Assessing spatial patterns of crime in Lima, Ohio

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Police departments, city officials and policy makers all recognize the importance of a better understanding of the dynamics of crime. Both theoretical and applied approaches, or combinations of the two, which provide insight into why and where crime takes place are much in demand. Macrolevel analysis helps to identify problem neighborhoods. Microlevel analysis helps to isolate precise trouble spots within neighborhoods and, as a result, allows for better evaluation of crime and specific socio-economic, demographic, land use and environmental characteristics associated with these trouble spots. This paper details a framework for better understanding the spatial characteristics of crime based upon the use of geographical information systems (GIS) and quantitative techniques. Lima, Ohio, provides a case study for a number of reasons. Many smaller communities have serious crime problems, so the study of crime in these communities is much needed. Lima (population 40,263) has violent crime rates well above average for its size, experiencing rates of violent crime equal to or above larger cities such as Columbus, Cincinnati and Toledo. Also, crime has an inordinately strong influence in the social and economic performance of small cities and hinders economic recovery efforts. The establishment of an analytical and theoretical framework for evaluating the relationship between aspects of place and the clustering of crime will undoubtedly lead to enhanced crime prevention strategies.

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Background

Criminal activity continues to be a major concern in contemporary society. Most nations are faced with unacceptable levels of delinquency and crime. In many of the world’s industrialized countries crime rates recorded by the police are two to three times those of 30 years ago (Waller and Welsh, 1999). When crime is measured by citizen’s reports of victimizations, rates of crime are even higher. The International Crime Victim Survey (ICVS) has collected data on 55 countries spread over six major world regions including Africa, Asia, Central and Eastern Europe, Latin America, New World and Western Europe. Findings show that for the 1989–1996 period more than half of the urban respondents reported being victimized at least once regardless of what part of the world they inhabit (Van Dijk, 1999). Among the conclusions drawn from the ICVS is that high crime rates are not unique features of a few nations, rather a statistically normal feature of life all over the world. Specifically, “no matter what part of the world, over a five year period, two out of three inhabitants of big cities are victimized by crime at least once”, and “the chances globally to be victimized by serious contact crimes (robbery, sexual crimes, or assault) are one in five” (Van Dijk, 1999).

Crime statistics at the global level are drawn almost entirely from large urban areas. However, studies that have focused on crime in smaller communities demonstrate that crime is not only a large city phenomenon. It is known from previous research that in the United States during the 1980s, the rate of violent crime increased faster in cities with fewer than 100,000 inhabitants than in larger urban areas (Gordon et al., 1992). Also, some mid-sized cities in Ohio (40,000–100,000 inhabitants) have higher rates of violent crime and property crime than the state’s largest cities (Ackerman, 1998b). A recent study of crime in Canada found that violent crime rates are higher in towns (<10,000 inhabitants) than in larger cities. In fact,
mean violent crime rates per 100,000 population (Table 1) are inversely related to city size (Hung and Nguyen, 2002). In the Canadian study, property crime rates follow a more theoretically expected pattern, highest in the large cities (>100,000 inhabitants), second highest in the medium cities (50,000–100,000 inhabitants), but the towns (<10,000 inhabitants) have higher rates of property crime than the small cities (10,000–50,000 inhabitants) (Hung and Nguyen, 2002).

In the United Kingdom crime rates in rural areas are lower than in urban areas, but “are still high enough to justify a concerted and determined response” (Beacon Council Research, 2001). The trends in recorded crimes in rural areas of the UK have generally mirrored the national picture over the last 50 years. A steady increase in rural crime occurred between 1945 and the early 1990s (Beacon Council Research, 2001). In Australia victimization rates by city size (Table 2) suggest widespread crime in places of less than 10,000 population and also in those from 10,000 to 50,000 inhabitants (Walker et al., 1990).

Research seeking to explain the geographic variation in the rate of crime has been ongoing for more than 150 years (Eck and Weisburd, 1995). On the global scale one major theoretical perspective used to explain crime is based on two factors: (1) those which increase the motivation to commit crime, and (2) those which enhance the opportunity for criminal activity (Felson, 1994; Van Dijk, 1994). Previous analyses confirm that the levels of content crimes and thefts are higher in nations where high proportions of people feel economically deprived (Stangeland, 1995; Van Dijk, 1994). Certainly, the prevalence of both property crime and violent crime is related to problems of economic hardship among the young no matter what region of the world (Van Dijk, 1999).

