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Exploring Accessibility versus Opportunity Crime Factors

by Elizabeth L. Davison
Appalachian State University

William R. Smith
North Carolina State University

ABSTRACT: The purpose of this study is to examine the effects of accessibility (street networks) and opportunity factors (land usages) on property crime among street segments in Raleigh, North Carolina. The analytical model for this research is patterned after the Beavon, Brantingham, and Brantingham (1994) study (hereafter referred to as "the Beavon study") of property crimes among Vancouver, Canada street segments. This study expands the scope of the Beavon study by including a measure of guardianship and analyzing additional opportunity measures (accounts of 10 business types and 4 residential land usages).

The purpose of this study is to examine the effects of accessibility (street networks) and opportunity factors (land usages) on property crime among street segments in Raleigh, North Carolina. The analytical model for this research is patterned after the Beavon, Brantingham, and Brantingham (1994) study (hereafter referred to as "the Beavon study") of property crimes among Vancouver, Canada street segments. This study expands the scope of the Beavon study by including a measure of guardianship and analyzing additional opportunity measures (accounts of 10 business types and 4 residential land usages).

The data assembled for this research contain two parts: Raleigh police crime incident reports and Wake County tax assessor information from 1993. We aggregated addresses from the tax information and police incidents to street segments (a segment is located between street intersections and includes addresses from both sides of the street). Out of 12,606 possible Raleigh street segments, a random sample of 20% (N=2,606) was selected for a street networking analysis (analysis of turns and flow). Exit ramps, freeways, and "no address" (street segments without street numbers) segments are deleted, leaving a final total of 2,207 street segments. The dependent variable, a count of property crimes per street segment, includes bicycle theft, auto theft, theft from auto, property theft, willful damage, and breaking & entering.

Accessibility Measures

To explore the connection between accessibility and crime, we used two street networking variables (i.e., *flow* and *turns*) to measure accessibility. The supposition is that less complicated and easily accessible street segments will have more criminal activity while street segments with limited access are expected to be less criminogenic. Complex street networks with limited access, such as dead-ends and cul-de-sacs, restrict the amount of through traffic in the area thus limiting exposure to criminal opportunity. Motivated offenders are less likely to know about potential targets in these restricted areas and are less likely to consider the areas as targets. On the other hand, streets with heavier volumes of traffic expose more people to criminal opportunities located on the segment (Brantingham and Brantingham, 1984).

An accessible street segment will have many turns or points of access into the segment. Street segments with four or more entries are considered more accessible than street segments with one entry into the segment. For our sample of Raleigh street segments, the number of *turns* into a single street segment ranges from one to eight. Since only nine segments fall under the categories of seven and eight, these values are collapsed into the newly created category of "six or more" turns. The categories of one and two are also combined for the analysis since there are only eleven segments with only one turn. *Flow* through a street segment is measured from one to four. "Ones" represent less traveled residential roads and "fours" represent major arteries.

Opportunity Measures

Regardless of accessibility, an area will not be victimized unless criminal opportunity exists. Similar to the Beavon study, we used the number of commercial establishments on each segment, a dummy variable for whether or not there is a middle or high school on a street segment, and the average value of any apartments on each block (Beavon et al. 1994:134). We included 14 additional land use measures (i.e., various residential or business parcels) to better understand specific criminal opportunities.

Targets that are perceived as guarded by potential offenders are less likely to be attacked because the risks seem greater (Felson and Cohen 1980). We used owner-occupied (i.e. whether the owner lives or occupies the building) as a measure of guardianship. The rational behind using an account of owner occupation is that since owners have an investment in their properties, they are more likely to take aggressive measures to ward off potential offenders by taking protective measures of their homes (locks, security devices, alarms, etc...) as well as "keeping an eye on" the street for suspicious or undesirable behaviors.

