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GEOGRAPHIES OF URBAN CRIME:
AN INTRAURBAN STUDY OF CRIME IN
NASHVILLE, TN; PORTLAND, OR; AND TUCSON, AZ

by
Meagan Elizabeth Cahill

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In Partial Fulfillment of the Requirements
For the Degree of
DOCTOR OF PHILOSOPHY
In the Graduate College
THE UNIVERSITY OF ARIZONA

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to Jesse
for giving me a reason to smile

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ABSTRACT

Understanding the context of crime is key to developing informed policy that will reduce crime in communities. In exploring criminal contexts, this dissertation tests criminal opportunity theory, which integrates social disorganization and routine activity theories. Methodologically, the dissertation presents unique ways of modeling space in crime studies. Analyses are undertaken in three cities, Nashville, TN; Portland, OR; and Tucson, AZ, chosen for their similar crime rates and varied demographic and social characteristics.

This dissertation includes three papers submitted for publication. Crime data were collected for nine crimes over the period 1998-2002. Census data, used to create an array of socioeconomic measures, and land use data were also used in the analyses, presented at the census block group level.

The first paper attempts to determine whether certain structural associations with violence are generalizable across urban areas. The idea is tested by first developing an Ordinary Least Squares model of crime for all three cities, then replicating the results for each city individually. The models provide support for a general relationship between violence and several structural measures, but suggest that the exploration into geographic variation of crime and its covariates both within urban areas and across urban areas should be undertaken.

The second paper explores an alternative to crime rates: location quotients of crime. A comparison of location quotients and rates is provided. The location quotients are then used in a regression modeling framework to determine what influences the crime

profile of a place. The results demonstrate the efficacy of simple techniques and how location quotients can be incorporated into statistical models of crime. The models provide modest support for the opportunity framework.

The final paper explores possible spatial variation in crime and its covariates through a local analysis of crime using Geographically Weighted Regression (GWR). Those results are compared to the results of a ‘base’ global OLS model. Parameter estimate maps confirm the results of the OLS model for the most part and also allow visual inspection of areas where specific measures have a strong influence in the model. This research highlights the importance of considering local context when modeling urban violence.

Chapter 1

INTRODUCTION

1.1 Urban geographies of crime

The past two decades have seen a growing recognition by policy makers, policing agencies, and researchers that understanding the context of crime—the where and when of a criminal event—is key to understanding how crime can be controlled and prevented. Consequently, the purpose of the present research is to explore how the geographies of different crimes intersect with the geographies of social, economic, and demographic characteristics in urban places and to develop an understanding of the implications of specific contexts of crime and the spatial relationships between those contexts.

The research presented here will further our understanding of the context of crime by testing the spatial relationships between crime and various neighborhood characteristics. As such, this research contributes to the environmental criminology literature, the goal of which is an understanding of the criminal event and, among other factors, “the legal, social, psychological, and physical backcloth against which crime occurs.” (Brantingham and Brantingham, 1998, p. 31). The focus, then is the environment in which crime occurs, referred to by various researchers as the backcloth, context, or situation (Brantingham and Brantingham, 1998; Wilcox et al., 2003; Felson, 1998). Specifically, the focus of this research is on the context of criminal opportunity, a term that will be discussed theoretically below. This concept provides a lens through which macrosocial elements of criminal context can be studied.

Considering macrosocial explanations of crime, the present research combines techniques and knowledge from two major fields of study: geography and criminology, and also incorporates public policy findings. Macrosocial levels of explanation look to organizations, systems, structures and cultures of communities for an explanation of differential rates of deviant behavior (Byrne and Sampson, 1986; Bursik, 1988; Short, 1997). This type of research is guided by a search for those characteristics of communities that are associated with high rates of violence. Macrosocial studies also attempt to discern between levels of crime associated with aggregations of criminal individuals and levels of crime associated with characteristics of the communities themselves that may be criminogenic (Sampson and Laurtisen, 1994). As such, macrosocial studies do not consider individual motivations to commit crimes. These types of studies, however, can and do include information on individuals in communities, as will be shown in the theoretical discussion. The focus of the present study, however, will be solely on characteristics of places.

Under the umbrella research question: “How do the geographies of different crimes intersect with the geographies of social, economic, and demographic characteristics of urban places?” several sub-questions were developed to guide the exploration of geographies of crime and environmental context. Using a set of several methods, macrosocial levels of crime will be explored in three different cities: Nashville, Tennessee; Portland, Oregon; and Tucson, Arizona. The following sub-questions will guide the work:

- Do places and/or neighborhoods specialize in crime, i.e., do certain types of crime cluster together spatially?

- How does crime specialization relate to neighborhood characteristics?
- Are models of crime generalizable across different urban areas (i.e., different cities)?

The literature is replete with studies using a variety of methods to determine both the location and character of clusters of crimes (Brantingham and Brantingham, 1997; Craglia et al., 2000; Eck et al., 2000; Messner et al., 1999). The methods are increasingly sophisticated, with the development of new techniques for identifying crime “hot spots” (Ratcliffe and McCullagh, 1999) or taking into account the relationships between and among different places and the crime that occurs there. Techniques do exist, however, that improve upon simple point maps (that display crime locations) or rate maps (that display levels of crime standardized by population or another measure) and identify an area’s crime profile, or the particular mix of crimes that dominate different areas. One technique employed here is the development of location quotients, a technique used mainly by economists and regional scientists that has recently been proposed for spatial analyses of crime (Brantingham and Brantingham, 1995, 1997; Carcach and Muscat, 1998). This technique for identifying an area’s crime profile has been overlooked despite its simplicity and utility to planners and police agencies.

After determining the location and character of different areas of specialization within the study area, the second question will be addressed. Here, the goal is to see if certain neighborhood types are invariably associated with certain clusters of crime types. This question will be addressed through the development of a body of statistical models of crime. Standard ordinary least squares regression models will be developed

for a variety of levels of analysis. In addition, an alternate modeling method will be employed, called geographically weighted regression. More specific methodologies will be described in more depth in Chapter 2.

1.2 Situating the research

Any study of community-level correlates of crime should begin with a recognition of the pioneers in the field. The original criminological writings now considered ecological in nature date back to nineteenth century Europe and the work of the so-called “cartographic criminologists” (Smith, 1986). A. M. Guerry and Adolphe Quetelet, along with other nineteenth-century writers, made great contributions to early spatially-oriented work on crime. They compared spatial distributions of crime to both ‘moral’ characteristics (“literacy, population density, wealth, occupation, nationality”) and physical characteristics of the environment (Smith, 1986). Their work exposed three main concerns in the study of crime:

- “a primary interest in crime as a social or collective phenomenon, of which individual behavior is a component, rather than in motivation of crime in the individual,
- the quantification and statistical analysis of data relating to crime and criminals to illustrate variations in time and place, and
- a stress on the role of objective social-structural factors.” (Sampson and Lauritsen, 1994, pg. 43)

The implications of these concerns were far reaching, and still underlie much of the modern ecological research. While the methods and to some extent the conclusions presented by Guerry, Quetelet and other early criminologists may now be questioned by modern criminologists, they did show that, “in general terms, differences in rates

of offending correlated with variations in social conditions and demography” (Jones, 1998), thereby setting the stage for future ecological work. Unfortunately, the ecological theories presented by these scholars were soon replaced by more popular biological and physiological explanations for crime that most often focused on the individual level of explanation. It wasn’t until the early 1920’s that ecological studies of crime again gained attention.