More than half of the victimization rates in 49 countries (representing all world regions) for burglaries, thefts, and thefts from cars can be explained by level of urbanization, economic deprivation, and affluent lifestyle (going out more often in the evenings for entertainment). The explanatory factors for robbery with weapon, sexual assault, and assault are economic deprivation, gun ownership, lower education and affluent lifestyle (Van Dijk, 1999). In many parts of the world large numbers of economically deprived youth are geographically close to well-to-do citizens, a situation which provides ample opportunity for crime (Van Dijk, 1999).

However, generalizations about the determinants of crime at the global scale fail to take into account important scale differences in the spatial analysis of crime. Previous research has revealed that not all cities in the same size categories have similar crime rates and that different sets of characteristics drive crime in different places (Ackerman, 1998b). There is increasing evidence of crime from larger cities impacting smaller and socio-economically sound communities. This “spillover” may become increasingly problematic as crime-fighting efforts in large cities disperse criminal activity. Small communities will be forced to react aggressively to this trend (Ackerman, 1998b). Further, evidence from 111 Ohio cities between 10,000 inhabitants and 99,999 shows that the socioeconomic problems which generated increasing crime in Ohio’s smaller communities (race, weak family structure, poverty, blighted neighborhoods, low educational attainment) results primarily from the massive deindustrialization of the postindustrial era (Ackerman, 1998b). Fully 44% of the manufacturing job loss in Ohio between 1970 and 1990 occurred in cities of 10,000–99,999. Results of the postindustrial transformation in smaller cities that experienced the greatest loss of jobs include closed factories, bankrupt business, and an increase in poverty, female-headed households, and a greater reliance on government-provided income assistance programs. Spatial consequences included the concentration of poverty, minorities, and crime in increasingly blighted neighborhoods, which although small in size, are the repositories of a highly disproportionate amount of crime (Ackerman, 1998b).

The purpose of spatial analysis is to identify pattern in geographic data and attempt to explain these patterns. Contemporary theory of the expected spatial pattern of crime suggests that poverty and its associated conditions and processes are the principal correlates of crime. The roots to this

### Table 1 Mean crime rates by city size: Canada

<table>
<thead>
<tr>
<th>Offense category</th>
<th>Large city (&gt;100 k)</th>
<th>Medium city (50–100 k)</th>
<th>Small city (10k–50 k)</th>
<th>Town (&lt;10 k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violent crimes</td>
<td>922</td>
<td>936</td>
<td>1037</td>
<td>1585</td>
</tr>
<tr>
<td>Property crimes</td>
<td>5118</td>
<td>4972</td>
<td>4372</td>
<td>4602</td>
</tr>
</tbody>
</table>

*Source: Hung and Nguyen (2002).* Rates per 100,000 population.

### Table 2 Crime victimization in Australia

<table>
<thead>
<tr>
<th>Size of place</th>
<th>Property crime</th>
<th>Burglary</th>
<th>Contact crime</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10,000</td>
<td>12.5</td>
<td>2.5</td>
<td>4.0</td>
</tr>
<tr>
<td>10,000–50,000</td>
<td>15.1</td>
<td>3.3</td>
<td>5.3</td>
</tr>
<tr>
<td>&gt;50,000</td>
<td>13.3</td>
<td>3.6</td>
<td>7.7</td>
</tr>
</tbody>
</table>

*Source: Walker et al. (1990).* Entries are percentage victimized one or more times.
theory can be traced to the early ecological studies of Shaw and McKay (1929, 1931, 1942). In their work Shaw and McKay fundamentally changed the nature of crime research by focusing on the characteristics of neighborhoods instead of the characteristics of the offenders. They argued that a general atmosphere of social disorganization is associated with high crime rates. Low socioeconomic status, ethnic heterogeneity, and residential mobility were hypothesized as being factors that disrupt community social organization, which in turn accounts for high rates of crime and delinquency. Studies by geographers and other social scientists have generated considerable supporting evidence on the distribution and spatial dynamics of crime (Brantingham and Brantingham, 1980; Brown and Oldakowski, 1986; Bursik and Grasmick, 1993). Findings reveal that higher than average rates of crime are disproportionately concentrated in areas with high rates of unemployment and poverty, large amounts of physical deterioration, and concentrations of minorities and youth (Harries, 1974; Ackerman, 1976; Rengert, 1981; Kohlfeld and Sprague, 1988). There exists a continuing line of research following the Shaw and McKay tradition. In a review of crime area research Dunn (1980) notes that most ecological studies assessing the relationship between crime and social variables focus on socioeconomic status, family structure and race. As a general rule areas characterized by poverty and unemployment, female-headed households, and a high percentage of African American residents tend to have the highest crime rates (Dunn, 1980).