Analysis of Street Accessibility

We used a multiple classification analysis of covariances to explore the effects of street networking patterns on total property crime. Table 1 shows how the mean of each covariate deviates from the grand mean of 3.18 property crimes per street segment. As found in the Beavon study, property crime increases as the number of turns and flow of a segment increases. Translating from the unadjusted deviation scores, the influence of turns into a segment, ranges from an average of 1.59 property crimes for segments with two turns to an average of 6.52 property crime incidents for streets with six or more turns (grand mean minus unadjusted deviation). Calculation of the deviations from the mean for road size, as measured by flows, shows that on average, feeder streets have 1.86 property crime incidents while major thoroughfares average 16.71 crime incidents.

The second column supports the interaction affects of the two accessibility factors by adjusting for the independent effects of the other variable. Although the magnitude of the influence is reduced, the hierarchial pattern is still present -- the greater the turns and flows, the higher the likelihood of crime (ranges are from 2.75 crimes for two turns to 5.56 for six turns; and 2 crimes for minor arteries to 16.4 for major arteries). The last column adjusts for both the main effects and the covariates. The same linear pattern is maintained, but the impact of each individual factor is greatly reduced. Although weaker, turns and flows still predict property crimes net of opportunity factors. Turns are reduced by the adjustment for flow more than flow is

reduced by the adjustment for turns (column 2). The covariates, however, have more of an impact on flow (reduces the adjusted mean more) than on turns.

Table 1: Turns vs. Street Flow

(Multiple Classification Analysis)

Variable and Category	N	Unadjusted		Adjusted for Independents		Adjusted for Independents and Covariates	
		Dev'n	Eta	Dev'n	Eta	Dev'n	Beta
TURNS							
2	444	-1.59		-.43		-.43	
3	126	-1.09		-.12		-.49	
4	939	-.46		-.61		-.29	
5	498	1.21		.60		.39	
6	200	3.34		2.38		1.67	
			.13		.08		.06
FLOW							
one *(residential)*	1561	-1.32		-1.18		-.37	
two	320	.52		.09		-.37	
three	226	2.41		2.18		.75	
four *(major artery)*	100	13.53		13.22		5.32	
			.29		.28		.11
Grand Mean	3.18						
Multiple R^2					.089		.460
Multiple R					.299		.678

Analysis of Accessibility and Opportunity

We used regression equations to further analyze the influence of accessibility and opportunity factors. By logging (natural logs are used throughout) both independent and dependent count variables, the relationship is linearized, in that, a proportionate increase in the independent variable is associated with a proportionate increase in the dependent variable. A dummy variable (MISSING TAX DATA) is used to account for missing cases.

The reference group for the regression models consists of one-family homes. The literature suggests there should be a negative correlation between the number of single family dwellings and crime (Roncek 1981). The negative relationship is expected because a predominance of single family dwellings suggests that people in the area are more likely to know each other and possibly work together to control unwanted criminal behavior (Stark 1987). Other types of residential use should positively differ from the reference category.

Table 2 reports regression estimates in which the independent variables are entered in blocks to explain the variation in total property crime among Raleigh street segments. In equation 1, the "number of places" count variable is entered before the turns and flows measures to control for the density of activity in an area. The criminal opportunities provided by this clustering of places are independent of the accessibility of an area as determined by the turns and flow variables. The presence of places positively correlates with crime and helps explain up to 33% of the variation of property crime among street segments. The most likely interpretation is that the number of places indicates the number of possible burglary and damageable targets, the amount of objects that could be stolen, and the number of people who regularly visit a street segment. We also find that segments with missing tax data have less crime than the segments with tax assessor information.

Equation 2 introduces the accessibility measures, as advocated by the Beavon study to explain additional variance. Both measures significantly affect crime in the expected direction. The greater the access (i.e., more turns and higher flow), the more likely the crime. The accessibility measures explain an additional 11% of the variation suggesting that accessibility of an area has an impact on which street segments become targets of property crime.