The study of crime on an intra-region or intra-urban level began with Henry Shaw’s, and later, Clifford McKay’s studies of Chicago. During the early-to-mid twentieth century, the research undertaken by Shaw and his associates became the best known of this genre (Shaw, 1929; Shaw and McKay, 1942, 1969). Their work in Chicago, rooted in the human ecology model (Park et al., 1925), was motivated by the belief that human behavior was best viewed as being situated. Among other things, this meant that the geographic context of human behavior was very important in sociological studies (Shaw, 1929). The last two decades in criminology have seen a strengthening of the sub-discipline of environmental criminology. The focus expanded from the earliest studies in this tradition and now considers a range of aspects of a criminal event.

1.3 Theorizing geographies of crime

While the majority of criminological theories currently used by researchers focus on individual offenders, a considerable number of theorists have advocated some variation of the ecological approach to crime studies (Bursik and Grasmik, 1993; Cohen and Felson, 1979; Miethe and Meier, 1994; Sampson and Groves, 1989; Shaw and McKay,

1969; Stark, 1996; Wilcox et al., 2003). The basic thrust of this modern stream of research is the pervasive belief that crime cannot be understood without having accurate knowledge of the full context—demographic, economic, geographic, and social—in which it occurs. The most immediate geographic contexts are the neighborhoods in which people live and the places where their lifestyles frequently situate them. Wider geographic contexts, reflecting variation in both individual-level resources and society-wide norms, are determined by the different activities, both routine and non-routine, in which these people engage.

For most of the last two decades, ecological studies of crime have been informed by two somewhat different perspectives: (1) social control-disorganization theory and (2) routine activities theory. Although the two schools of thought are closely related, an important distinction can be made. Social control-disorganization theory focuses on the ability (or lack thereof) of residents of some geographic unit (e.g. a neighborhood) to come together to achieve a common goal, like reducing predatory crime. Alternatively, routine activities theory focuses on the presence of opportunities for crime in an area, as shaped by residents' daily activities. In addition, the two theories suggest different levels of analysis: social control theory considers community explanations for crime, while routine activities theory is often interpreted as focusing on the individual. However, the difference between the two perspectives can be reconciled, and an integration of the two theories provides the most robust theoretical explanation for ecological studies of crime. Wilcox, Land, and Hunt's (2003) recent articulation of the integration of social control-disorganization and routine activities theories into a criminal opportunity perspective provides the most successful attempt yet.

Researchers have not always recognized the value of theory integration, especially of theories with different levels of analysis. Byrne and Sampson (1986) point out that attempts at integrating theories often end in the rejection of one or more theories. Bursik's (1988) brief history of criminology identified a one-level disciplinary focus through much of the twentieth century, vascillating between an obsession with individuals and places. Shaw and McKay's work in the 1920s lead to an explosion of social disorganization research in the decades immediately following. Subsequent to Robinson's (1950) findings, many researchers believed that ecological models of crime lacked any real value, and Bursik lamented the resultant shift in disciplinary focus in the mid-1950s away from social disorganization as an explanation for crime. The disciplinary shift involved a change of focus to opportunity models of crime—identifying and studying the spatial patterns of crime targets and routine activities of people that lead to crime and victimization—which Bursik says “had a very individualistic flavor” (1988, p. 158). Bursik thus characterizes the history of criminology as swinging from an overemphasis on group process to an overemphasis on individuals and the exclusion of group aspects.

As recently as a decade ago, most researchers took an exclusive focus on either the individual or aggregate level. Concurrent with a revival in the use of social disorganization theory, however, recent history has seen a number of researchers advocating the development and use of multilevel models of crime, considering individual, situation, and social context at once. Smith and Jarjoura's (1989) empirical work integrated measures suggested by social disorganization and opportunity models. Using household measures of opportunity and neighborhood contextual affects measuring disorganization, the results lent support to elements of both models. The authors concluded that

their results demonstrated the necessity to consider multiple levels of analysis.

Miethe and Meier's (1994) work presented an integration of theories explaining crime and victimization. Social control and routine activity theories were among those from which they drew. Like the integrated opportunity theory used to guide this research, Miethe and Meier advocated cross-level studies, considering micro- and macro-level explanations for crime and victimization at the same time. However, their integrated theory had a wider focus than the theory employed here, integrating several criminological theories, and the authors did not as thoroughly address some of the inconsistencies between different theories as did Wilcox et al. (2003). A more empirical method of integration was provided by Smith et al. (2000) who suggested using interaction terms, or the products of different variables, from both theoretical perspectives in a regression model framework.

The basis of Wilcox et al.'s opportunity theory is that the "amount or rate of occurrence, location, and distribution of criminal acts across social and physical space can best be explained in terms of criminal opportunity contexts—the circumstances surrounding the convergence in time and place of motivated offenders, suitable targets, and the absence of capable guardians" (2003, p. 16). The theory is multicontextual in that it considers multiple levels of influence on criminal opportunities at once. In order to fully describe the implications of the integrated theory, however, an understanding of each of the component theories is necessary.

1.3.1 Social control-disorganization

Shaw and his associates (Shaw 1929; Shaw and McKay 1942; Shaw and McKay 1969) provided perhaps the earliest and best known work on social disorganization. For the most part Shaw and McKay and others in this emerging ecological school searched for environmental correlates of crime, looking at the spatial variation of crime rates and the characteristics of places where crime occurred most. A major conclusion was that poverty or deprivation was most closely related to the geography of crime (Ackerman, 1998). Moreover, their 1942 study reached a number of other important conclusions focusing on the idea that population stability in an area was usually associated with decreasing delinquency rates (Harries, 1974). This eventually led to the emergence of social disorganization theory, which claims that neighborhoods and communities that cannot solve commonly experienced problems will tend to have high crime rates. Three area-specific factors—high economic deprivation, high residential mobility or population turnover, and high racial or ethnic heterogeneity—were recognized to invariably characterize socially disorganized and distressed areas. Shaw and McKay’s extensive research led to various conclusions, one of which was that social disorganization was a major factor inducing the high juvenile delinquency rates that were found in certain urban neighborhoods.

However, it should be noted that Shaw and McKay could not fully articulate any direct causal linkage between economic deprivation (or status) and high rates of delinquency, partly because of inadequate data. Many problems arose among subsequent researchers when attempting to use the somewhat fuzzy notion of social disorganiza-

tion in their empirical work. Interpretation of the theory was often difficult because researchers had trouble discerning what was social disorganization per se and what was instead a manifestation of social disorganization. Shaw and McKay's version of the theory was eventually relegated to "little more than an interesting footnote in the history of community-related research," (Bursik, 1986, p. 36).