Ecological studies represent a very common spatial analysis technique. The availability of detailed socioeconomic and demographic data at neighborhood scales combined with crime rate information and advanced computer technology permit a number of quantitative techniques to be used to assess potential cause and effect relationships. For a through review of much of this literature see Swartz (2000). Perhaps the most significant of the new tools available are geographical information system (GIS) and crime mapping software combined with spatial analysis techniques. The capabilities of these quantitative methods continue to evolve and allow for better evaluation of crime at the microlevel (see Anselin, 1998; Messner et al., 1999; Murray et al., 2001). Specifically, the application of pattern detection and spatial statistical analysis techniques for exploring the occurrences of crime are critical in the analysis of criminal activity (Hirschfield et al., 1995; Weisburd and McEwen, 1997). Macrolevel research, e.g., ecological analyses at the census tract level, helps to identify problem neighborhoods. Microlevel research helps to isolate precise trouble spots within neighborhoods and allows for better evaluation of crime and specific socioeconomic, demographic, land use and environmental characteristics that may be contributing to crime occurrences.

The aim of this research is to establish an analytical and theoretical framework, employing both qualitative and quantitative techniques, for evaluating the relationship between aspects of place (socioeconomic, demographic, land use) and the clustering of crime. Spatial patterns of crime in Lima, Ohio, are examined. Findings are expected to enhance crime monitoring and policing capabilities across the urban size spectrum, but particularly in smaller cities.

**Framework of analysis**

As noted previously, crime in smaller cities is a serious problem. Lima, Ohio, is a small city that is characteristic of this phenomenon. Previous research on urban crime has typically employed either ecological analyses at the census tract or city-wide level or microlevel approaches which examine site-specific characteristics believed to influence victimization (Swartz, 2000). The framework proposed in this analysis (Table 3) combines a macrolevel ecological approach at the census tract level to identify problem neighborhoods and associated characteristics, a mesolevel ecological and quantitative analysis at the city block level and a microlevel analysis at the address level to determine the relationship between crime incidents and site-specific physical features, social characteristics and land use.

At the macrolevel, choropleth mapping of crime incidents by neighborhood is conducted. Factor analysis of census data is also employed to identify

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Table 3 Framework of analysis

<table>
<thead>
<tr>
<th>Macrolevel</th>
<th>Mesolevel</th>
<th>Microlevel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choropleth Mapping of Crime at the Neighborhood Level</td>
<td>Choropleth Mapping of Crime at the Block Level</td>
<td>Point Incident Mapping of Crime by Address</td>
</tr>
<tr>
<td>Qualitative Analysis of Patterns</td>
<td>Qualitative Analysis of Patterns</td>
<td>Qualitative Analysis of Patterns</td>
</tr>
<tr>
<td>Factor Analysis of Neighborhood Characteristics</td>
<td>Police Interpretation/Explanation of Patterns</td>
<td>Quantitative Analysis of Patterns</td>
</tr>
<tr>
<td>Choropleth Mapping of Neighborhoods by Type</td>
<td>Factor Analysis of Block Characteristics</td>
<td></td>
</tr>
<tr>
<td>Qualitative Analysis of Patterns</td>
<td>Choropleth mapping of Blocks by Type</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Qualitative Analysis of Patterns</td>
<td></td>
</tr>
</tbody>
</table>

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socioeconomic characteristics of neighborhoods. Such approaches enable qualitative evaluation of patterns of crime and patterns of socioeconomic status. At the mesolevel, choropleth mapping of crime data is also employed, but for finer spatial resolution like census blocks and actual incident locations. Factor analysis of block group level census data is employed to explore within neighborhood socioeconomic characteristics and to permit qualitative evaluation of crime and socioeconomic status at a finer scale. Microlevel research emphasizes the analysis of crime at individual locations (hot spots) and attempts to explain the relationship between site-specific physical features, social characteristics and crime (Bennett, 1986; Weisburd et al., 1992). Hot spots can be of variable size and may include high crime street corners, bars, crack houses, or low-income housing projects (Block and Block, 1995). Factor analysis at this scale also allows for a qualitative evaluation of crime patterns compared to patterns of socioeconomic characteristics.