The guardianship measure (owner-occupied) is entered in the third equation. The initial factors remain significant as established in the previous equations. The owner-occupied variable negatively impacts crime as expected. Owners may be more likely to take steps to ward off crime in order to protect their investments. The addition of the owner-occupied variable increases the explained variance by ten percent.

Equation 4 enters the opportunity measures used in the Beavon study. The number of middle or high schools and the number of commercial establishments on each segment significantly contributes to crime incidents on a street segment while average value of apartments does not significantly contribute to our understanding of property crime among street segments. Since offenders are typically school age, the existence of a middle or high school on a segment represents a gathering of potentially motivated offenders and increases the risk of property crime to the area. Having the greatest impact is the presence of commercial establishments on a segment. These measures help explain an additional 6% of the crime variation among Raleigh street segments.

As seen in equation 5 of table 2, the additional land use measures from the tax assessor file significantly add 4% of the explained variation, a meaningful effect considering that these variables are entered into the equation last. All of the land use variables, except for rooming houses, youth places and vacant lots, are correlated with crime. These measures take away some of the explanatory power of the "places" variable (as noticed by a drop in the regression coefficients), but offer a more specific breakdown of the importance of the "type" of place.

These measures identify what type of buildings are more predisposed to crime. All non-onefamily residents significantly increases crime with garden apartments having the greatest impact. Of the commercial establishments, shopping centers and storage facilities (warehouses) seem to be the strong catalysts for crime compared to the other factors. This supports other research studies (e.g., Felson 1987; Engstad 1980), which also find that shopping centers provide a lot of criminal opportunity because of the availability of cash, merchandise, people and automobiles.

Discussion

A total of 63% of the variance in property crime is explained when all accessibility and opportunity variables are entered into the equation. Opportunity and accessibility measures are very strong predictors for such a small unit of analysis. By explaining a large proportion of the variance in property crime, at a small level of aggregation, we are able to demonstrate that crime is a nonrandom event and is very predictable.

This research has established not only that crime patterns exist, but that crime is more often found in accessible areas with commercial land use. Shopping centers, storage places, schools, service stations, and restaurants tend to attract criminals along with legitimate customers to the area. Hence, commercial centers are good for both business and crime. The type of residential land use also has an effect on property

crime. The more housing units on a street segment, the greater the property crime risk. Additionally, street segments without a predominance of owner occupancy are more likely to be victimized.

The implications of this research are important in being able to identify "hot spot" areas. If certain areas or even certain places of a city are considered "hot spots" then efforts should be taken towards making these areas less criminogenic by reducing accessibility opportunity and/or increasing guardianship factors.

Table 2: Total Property Crime (Ordinary Least Squares)

Standardized Regression Coefficients

VARIABLES	**Equation 1**	**Equation 2**	**Equation 3**	**Equation 4**	**Equation 5**
CONTROLS	.723***	.754***	.893***	.796***	.582***
Number of Places	.205***	.235***	.126***	.075*	.094**
Missing Tax Data					
ACCESSIBILITY		.137***	.125***	.124***	.107***
Turns		.254***	.159***	.123***	.073***
Flow					
GUARDIANSHIP			-.408***	-.329***	-.176***
Owner Occupied Place					
OPPORTUNITY				.031	-.044
(BEAVON STUDY)				.193***	-.047*
Av. value of apartments				.096***	.093***
Num. of Commercial places					

Middle or High School					
(LAND USE -RESIDENTIAL)					
Two Family Homes					.074***
More Than Two Families					.088***
Garden Apartments					.140***
Rooming Houses					.017
(LAND USE -COMMERCIAL)					
Motels/Hotels					.047**
Youth Places					.024
Businesses/Offices					.102***
Industries					.102***
Institutions					.042**
Gas Stations					.081***
Restaurants					.062***
Shopping Places					.134***
Storage Facilities					.134***
Vacant Lots					.010
R^2	.33709	.44530	.54567	.58367	.63235
Adj R^2	.33648	.44429	.54463	.58215	.62863

*p<.05 **p<.01 ***p<.001

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