By the middle of the twentieth century, quantitative research on neighborhood crime had gradually moved into a new phase, one that was increasingly characterized by multivariate analysis, often adopting the factor-ecological approach. But much of this new research, which tended to be empirically rich but theoretically shallow, soon attracted criticism from competing schools of sociologists (e.g., rational choice, social control) and the focus of criminology in the U.S. began shifting to the study of individual motivation in the incidence of crime.

In the last two decades, a revival of social disorganization theory has occurred, and theorists in this vein have suggested a reformulation that addresses many of the early problems with the theory. Sampson (1985; 1986b; 1986a; 1988), building on the contributions of Kasarda and Janowitz (1974), Kornhauser (1978), and others, was instrumental in reviving the interests of criminologists in social disorganization theory. Kornhauser (1978) identified two forms of disorganization theory: a strain version and control version. Upon review of the two forms, Kornhauser adopted the conceptualization of social disorganization as a control theory that focuses on social controls in areas. Sampson (2002) has very recently also advocated an emphasis on the control aspects of disorganization theory; the implications of this are discussed in more detail below.

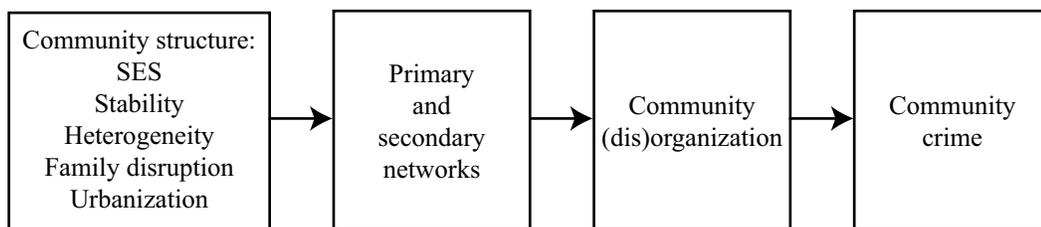


FIGURE 1.1. Systemic model of social disorganization, adapted from Sampson and Groves (1989), Bursik and Grasmik (1993), and Wilcox et al. (2003).

A systemic model Visualizing the local community as “a complex system of friendship and kinship networks and formal and informal associational ties rooted in family life and ongoing socialization processes,” Sampson and Groves (1989) suggested that when social organization and disorganization are viewed as “different ends of the same continuum with respect to systemic networks of community social control,” the concept of social disorganization is easily discernible from its causes, such as racial or ethnic heterogeneity, and its manifestations, such as increased delinquency. Likewise, Bursik and Grasmik (1993) claimed that the “modern reformulation of social disorganization as a systemic model of neighborhood control” helps to clarify the distinction between social disorganization and its manifestations. They argued that a well-articulated systemic model should recognize those primary and secondary relational networks that control neighborhood crime, should include the role of local neighborhood organizations as agencies of social control, and should address the (power-based) ability of the neighborhood to acquire external resources to fight crime. Figure 1.1 illustrates the relationships between social structure, relational networks, and levels of crime.

Empirical research testing this reformulated social disorganization theory suggests that “the structural elements of social disorganization have relevance for explaining

macrolevel variations in urban violence” (Sampson, 1997, p. 38). In particular, five exogenous structural elements have been identified as main sources of social disorganization. Three are drawn from Shaw and McKay’s work: low socioeconomic status, high residential mobility or population turnover, and high racial or ethnic heterogeneity. Two other factors, family disruption (e.g., divorce, single parent families) and urbanization (often measured with a density variable) were later added to Shaw and McKay’s factors (Sampson and Groves, 1989; Stark, 1996).

Sampson (1986b) identified the process by which the main causes work to increase disorganization. He described a breakdown in social integration due to population turnover, ethnic or racial heterogeneity, and broken families. In these areas, residents are not organizing to address crime and other problems. The socialization of children becomes problematic due to the lack of social integration, and informal control of youths in those areas is difficult. Adults are either not present to provide supervision or are hesitant to supervise children that are not their own, as often happens in relatively stable neighborhoods. The result is that children are not socialized or supervised, leading to the acceptance, or at the very least, unawareness of deviant behavior. Levels of poverty and urbanization exacerbate the process of an area becoming disorganized. Poverty affects the ability of an area to garner the resources to address problems. Urbanization generally indicates areas with large populations and areas where many people come into and out of the area on a daily basis for work, recreation, etc. This can decrease the level of control residents can exert on an area.

The combination of these different characteristics in one area can lead to growing “illegitimate opportunity structures and dysfunctional lifestyles” including violence

and crime (Elliott et al., 1996, p. 394). Elliott et al. also argue for multidimensional measures of social disorganization in order to account for conditional effects of some measures. For example, the authors cite poverty as a measure that might have different effects on the level of crime in an area according to other characteristics of the area. The following is a more in-depth exploration of the theorized causes of social disorganization.

Socioeconomic status (poverty) Poverty can contribute to increased social disorganization in several ways. High levels of poverty can leave residents lacking any of the resources necessary to organize in the neighborhood—residents may be unable to attract or harness resources that would allow them to make changes in the community. This lack of resources in turn can lead residents to become disengaged in the community, weakening social ties and informal networks. Neighborhood poverty can also have the effect of increasing isolation of residents from social mainstreams, furthering the inability to control, or even the acceptance of, deviant forms of behavior.

The empirical relationship between poverty and levels of crime in areas is controversial. On the one hand, empirical support for a positive relationship between the two has been found. Studies by Crutchfield et al. (1982) and Mladenka and Hill (1976) show support for a positive relationship between percentage of population living below the poverty level and burglary, a finding supported by Sampson's (1986b) victimization study. Miethe and Meier's (1994) correlation analysis at the census tract level shows strong support for an inverse relationship between murder and assault and family income. Their study, however, compared correlations between crime and the poverty

measures across different levels of aggregation and crime types and the measure was significant only in this case, casting doubt on the finding as generalizable and in support of theory. Warner and Pierce's (1993) analysis of calls to the police found that poverty was positively and significantly related to both assault and burglary rates. They also found that poverty was significant even when other variables were controlled for, including family disruption, which has been identified in some research as tempering the effect of poverty on crime (Smith and Jarjoura, 1988).

On the other hand, there is disagreement among researchers as to which measure of poverty is the most salient, and arguments have been made for using measures of relative deprivation or inequality instead of absolute poverty measures. Blau and Blau (1982) tested the effects of relative deprivation (measured by the Gini coefficient of family income) and poverty on crime and found that once relative deprivation was controlled, poverty became insignificant. They also concluded that economic inequalities tempered the relationship between race (specifically, African Americans) and crime. Sampson's (1985) research on neighborhood clusters did not provide support for the importance of either income inequality, measured with the Gini index, or poverty levels as having a significant effect on levels of victimization. In fact, density, family disruption, and residential mobility all showed stronger statistical relationships with violent crime than did the economic measures. However, Sampson suggests a relationship between economic measures and a measure of urbanization, which he goes on to employ in a later study (Sampson and Groves 1989).