At the microlevel, crime by type may be mapped at the address level and superimposed on choropleth maps of socioeconomic characteristics at the neighborhood level. Fundamentally, a major interest is whether crime hot spots exist. To support this, local spatial statistics, nearest neighbor hierarchical clustering and non-hierarchical cluster analysis are advocated for identifying and assessing potential hot spots in crime analysis (Harries, 1999; Messner et al., 1999; Levine, 2000). Operationally, the delineation of hot spot boundaries is somewhat arbitrary. As Levine (1999) notes, crime density is measured over a continuous area. Therefore, the boundaries separating hot spots of crime from areas without enough activity to merit the label hot spot are perceptual constructs. Moreover, depending on the scale of geographic analysis, a hot spot can mean very different things (Harries, 1999). Recent studies by the Crime Mapping Research Center at the National Institute of Justice categorize hot spot detection and analysis methods. These techniques have been classified as follows (Harries, 1999; Jeffries, 1999): visual interpretation, choropleth mapping, grid cell analysis, spatial autocorrelation and cluster analysis.

The existence of geographic concentrations of crime and their specific locations suggests a way influence between place and criminal activity. Site characteristics can facilitate criminal activity and concentrations of crime have deleterious effects on place. There is considerable evidence supporting the concentration of crime at relatively few places and these clusters of crime appear to be relatively stable over time (Pierce et al., 1986; Sherman et al., 1989, 1992; Eck, 1995; Spelman and Eck, 1989; Spelman, 1995). The precise identification of concentrations of crime (hot spots) is complex and various conceptualizations suggest different analytical methods that may be useful for evaluation (Goldsmith et al., 2000). Isolating crime concentrations allows for detailed study of place (socioeconomic demographic, land use, and environmental structures), the possible identification of criminogenic elements, and possible strategies for intervention. There is evidence that strategies which target specific places or areas with heightened control efforts significantly decrease reported crime and calls for service (Kennedy et al., 1997).

The case of Lima, Ohio

The framework outlined above is employed using data for Lima, Ohio, at the specified levels of analysis to identify neighborhoods with the most serious crime problems and then to pinpoint clusters of crime within those neighborhoods. The analytical and theoretical framework proposed for evaluating the relationship between aspects of place and the clustering of crime will certainly lead to enhanced crime prevention strategies. Findings allow policy makers to better identify what types of resources are needed and precisely where they should be employed.

Lima, a city of approximately 40,263 inhabitants (US Bureau of the Census, 2000) situated in northwestern Ohio, suffered substantial job loss in manufacturing (nearly 40% or approximately 15,000 jobs) during the massive deindustrialization of the 1970s and 1980s. As a result, levels of poverty, unemployment and crime, as well as the number of female-headed households, increased and became more concentrated in older, downtown neighborhoods. Already overwhelmed by the economic upheaval and resulting social disorganization associated with deindustrialization community leaders did not react immediately to increasing rates of crime, especially violent crime (Ackerman, 1998a,b). Property crime began to increase between 1978 and 1979, reached a peak in 1980, and by 1985 declined to a level below the citywide mean for the 1976–2000 period. Following a slight increase in 1989 to a level slightly above the period mean, property crime has generally declined and since 1992 has remained below the city average for 1976–2000 (Figure 1). However, despite the recent decline, throughout the 1976–2000 period the level of property crime in Lima was well above the average for Ohio cities in the size range from 40,000 to 99,999 inhabitants. Indeed, Lima’s property crime rate per 50,000 inhabitants mirrors that of Ohio cities of 300,000 or greater (Figure 1). For the 1998–2000 period, Lima ranks fifth in the state in...
property crime behind Dayton, Columbus, Springfield and Toledo.

Violent crime began to increase after 1976 and continued up in a somewhat discontinuous fashion until 1988 after which it increased sharply to a level well above the citywide mean for the period 1976–2000 (Figure 2). After 1995 violent crime declined sharply and since that time has remained below the 1976–2000 period mean. However, like property crime, the rate of violent crime per 50,000 inhabitants is substantially above the mean for cities in the 40,000–99,999 size range for the entire 1976–2000 period. The mean rate of violent crime for the period 1984–1991 and 1992–1998 was above the mean for Ohio’s largest cities (Figure 2). In the period 1998–2000, the rate of violent crime in Lima ranks the city as the sixth highest in Ohio behind Canton, Springfield, Cleveland, Hamilton and Youngstown (FBI, Uniform Crime Reports, 1976–2000). The above framework proposed for analyzing the spatial pattern of crime in Lima reveals some noteworthy findings.

