September 2010 http://www.hawaii.edu/hga/Standard/ngs912.htm#top
"Geospatial Technology Competency Model." careeronestop pathways to career success. 2010. U.S. Department of Labor, Employment and Training Administration. 20 September 2010 http://www.careeronestop.org/CompetencyModel/pyramid.aspx?GEO=Y
"Mr. Spencer Chainey." UCL JILL DANDO INSTITUTE OF CRIME SCIENCE. 20 August 2009. UCL. 7 September 2010 http://www.ucl.ac.uk/jdi/people/academic/chainey.php
O'Leary Zina. The Essential Guide to Doing Your Research Project. California: Thousand Oaks, 2009.

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