Patterson's (1991) study of burglary and violent crime in neighborhoods in three SMSAs found no significant relationship between inequality and either violent crime

or burglary, but did find support for a positive relationship between levels of absolute poverty (percentage of population with annual income below \$5,000) and violent crime. Finally, Messner and Tardiff (1986) did not explicitly test social disorganization theory but tested the effects of relative inequality on violence at the neighborhood level. Their model included control variables consistent with social disorganization. Their results showed that neither inequality nor racial composition was significantly associated with violence. The control variables, however, a family disruption measure and the size of the population living in poverty, were significant and positively related to crime.

In addition to those mentioned above, several studies have noted a conditional effect of poverty, mediated by other causes of disorganization, namely, family disruption and mobility. Smith and Jarjoura's (1988) macro-level study of victimization in 57 neighborhoods across three different metropolitan areas showed that a conditional effect exists between poverty and mobility. The effect of mobility on violent crime rates is exacerbated in poorer neighborhoods but is significantly diminished in more affluent areas, i.e., poor areas with a mobile population have higher victimization rates than affluent areas with a mobile population or poor areas with a more stable population. This relationship held even when other neighborhood characteristics were controlled for. This conditional relationship, however, was nonsignificant in the model predicting burglary rates. In addition, Sampson (1985) found that the effects of poverty on crime were attenuated when family structure, mobility and density measures were included.

Heterogeneity Ethnic or racial heterogeneity is hypothesized to contribute to social disorganization because it “generates diversity in cultural values and norms.” Different

values, norms, and languages can impede communication and a “level of consensus achieved within the neighborhood about appropriate goals and standards of behavior” (Elliott et al., 1996, p. 393).

Smith and Jarjoura’s (1988) study compared different models for violent crime and burglary and found that racial heterogeneity was significant only in the burglary model. The authors characterize burglary as a rational choice crime and explain their finding terms of social disorganization by suggesting that burglary occurs in places where populations are transient and segmented as a result of racial heterogeneity, thereby creating “conditions of anonymity” and providing increased opportunities for burglary.

Racial heterogeneity was found to have a significant positive effect on burglary rates in Warner and Pierce’s (1993) study of calls to the police. However, the effect was conditionally related to the level of poverty. Specifically, in areas where poverty was especially high, high levels of heterogeneity serve to decrease crime. They had the opposite effect, however, where poverty was especially low. They suggest that their findings can be explained by changes in society since the original formulation of social disorganization theory, referring specifically to the consequences of economic deprivation in the late 20th century. They argue that under current conditions, those suffering from the most extreme levels of poverty cannot afford to move and instead are relegated to public housing and ghetto areas from which they cannot escape. The population is homogeneous but because it is isolated from mainstream society, it suffers from high levels of disorganization and the highest crime rates.

Residential mobility Residential mobility, also termed population turnover and population stability, generally measures the number of residents moving into and out of an area during a given time period. This factor is postulated to contribute to levels of social disorganization because trust and social ties take time to develop (Sampson, 1997). A mobile population, where residents are continuously moving in and out, is a “barrier to the development of extensive friendship networks, kinship bonds, and local associational ties” (Sampson and Groves 1989, p. 780). High levels of mobility lead to lower levels of control, both formal and informal. Sampson and Groves, however, failed to find support for the mobility hypothesis, suggesting that the influence of mobility on crime rates in an area were mediated by local social networks, which they measured and included in a structural model.

Crutchfield et al.’s (1982) ecological study of residential mobility in metropolitan areas found a positive relationship between levels of mobility and crime measures, especially property crime and sexual assault. The authors operationalized mobility and population size into a composite measure they termed “social integration,” arguing that residents in large urban areas with mobile populations lack social integration, i.e, they do not have strong ties to other residents in the area. The authors also cautioned that the results suggested the types of places where crime was more likely to occur and did not indicate what were specific causes of criminality in an individual. More recent studies have shown positive relationships between mobility and crime (Patterson, 1991; Warner and Pierce, 1993; Miethe and Meier, 1994). Other studies have considered the effects of change in mobility on changing crime rates. These studies have generally supported the theorized relationship but there does seem to be a confounding effect

with poverty (see review by Sampson and Lauritsen, 1994).

Family disruption Sampson has been one of the most ardent proponents of the idea that family disruption, including such factors as divorce and single-parent families, increases levels of social disorganization. Sampson (1986) outlined the importance of considering family disruption in ecological studies of crime, suggesting that it affects involvement in both formal and informal control mechanisms. Researchers agree that at the individual level, family disruption does not predict delinquent behavior, e.g., children of divorced parents are not more likely to be delinquent. At the macrosocial or community level, however, it does contribute to levels of crime, through process described by social disorganization theory. The macrosocial effect is postulated to occur through the participation by adults in community organizations, the socialization and supervision of youths in an area, and the active guardianship of an area.

Control theory suggests that family disruption will affect the ability of adults to form local networks, thereby decreasing local levels of social control (Sampson, 1997). Such local control can take the form of recognizing strangers in the area, guarding each others' property, and providing supervision for youths. In neighborhoods with high levels of family disruption, Sampson (1986) suggests that formal social controls may be decreased "since communities with high family dissolution tend to suffer low rates of participation in formal voluntary organizations and local affairs" (p. 26) Blau and Blau (1982) argue further that family disruption can be viewed as an indication of general disorganization and weak relationships among adults at the neighborhood level: "disproportionate numbers of divorced and separated in a population may be

indicative of much instability, disorientation, and conflict in personal relations” (p. 124).

The social control of youths is a group process that is impeded when family structures break down (Sampson 1985). Stable families are assumed to be much more able to provide supervision and support for youths. “Because of the occurrence of group delinquency, neighborhood family disruption is likely to influence the extent to which neighborhood youth are provided the opportunities to form a peer-controlled system free of the supervision or knowledge of adults.” (Sampson, 1997, p. 56). In other words, family disruption increases the opportunity for youths to spend much of their time without adult supervision, from their own parents or others’.

Smith and Jarjoura (1988) included a measure of community family structure in their study of violent crime and burglary. They found that the measure was significant in models for both types of crime. They also found that when the family structure measure was included as a control variable, their measure of racial composition became non-significant, lending credence to Sampson’s (1985) supposition that measures of racial composition are not significant in models of crime when other characteristics are controlled for. Miethe and Meier’s (1994) correlation analysis at the census tract level also supported the postulated negative relationship between crime and mobility.

Family disruption has also been related to chances of victimization. Felson and Cohen (1980) demonstrated that single and divorced persons in primary-individual households (one person households) were at a higher risk for victimization of violent crimes like rape and robbery. This effect was due largely to the decrease in levels of guardianship. This concept will be discussed in more detail as part of routine activity

theory, but it does fit into a control framework as well.