Lima crime—macrolevel analysis

Substantial prior research suggests that higher than average incidents of crime concentrate in areas with high rates of unemployment, poverty, physical deterioration, and concentrations of minorities and youth (see Swartz, 2000 for a review). In Lima, many of the socioeconomic variables which correlate highly with crime are also highly intercorrelated (Ackerman, 1998a,b). Because of intercorrelation in the data, principal axis factor analysis with varimax rotation is employed as a macrolevel approach to identify underlying constructs. Results allow for the mapping of socioeconomic variation in order to assess the spatial relationship between patterns of crime and socioeconomic characteristics of areas.

Previous ecological analyses of crime in Lima reported by Ackerman (1998a, 2000) at the census tract level using data (1988, 1992 and 1997) and applying factor and regression analyses found evidence that crime in Lima was concentrated in low socioeconomic status neighborhoods in and around the Central Business District (CBD). The factor analysis at the census tract level allowed for the
identification of low socioeconomic vs. high socioeconomic status neighborhoods (Figure 3). Those characterized as low status combined above average levels of poverty, unemployment, female-headed households and minority populations (Ackerman, 1998a, 2000). This earlier study also discovered a significant statistical relationship between areas with the most violent crime and those with the most property crime (Ackerman, 1998a).

Violent crime: macrolevel

Since 1988 the pattern of violent crime in Lima has remained remarkably consistent (Figure 4). In 1988 five census tracts experiencing numbers of violent crimes equal to or greater than plus one-half standard deviation above the mean were responsible for 48% of Lima’s violent crime incidents. These census tracts (125, 127, 128, 134 and 138) are concentrated along a north–south axis centered on Main Street in the historical downtown. The patterns formed by those tracts ranking highest in violent crime and those ranking lowest in socioeconomic status are nearly identical (Figures 3 and 4). The number of violent crimes in Lima increased between 1988 and 1992 by just over 20%. As in 1988, five census tracts (127, 128, 134, 135 and 138) with numbers of crime equal to or greater than plus one-half standard deviation above the mean account for 48% of the violent crime incidents. The spatial pattern changed only slightly from 1988 to 1992. Tract 125 was replaced by tract 135 making the north–south axis more pronounced (Figure 4). Earlier studies by Pyle et al. (1974) and Block (1976) discovered a similar crime concentration corridor in Cleveland and Chicago, respectively.

Between 1988 and 1997, Lima witnessed a reduction in violent crime of 32.5%, a decline that mirrors the national trend for that period. But in Lima, the decline far exceeded the national average rate of 12.8% (Federal Bureau of Investigation, 1967–1997). Lima’s ability to reduce the level of violent crime is credited to a determination by the city to increase crime-fighting efforts by adding
additional officers and initiating community policing, eventually leading to the location of five community policing sub-stations in problem areas (Ackerman, 2000). The basic spatial pattern, however, remained unchanged and the same five census tracts that witnessed the most violent crime in 1992 were those with the most incidents in 1997 accounting for 49% of Lima’s violent crime (Figure 4). Data for 2000 and 2001 indicate that the number of violent crimes appear to be stabilizing in Lima. In 2001, six census tracts which are plus one-half standard deviation above the mean account for 49% of Lima’s violent crime (Figure 4). The six tracts now contributing the majority of violent crime include 127, 128, 134, 135, 136 and 138. The basic north–south linear pattern is maintained, perturbed slightly by an eastward extension into tract 136. However, the relationship between the pattern of violent crime and the pattern of low socioeconomic status remains obvious.

Property crime: macrolevel

Since 1988 property crime in Lima has expanded and demonstrates a progressively weaker relationship to socioeconomic status (Figure 5). In 1988, two census tracts experienced numbers of property crimes equal to or greater than plus one-half standard deviation above the mean. These tracts (128, 134), also among those with the most violent crime for this period, are located in the CBD and just south of the CBD. These two tracts account for 25% of the property crime in the city in 1988 (Figure 5). Property crime in Lima declined between 1998 and 1992. In 1992, three tracts have numbers of property crimes equal to or greater than one-half standard deviation above the mean. These tracts (128, 130, 134) account for 33% of the property crime in Lima. Tracts 128 and 134 are consistent with the 1988 pattern and support the pattern of low socioeconomic status downtown concentration. Tract 130, however, located west of the CBD, suggests an incipient expansion of property crime into a middle status neighborhood not proximate to the previously identified crime axis (Figure 5). Such change is not unexpected based on findings from other research (Brown, 1982) as a result of the expansion of retail activity along major travel corridors and greater mobility of criminals. Lima tract 130 is bounded on the north by the major east–west arterial through the city. The tract is also bisected by a second major east–west street that is a typical retail ribbon.