Urbanization and density It is a well known fact that crime clusters in the most urbanized areas of cities, which are generally at the center of an urban area. Any study of urban crime, then, should consider the unique nature of the most urbanized parts of the city in relation to crime rates. Researchers often offer the explanation that population size and density both contribute to the creation of crime clusters in urban areas (Sampson and Groves, 1989; Stark, 1996; Wikstrom, 1991). Population size can affect the level of crime in an area by increasing the level of anonymity among residents of an area. Building on this idea, Sampson and Groves (1989) suggested that urbanization may thus decrease the ability of residents to form strong networks and they included a measure of urbanization in their study of crime in Britain to capture that process.

Population density also plays a role in the level of crime, but the relationship between the two is not as clear as with other measures of urbanization. Stark's (1996) synthesis of earlier research looking for the ecological sources of deviant behavior identified characteristics of deviant places which fit into a social disorganization framework. In particular, Stark identified two measures as "essential factors" describing deviant urban places: population density and housing vacancies. Under Stark's conceptualization, population density is a measure of crowding in an area and thus a measure of dilapidation. The greater the density of persons in an area, according to Stark, the more likely residents are to spend time outside of their homes. It is in this case that unsupervised youth groups might form. In addition, places with larger populations and higher densities can be expected to have a larger variety of land uses. In this way,

more opportunities for crime may exist in area than if it were simply residential, retail, or industrial. The mix of land uses may bring together opportunities and offenders who might not have otherwise met. By increasing the number of opportunities and offenders in an area, density can work to increase crime. Under those postulates, then, population density is expected to show a positive relationship with crime rates.

The relationship between density and crime is somewhat fuzzy, however, because higher densities of persons can also indicate increased levels of control. The more persons who reside in an area, the more people who are generally around the area to “keep an eye on things.” For similar reasons, housing density also displays an unclear relationship with crime. Routine activities theory also struggles with the relationship between crime and population because of this issue.

Despite the unclear relationship between density and crime, the relationship between urbanization and crime levels can be thought of to work by weakening social ties and increasing opportunities for crime. Thus, more motivated offenders will be introduced to the area, and more criminal events can be expected to take place (Wikstrom, 1991).

Current status of social control-disorganization theory The systemic reformulation of social control has been criticized recently on a number of points. Namely, several ethnographic studies found high levels of organization, measured as social networks, among residents of urban communities with relatively stable populations. As organized areas, there was a level of supervision of youth and of mobilization into community groups. The neighborhoods were thus considered “organized” in a social disorgani-

zation framework but were also characterized by organized crime and gang activity. Thus even while informal social control of some deviant behavior was operating in the area, so were sources of crime and violence (Pattillo, 1998; Venkatesh, 1997). Because of the term “disorganization,” the theory has also been criticized for implying the existence of a lower class culture and morality, i.e., suggesting that residents of lower class areas have different attitudes towards violence and delinquency than the rest of society. Indeed, Holloway and McNulty warn that social disorganization’s focus on structural characteristics of places implies that neighborhoods have “inherent traits that lead to pathological or deviant behavior” (2004, p., 206). This implication can lead to “stigmatization” of the community, and by association, the individuals in that community. The problem, they point out, generally has to do with the implied culture that exists in these places identified as disorganized.

Sampson (1999; 2002) recast the concept of community in order to move away from those criticisms of modern social disorganization theory and towards a theory that emphasizes informal social control and organization *for a common goal*. He asserts that social disorganization theory is centered on community goals, and identifies communities as “important arena[s] for realizing common values and maintaining effective social controls” (Sampson, 1999, pg. 242). This control is centered on commonly agreed-upon goals, not goals that are forced or “equated with repression;” indeed, one of the most universal goals in communities of all types is the desire for “safe and orderly environments free from predatory crime” (Sampson, 1999, pg. 101). This new conceptualization thus allows for organization to be present in high crime areas (as was demonstrated in the ethnographic studies), if the organization is not centered around

the goal of decreasing or controlling levels of crime. Further, the need for homogeneity, whether social or cultural, is also rejected as a necessary condition for organization. Sampson thus creates a new term, “differential social organization” in an attempt to move away from the negative connotations of “disorganization.” The new term emphasizes the ability of very heterogeneous populations to organize formal and informal control around common goals.

This very recent reconception of social disorganization theory was practically concurrent with Wilcox et al.’s (2003) integrated theory and was thus not addressed by those authors. However, in emphasizing even more strongly the importance of control and goal orientation, there is no reason why this newer conceptualization of social control-disorganization theory cannot fit into the Wilcox et al.’s opportunity framework.

1.3.2 Routine activities theory

Routine activities theory is at its core a criminal opportunity theory focusing on the daily rhythms of life in a geographic area and how those rhythms, created by the activities of residents and visitors, create opportunities for crime. Central to the theory is the idea that the spatial and temporal variation of three key elements—offenders, targets, and guardians—creates criminal opportunities. Specifically, a motivated offender, a suitable target, and the absence of a capable guardian are necessary conditions for a criminal event. In this perspective, the underlying motivations of individual offenders is not considered.

Because of the theory's focus on criminal events and not individual criminality, the theory can be used to explain both offending and victimization in places. Place thus takes center stage in explanations of criminal events (Eck et al., 2000). Historically, however, researchers applying routine activities theory emphasized individual-level perspectives, i.e. individual-level victimization based on routine activities of that individual.

Hindelang, Gottfredson, and Garafalo's (1978) work, *Victims of Personal Crime*, was one of the earliest to suggest that an individual's lifestyle affected his or her likelihood of victimization. This so-called 'lifestyle exposure' theory was the precursor to more fully developed routine activities theory. The authors asserted that lifestyles are determined by sociodemographic characteristics strongly correlated with levels of victimization. A person's lifestyle included daily activities created by work, education, keeping a home, and recreation, among other things.

While there are several elements to the lifestyle model proposed by Hindelang et al., of most relevance to this work is their identification of structural constraints that influence an individual's lifestyle. For example, economic constraints can restrict the "range of choices" from which one can decide where to live, what leisure activities to pursue, "mode of transportation, and access to education opportunities" (1978, p. 242). The authors also identify familial and legal constraints as important. Miethe and Meier (1994) describe the process by which social structures determine lifestyle, which in turn, influences the victimization rate of individuals:

Differences in lifestyles are socially determined by individuals' collective responses or adaptations to various role expectations and structural constraints. Under this theoretical model, both ascribed and achieved status characteristics (e.g., age,

gender, race, income, marital status, education, occupation) are important correlates of predatory crime because these status attributes carry with them shared expectations about appropriate behavior and structural obstacles that both enable and constrain one's behavioral choices. Adherence to these cultural and structural expectations leads to the establishment of routine activity patterns and association with others similarly situated. These lifestyles and associations are expected to enhance one's exposure to risky or vulnerable situations that, in turn, increase an individual's chances of victimization. (p. 32)

Cohen and Felson were instrumental in advancing a number of ideas in the development of routine activities theory (Cohen and Felson, 1979; Felson and Cohen, 1980). In Cohen and Felson's original formulation, the theory was designed to explain "direct contact predatory violations," i.e. crimes in which an offender comes into direct contact with another person or object which the offender "intends to take or damage." They suggested that illegal activities feed off of routine legal activities: "daily work activities separate many from those they trust and the property they value" (1979, p. 591), thus creating opportunities for crime such as burglary or theft. They reformulated routine activities theory to focus more explicitly on places, moving away from previous preoccupations with the routine activities of aggregations of individuals, particularly those who had been victimized. The theory thus moved to a macrolevel consideration of lifestyles or routine activities. This reformulation was effectively a synthesis and coherent organization of a diverse and unconnected, but related, literature. The authors suggested that previous work failed to articulate "systematically the theoretical linkages between routine legal activities and illegal endeavors" (Cohen and Felson, 1979, p. 593).

Cohen and Felson's rearticulation of lifestyle theory included the foundational proposition that opportunity for crime is created with the spatial and temporal in-

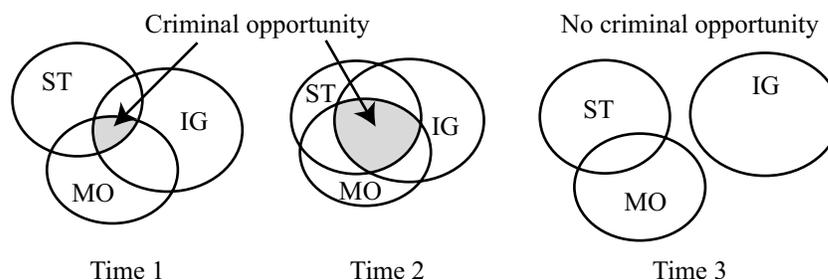


FIGURE 1.2. Criminal opportunity at three time periods, adapted from Wilcox et al. (2003).

tersection of the three key elements of a target, a motivated offender, and the lack of a capable guardian. The concept is illustrated in Figure 1.2. The supply of motivated offenders (MO) and suitable targets (ST) and level of ineffective guardianship (IG) are constant at each time period. However, the spatial convergence (or lack thereof) of the three elements at each time period demonstrates the creation of criminal opportunity, and the associated likelihood of victimization: increased opportunity suggests increased likelihood of victimization. At Time 1, criminal opportunity exists, but is relatively small. At Time 2, criminal opportunity is increased with an increased spatial overlap of the three elements. At Time 3, no opportunity exists as there is no ineffective guardianship (i.e., there *are* capable guardians in the area), preventing criminal opportunity from arising.

With a renewed interest in the macrolevel aspects of routine activity theory, an integration of the micro- and macro-level approaches was advocated, using routine activities as a theory of both crime in an area and victimization of individuals. Theoretically, Cohen, Kluegel, and Land's (1981) early exposition of social inequality and individual victimization brought the micro- and macro-levels together. The authors

based their theoretical arguments on several elements of criminal events, including: *exposure*, or the “visibility and accessibility” of targets; *proximity*, or the physical distance between targets and offenders; *guardianship*, or the ability of persons in the area to prevent crime; and *target attractiveness*, or the value of the target for the offender.

From these concepts, Cohen et al. (1981) articulate four main propositions:

1. All else being equal, increased exposure, e.g. spending more time out of the home, leads to increased risk of victimization.
2. All else being equal, lower levels of guardianship (many single-person households, few residents at home during the day, fewer physical guards like gates, locks, dogs) will lead to increased risks of victimization.
3. All else being equal, targets who live in closer proximity to areas with high rates of offending will have a greater risk of victimization than targets who live farther away.
4. All else being equal, the more attractive or valuable a target is, the more likely that the target will be victimized.

With their consideration of both individual and structural routine activities, these propositions provide a foundation for an integrated theory that operates at multiple levels, i.e. considers both micro- and macro-levels of victimization. However, at this point, most researchers were still exploring the main postulates of routine activities theory at the individual level. The propositions above did, however, point to the importance of a consideration of the social structures within which routine activities develop and operate, and set the stage for a number of studies on routine activities that considered routines at an aggregate level.

Structural changes in the routine activities of residents affect the convergence in space and time of the offender, target, and guardian, thus changing opportunities for crime and, in turn, a place’s level of crime (Cohen, 1981). Figure 1.3 illustrates this concept. Contextual factors of a neighborhood, like sociodemographic characteristics

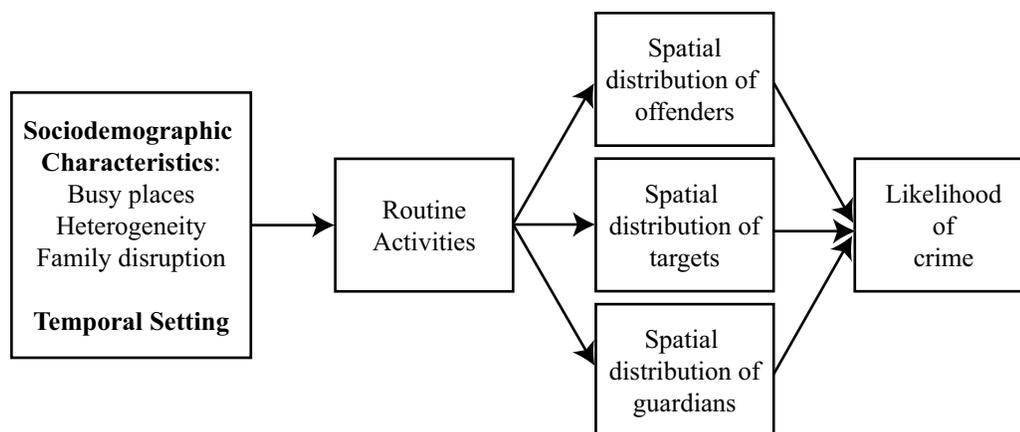


FIGURE 1.3. Contextual determinants of routine activities and the likelihood of crime, adapted from Rountree and Land (1996) and Messner and Tardiff (1985).

and the temporal setting, affect routine activities of residents and non-residents alike. Those routine activities in turn affect the spatial distribution of offenders, targets, and guardians. Residents' routine activities can thus also affect the attractiveness of an area to non-resident offenders, as was made clear in the discussion on family structure and households.

The existence of the three key elements of criminal opportunity is a function of the routine activities of area residents around such things as work, family, recreation, and education. "The prevalence and mix of different kinds of routine activities vary between communities" and in turn affect the levels of formal and informal social control that exist in an area (Wikstrom, 1998, p. 293). Sampson and Morenoff underscore how this structure of routine activities and criminal opportunity affects levels of crime and victimization in areas—not just for individuals or households, asserting that "motivated offenders may be influenced by the criminal opportunity structure of entire areas" (2000, p. 373).