Property crime continued to decline between 1992 and 1997 but became more widespread. In 1997, six tracts (109, 127, 128, 129, 130, 134) experienced numbers of property crimes which placed them equal to or greater than plus one-half standard deviation above the mean (Figure 5). One can now clearly discern an east–west axis following the major traffic arteries. Tract 109 on the western edge of the city is notably of upper income. It does, however, have significant retail business in ribbon developments along major streets plus strip malls. In 1997, the six tracts identified account for 50% of property crime in Lima.

Property crime increased slightly between 1997 and 2000 and again between 2000 and 2001. In 2001, five census tracts (127, 128, 129, 130, 134) were equal to or greater than plus one-half standard deviation above the mean (Figure 5). Notably tract 109 on the upper income west side experienced a reduction in property crime from 1997 and is no longer significantly above the mean. However, the east–west axis is largely maintained. The five tracts identified for 2001 have 39.6% of the property crime in the city.

Lima crime–mesolevel analysis

The persistence of pattern for crime in Lima at the census tract level clearly identifies problem neighborhoods and suggests the need for a mesolevel approach to further isolate trouble spots within these neighborhoods. The goal is to generate and

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**Figure 3** Socioeconomic status with COP stations
evaluate patterns at a finer scale that permit a clearer understanding of the location of crime and associated socioeconomic, demographic, land use and environmental characteristics of high crime areas.

There are 650 census blocks in the City of Lima and 101 blocks have a number of violent crimes in 2000 which are more than one-half standard deviation above the mean (three incidents or more). These 101 blocks (15.5% of the city total) account for 61.4% of the violent crime in the city (Figure 6). It is noteworthy that only 45 blocks experience five or more violent crimes (plus 2 or more standard deviations above the mean), but account for 40%
of the violent crime in Lima. Those blocks exhibiting the highest numbers of violent crime are concentrated in the area south of the downtown and in areas with significant low-income housing projects in the north end. The spatial extent of the north end concentration is misleading due to the inordinately large block size in that area resulting from large areas of undeveloped land. In 2001, 115 blocks (17.7% of the city total) experience rates of violent crime placing them equal to or greater than one-half standard deviation above the mean (three incidents or more). These 115 blocks account for 65% of the violent crime in Lima. Thirty-two blocks (4.9%) are two or more standard deviations away from the mean.
above the mean (six incidents or greater) and account for 31.2% of the violent crime. The pattern for 2001 is nearly identical to that for 2000 (Figure 6).

In 2000, 89 blocks experienced numbers of property crimes that rank them equal to or greater than one-half standard deviation above the mean (seven incidents or more). These 89 blocks comprising 13.7% of the city total account for 46% of the property crime in Lima (Figure 7). Twenty-seven blocks experience numbers of property crimes that place them equal to or greater than two standard deviations above the mean (16 incidents or more). These blocks (4.1% of the city total) are home to 25% of the property crime in Lima. More than two-thirds of these blocks are located in the CBD and in a nearly circular pattern around the CBD in tracts contiguous to the city center. Significant outliers include one block on the west side in tract 130 and two blocks in the north end. In 2001, 89 blocks (13.7% of the city total) rank equal to or greater than plus one-half standard deviation from the mean (eight or more incidents). These 89 blocks account for 48% of the total property crime in the city (Figure 7). In this time period 17 blocks (2.6% of the city total) ranked equal to or greater than two standard deviations above the mean (19 or more incidents) and accounted for 21% of the total property crime in the city.

At the city block level, the east–west pattern for property crime apparent at the census tract level is replaced by a more circular pattern focused on the CBD and contiguous areas. Most important, the block level analysis demonstrates that while crime is concentrated in a few census tracts in the City of
Lima, it is further concentrated within a few blocks in those tracts. However, the block level analysis uncovers additional information about the spatial distribution of crime in Lima. At the north end of the city (tract 122), two blocks experience rates of violent and property crime among the highest in the city. These specific blocks are the location of three large low-income housing projects. Other research has also reported a relationship between high crime rates and public housing projects, especially violent crime rates (Fagan and Davis, 2000; McNulty and Holloway, 2000).