Family structure and households Several aspects of routine activities theory as conceptualized by Cohen, Felson, and others emphasize the role of the household and family in determining routine activities and victimization risks. Cohen suggested that criminal victimization varied inversely with “the concentration of patterned or routine activities in or near households, particularly familial households,” (1981, p. 141). In other words, those who spend more time with family members and whose routine activities are focused around the home will have lower risks of victimization.

Family structure in particular plays a key role in influencing routine activities. Individuals will be at greater risk of victimization when they “disproportionately associate with, or come in contact with, members of demographic groups that contain a disproportionate share of offenders” (Sampson and Lauritsen 1994, p. 14). More time away from home means increased proximity to offenders and decreased guardianship of the home. Specifically, single and divorced persons are more likely to live in primary-individual households and to spend more time outside of the home, as partially determined by sociodemographic factors like age. For example, young, single, males tend to have lifestyles that put them in closer proximity to offenders and away from the home, and they therefore have a greater risk of victimization.

These factors increase the likelihood of victimization for single and divorced individuals and also the likelihood of crime in the areas where they live. Areas with a large percentage of the population in such situations often provide or create anonymity for the residents, preventing social ties and effective guardianship. Even if single or divorced residents are at home, the level of guardianship in these areas tends to be lower than in households where more than one person resides. Thus, “regardless of one’s

household family composition and even proximity to offenders, living in a community with low guardianship and surveillance may increase victimization risk” (Sampson and Wooldredge, 1987, p. 373).

Here, the parallel between social disorganization theory’s conceptualization of control and routine activities theory’s conceptualization of guardianship is clear. Control or guardianship plays a key role in decreasing the opportunity for crime in areas, and these concepts play a central role in both theories.

Felson and Cohen’s (1980) empirical study of crime trends in the United States found that the percentage of one-person households was directly related to burglary levels during the years 1950-1972. Messner and Tardiff (1985) also tested routine activities theory, using homicide data from Manhattan. They hypothesized that sociodemographic characteristics would affect routine activities of individuals and would thus be associated with homicide levels in an area. Their results supported that hypothesis.

Sampson and Wooldredge’s (1987) study found support for routine activity theory, in particular for the hypothesis that single-person households are at greater risk for victimization. However, the authors interpret their results cautiously, noting that the greatest effects on burglary and personal theft rates were structural factors instead of those factors that directly measured lifestyles. The authors thus suggest variations in lifestyles, while surely affecting one’s risk of victimization, “are arguable less important than the substantial variations in criminal offending rates by demographic and structural characteristics such as age, sex, and urbanization.” (391). The paper concludes with the assertion that analyses of crime need to consider both the micro- and macro-level contexts within which crimes occur.

Land use patterns The spatial pattern of land use across an urban area is an important consideration in any study of routine activities as the land uses in large part determine what kinds of human activities can and will take place in an area (Wikstrom, 1991). Sampson and Morenoff also identify land use patterns as an important element in determining routine activities of an area and whether certain types of crimes may be more likely to occur. For instance, if an area comprises mainly of retail space, certain types of theft, like shoplifting or motor vehicle theft are probably more likely. The number of bars in an area may cause an area to be particularly prone to crimes like assault. Residential areas may be prone to other types of crime, like burglary. The land use patterns also have a temporal element: crimes in residential areas are most likely occur during the day, while residents are at work. In retail spaces, crimes may also be more likely during the day. However, in areas with a large number of bars, crimes will be more likely to take place in the evening or nighttime hours.

Groff and La Vigne (2001) used opportunity theory to investigate the land use characteristics of places, developing a GIS-based opportunity surface for burglaries. Using land use data, they tested the hypothesis that areas with certain characteristics (e.g., near a bus stop, high levels of rental housing and/or vacant units, presence of street lighting) would determine an area's likelihood of being burglarized. Their models yielded accurate predictions of repeat-burglary areas but not single-burglary areas. Smith et al. (2000) also considered land use variables in their analysis of routine activities and social disorganization as determinants of street robbery at the block level. They employed several interaction terms, hypothesizing that land use measures would interact with social disorganization measures in their influence on crime rates. They

also found that land uses measures closer to downtown areas had significant effects on street robberies.

Urban structure in the twentieth century Felson's text, *Crime and Everyday Life* (1998; 2002) provides a current exposition of routine activities theory as it applies to urban life in the late twentieth century, and how structural changes in the United States have led to changing routines and thus changing levels of crime, especially in cities. He reviews the major points of the theory, treating crime as a routine (albeit rare) activity. He then describes the developmental stages of cities, based on Hawley's work in the early 1970s. Felson characterizes today's urban areas as a product of both the interstate highway system and growing suburbanization, especially of residences (1998). He describes the present-day urban area as a place where people and households are dispersed, helping people to avoid interaction with neighbors and increasing face-to-face interaction with people who live farther away. In addition, people spend much more time outside of the household than they used to. One important element in this dispersal of activity away from the household was the rise in the number of women in the labor force. This structural change has created empty residential areas during the daytime. An increase in car ownership also contributed to this dispersal, allowing more family members to participate in divergent activities.

Felson also identifies changes in the family structure as contributing to changing routine activities. Specifically, since about the 1950s, family life has gradually involved decreased parental control and involvement with children. At the same time, the independence of teenagers has increased. A change in the employment opportunities

of youth which increase their contact with other young people and provide teenagers with the resources (e.g., gas money) to escape parental controls. Thus, with more women in the labor force and decreased supervision of youths, combined with increased youth independence, opportunities for crime and crime itself have increased since the mid-twentieth century. Admittedly, Felson's description of urban areas is somewhat simplistic, but it does provide solid examples of how larger structural changes (e.g., increased female participation in the labor force) can affect routine activities at the neighborhood and individual level.

Current status of routine activities theory Most of the studies on lifestyle theory to this point were conducted at the microlevel, focused on the individual's activities and risk of victimization. Recently, the multilevel (or multicontextual) approach has been advocated by a number of researchers (Kennedy and Forde, 1990; Miethe and Meier, 1994; Rountree and Land, 1996; Sampson and Wooldredge, 1987; Simcha-Fagan and Schwartz, 1986). Miethe and Meier (1994) asserted that the importance of these multilevel models lies in their implicit recognition that the risk of victimization is a "function of both the routine activities of residents and the composition and structure of the wider geographical area" (p., 45). Bottoms and Wiles (1992) also recognized that a multicontextual focus was crucial to an appreciation of spatial patterns of crime and offending. They asserted that the spatial qualities of crime can only be understood if the model employed to explain them incorporates everything from the built environment to social, political, and economic structures of areas to individual and corporate actions in areas.

It is from this point, advocating multicontextual theories of crime, that I move to a discussion of Wilcox et al.'s exposition of a multicontextual criminal opportunity theory. Theirs is a theory that draws from both social disorganization and routine activities, reconciles some of the apparent conflicts between the two theories, and promotes dynamic explorations of crime in multiple contexts or levels.