To assess socioeconomic variation at a smaller scale and to compare these patterns to crime, a factor analysis using 2000 census data at the block group level was also carried out. The analysis of socioeconomic data at the block group level generates two factors. These two rotated factors explain 71% of the variance in the data. Factor one combines measures of high vacancy rates, low educational attainment, low income, minority population, and unemployment. This factor is identified as a measure of human capital deficiency, economic marginalization and race. Factor two combines measures of poorly educated youth and female heads of household with children under 18 and no husband present. Factor two is a measure of youth and weak family structure. Factor one demonstrates a pattern for low socioeconomic status similar to the pattern at the census tract level (Figure 8). The CBD and the immediately contiguous block groups are most notable. Factor two also demonstrates the previously described north-south axis but with obvious exceptions. For instance, the CBD is not characterized by youth and female-headed households. Also the pattern of low status is elongated to the north and extends farther to the southeast (Figure 8). The expected relationship between low socioeconomic status and high crime is apparent.

**Mesolevel police interpretation—qualitative analysis**

City blocks experiencing violent and property crimes equal to or greater than two standard deviations above the mean in 2000 and 2001 were discussed with the Lima Police Department on January 29, 2003. Officer Johnny Elchert was assigned to take the first author on a tour of each of these areas. This was done to evaluate land use and environmental structures and to elicit police response to the areas found to have above average numbers of crime. In tract 134 between Elizabeth Street and Vine Street, the officer immediately identified a particular bar as a major problem. This is an area of old, run-down buildings with upstairs apartments and largely minority businesses. Officer Elchert characterized the area as one in which the police experience problems with drugs, guns, prostitution, assaults relating to bar fights and drug fights. In several of the areas we visited the officer could come up with the name of a particular individual as someone involved with much of the crime. In one instance he spotted a man on the street and commented “we are constantly arresting him, I don’t know how he stays out of prison” (Elchart, 2003). Other observations from the city tour included the relationship between crime and

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**Figure 8** Block group factor scores
run-down or vacant housing, businesses where large numbers of youth congregate, concentrations of unemployed minorities, and the turf of known drug dealers. In one specific instance (block 2004 in tract 127), located just east of the CBD, there were high numbers of violent crime in 2000 but not in 2001. An officer familiar with the area mentioned a particular individual by name who had been dealing drugs out of an older downtown hotel. He was gone in 2001 and so was the crime (Elchart, 2003).

Socioeconomic conditions at the census block group level employing 2000 census data generally support the expectation that crime will be geographically associated with areas of the city experiencing the highest levels of economic marginalization and racial minorities (Figure 8). Weak family structure is also apparent. Female-headed households with children under the age of 18 and no husband present and large numbers of 16–19 year old youth, not in school and without a high school education are also associated with higher crime areas (Figure 8).

**Lima crime: microlevel analysis**

The identification and analysis of geographic concentrations of crime for increasingly smaller areas make an important contribution to improving the efficiency and effectiveness of law enforcement. The ability to accurately delineate areas of concentrated criminal activity enhances the opportunity to more carefully evaluate why crime is occurring at those specific places. If you can explain the pattern you can more accurately predict outcomes and perhaps intervene with solutions. Thus, maps that spatially identify hot spots should influence decision making and the geographic focus of police activities and social service anti-crime initiatives (Goldsmith et al., 2000). The ability to accurately isolate concentrations of criminal activity allows police departments to marshal their forces in a way that obtains maximum results from minimum expenditures.

UCR data for violent crime and property crime at the address level from 1999 were obtained from the Lima Police Department. These incidents are plotted on maps of socioeconomic status of Lima census tracts generated from a factor analysis employing 2000 census tract data. From this analysis one factor is generated which explains 72% of the variance in the data. This factor combines measures of poverty, high vacancy rates, race, unemployment, low educational attainment, female-headed households with children under 18 and no husband present, and older housing. This factor is indicative of economic marginalization, human capital deficiency, minority population and weak family structure. Eight census tracts in Lima exhibit low to very low socioeconomic conditions (Figure 9). These tracts are generally aligned along
a north–south axis and include the CBD and seven contiguous tracts to the south, east, and west of the CBD. There is a high degree of spatial correlation between tracts with low socioeconomic development and those with elevated violent crime. The spatial relationship between property crime and socioeconomic status began to weaken between 1988 and 1992 and the pattern reflects that trend (Figure 9). The opportunity for property crime measured by retail employment is significant (Ackerman, 1998a).

An important question is raised by these incident distributions. Are there clusters? Is there a discernable pattern? It seems apparent from studying these figures that spatial pattern assessment techniques are necessary to evaluate this crime incident data. In this paper a number of different spatial analysis techniques were employed. These fall under the general heading of exploratory analysis of point incidents. The basic approaches include quadrat analysis, kernel density, nearest neighbor, cluster analysis (hierarchical and non-hierarchical), and standard deviation ellipses, as noted previously. We focus here on the results depicted in Figure 10 showing the kernel density of violent crimes. The indicated hot spots are consistent with those found using many of the other techniques. The resulting microlevel kernel density pattern of violent crime (Figure 10) clearly mirrors the macrolevel census tract pattern (Figure 4), and the meso-level block analysis for the area south of the CBD (Figure 6). The center of the microlevel cluster more clearly pinpoints the highest level of violent crime in Lima and provides a clearer spatial definition of the landscape of violence which is centered south of the CBD and extends in a semi-circular pattern to the east and northeast. This is a part of Lima characterized by low income and minority population, older and run-down housing where guns, prostitution, bar fights and drug turf struggles are a continuous problem. It is clearly a part of Lima needing additional policing and community resources.

However, the kernel density technique fails to identify the high level of violent crime in the north end which was apparent at the mesoscale analysis of city blocks and which appears to be associated with high density low-income housing. Perhaps this can be explained because only two blocks are involved in the north end surrounded by low crime areas while in the south CBD area numerous blocks experience high crime in close proximity. For best understanding the spatial distribution of crime in Lima the combination of techniques discussed in our framework employing macro, meso, and microscale analyses provides the best overall results.

Summary

Although crime is increasingly a problem in many smaller cities worldwide, the study of crime in these cities continues to be an underdeveloped area of research. In cities with a serious crime problem, regardless of population size, police departments, city officials and policy makers all recognize the importance of a better understanding of the dynamics of crime.

In this paper we have provided an analytical and theoretical framework, employing both qualitative and quantitative techniques, to study violent and property crime at the macro, meso, and microlevels of analysis. We identify problem neighborhoods, problem areas within identified neighborhoods, and hot spots within those problem areas. We evaluate the relationship between aspects of place (socioeconomic, demographic, land use and environmental structures) and the clustering of crime. Lima, Ohio, was used to illustrate this analytical and theoretical framework. It is a small city (population 40,263) with a serious crime problem. Lima is also typical of many smaller postindustrial rustbelt cities. The community lost 15,000 manufacturing jobs in the 1970–1980s. Population declined from 53,734 in 1970 to 40,265 in 2000 (US Bureau of the Census 1970; 2000). The city is also losing upper and middle class population and businesses to surrounding townships. The loss of tax base resulting from this out migration negatively impacts police department budgets, and the related
economic and structural blight undermines revitalization efforts. Spatial consequences include the concentration of poverty, minorities, and crime in increasingly blighted neighborhoods.

Our findings show that since 1988 the pattern of violent crime at the macrolevel has remained remarkably consistent in Lima, concentrated in low socioeconomic status census tracts situated on a north-south axis centered on Main Street in and south of the CBD. In contrast, property crime, demonstrating a weakening relationship to socioeconomic status, has expanded to the west from the CBD along major traffic arteries. The meso-level analysis demonstrates that violent and property crime concentrates in a few block within the high crime tracts. Additionally, the mesoscale analysis identifies two high crime blocks in Lima’s north end not delineated at the macroscale. These two blocks are home to three large low-income housing projects. The microlevel kernel density pattern of violent crime adds additional spatial information which is useful in the explanation of crime location and for developing strategies to reduce criminal activity. The center of the hot spot identified by the kernel smoothing technique is located in one census tract and covers approximately 10 city blocks. This encompasses an area of the city characterized by low socioeconomic status, a high concentration of old, run-down buildings, largely minority businesses, and high vacancy rates.

The analytical approach developed here accurately delineates areas of concentrated criminal activity and permits policy makers and police departments to develop strategies and to marshal their forces in way that should provide maximum results with minimum expenditures. Our results suggest that in Lima community policing should be re-established in carefully selected areas, large-scale low-income housing projects should be discouraged and replaced in future planning with smaller more widely scattered projects, and careful consideration should be given to the renewal of liquor licenses for bars consistently generating problems. The police, however, in spite of their knowledge and capabilities, can only attack the symptoms of a larger problem. The long-term solution to the crime problem must emphasize the reduction of poverty and the reversal of the trend toward the concentration of minorities and poverty.

References


Assessing spatial patterns of crime in Lima, Ohio: W V Ackerman, A T Murray