1.3.3 Multicontextual criminal opportunity theory

The discussions above highlighted the main postulates of both social control-dis-organization and routine activities theories. Social disorganization, as outlined above, takes a macro-level focus, considering ecological units and the development of formal and informal controls within those units. The discussion emphasized the control perspective of social disorganization, and I concur with Sampson's (2002) suggestion that 'differential social organization' may be a better term to describe the main focus of that theory. In addition, recent work has employed survey data for residents of study areas to determine the level of social integration in the area, thus including a consideration of individual-level processes. The discussion of routine activities theory demonstrated the focus of that theory on both individual routines and the emergence of criminal opportunity in places, both of which are products of a larger social structure. The discussion thereby illustrated the theory's utility from both a micro- and macro-level perspective.

In recent work, Sampson, Bursik, and others who have made enormous contributions to the development of social disorganization theory, have recognized the importance of routine activity measures in ecological or environmental studies of crime, and

have advocated their inclusion in models of crime that consider so-called “neighborhood effects” (Bursik and Grasmik, 1993; Sampson and Morenoff, 2000; Sampson et al., 2002). Bursik’s (1993) systemic model of social disorganization integrates key elements from routine activities. Capowich (2003) describes Bursik’s idea of systemic controls, both formal and informal, as influencing the routine activities of residents which in turn affects the opportunities for crime. From social disorganization, Bursik drew the control ideas, and from routine activities theory came the framework for consideration of resident’s lifestyles. The two elements were brought together conceptually under a control model. Other authors have also advocated the integration of the two theories, although none has offered as complete an effort as Wilcox et al. (Kennedy and Forde, 1990; Miethe and Meier, 1990, 1994; Sampson and Wooldredge, 1987; Simcha-Fagan and Schwartz, 1986; Smith and Jarjoura, 1988; Smith et al., 2000; Wikstrom, 1998).

Wilcox et al. (2003) suggest that the theories are “complementary” and that when integrated together, they can form a more parsimonious and robust theory of both criminal events and victimization, and of offending and victimization risks. However, there are differences between the two models which should be reconciled, e.g., the way each perspective handles offender motivation. Integration of the two theories is not as simple as including similar explanatory variables from both theories in a statistical model, nor should one theory simply be absorbed into the framework of the other. The two theories are best brought together theoretically under an opportunity model; thus the framework guiding this research is the ‘multicontextual integrated opportunity theory’ presented by Wilcox, et al. (2003).

The multilevel focus In presenting their multicontextual model, Wilcox et al. (2003) first discuss the utility of integrating different levels of analysis (e.g., micro- and macro-level) into one model. The microlevel explanations of crime provided by routine activities theory generally focuses on the individual level, considering an individual's routines and personal risks of victimization. The macro-level explanations provided by social disorganization, and to some degree by routine activities, focus on the larger community structures that influence individual behaviors, including routines, participation in organizations, and social networks, and risks of victimization. The idea behind the multicontextual focus is that, according to Wilcox et al., "individual behavior can not be taken out of these environmental contexts, because they have a substantial effect on individual characteristics." Previous attempts at integrating micro- and macro-level data into a single analysis have demonstrated varying degrees of success with a multitude of statistical techniques (see above discussion). However, Wilcox et al. point out that many researchers in this vein are satisfied with an increase in the explained variance, and fail to fully discuss or consider the implications of their attempted theoretical integration.

Theoretical parallels Wilcox et al. argue that there are several points on which the two theories are compatible, and that any differences can be theoretically reconciled. Perhaps one of the most important parallels is the ecological focus that is central to both theories. The two theories are compatible in terms of level of analysis, described above. Both theories are employed to describe differences across space and time in criminal opportunities. Social disorganization focuses mainly on the neighborhood or community

level, but is also concerned with individuals in that social networks and organization among residents is important. Routine activities theory focuses on individual or aggregate routines in creating opportunities, but the theory also recognizes the importance of societal routines and structures that influence those routines. Furthermore, the rise of multilevel modelling is providing new statistical methods for incorporating different levels at once. Thus, as long as the theories rest on compatible assumptions, the differing levels of analysis becomes a secondary consideration.

On the control issue, the theories are also compatible. Social disorganization theory emphasizes formal and informal social controls in determining levels of crime. The parallel in routine activities theory is the concept of guardianship, one of the three necessary elements that determines whether criminal opportunity exists in a specific place. Wilcox et al. point out that these ideas of control and guardianship are “inextricable linked” in that “insufficient controls create opportunities for successful crime or victimization” (2003, p. 52).

The stance each perspective takes on the issue of motivated offenders is not as easily reconciled as the level of study or control issues. Wilcox et al. undertake a thorough exposition of this issue, recognizing that theoretical integration will not be successful unless underlying assumptions of the integrated theories are compatible. The authors also recognize the singular importance of the issue of motivation in criminological research. Briefly, the point of contention surrounding motivated offenders is whether each of the theories treats motivation as a given (the classical viewpoint) or assumes that motivation is differential (the positivist viewpoint). Classical criminologists assume that motivation exists in all individuals—there is no difference between criminals and

non-criminals. Their focus is thus on the conditions under which individuals decide to act upon their motivation (Bohm, 2001). Positivists instead suggest fundamental differences between criminals and non-criminals, i.e., they believe that motivation to commit crimes varies from person to person. Studies in the positivist tradition examine what conditions create the motivation to commit crimes. Those conditions could be biological, psychological, or social (Bohm, 2001).

Wilcox et al. point out routine activities is generally assumed to take the classical view, assuming that motivation is given and focusing on the other aspects of the theory. However, their exegesis of Cohen and Felson's work reveals a possible positivist interpretation. Likewise, social disorganization from Shaw and McKay's view can be interpreted as taking a positivist stance. To reconcile these differences, the authors reinterpret some of the main arguments of theorists in both traditions, and demonstrate how each of the different theoretical traditions can be worked into a classical stance on motivation. They thus conclude by asserting that an integration of the two theories can be founded on the classical tradition of criminology, taking an amotivational stance. Furthermore, "making a strong, classical, amotivational assumption is useful if one wants to focus on the circumstances that give rise to crime rather than focusing on characteristics of the criminal" (2003, p. 59).

Main postulates of the integrated theory Following their review of each perspective, the social control perspective and routine activities theory, Wilcox et al. presented four main postulates that build the foundation of their theory. Those postulates are presented below:

Postulate 1 Criminal behavior is accomplished in an opportunity context.

Postulate 1a An opportunity context is the convergence of motivated offenders, suitable targets, and capable guardians in time and space.

Postulate 1b Criminal opportunity contexts exist at the individual and environmental levels.

Postulate 1c Environmental contexts are manifested in a variety of bounded locales (e.g., schools, neighborhoods, or cities).

Postulate 2 Individual-level criminal opportunity context is a function of the convergence of exposure to motivated offenders, of target vulnerability, target antagonism, target gratifiability, social control, and social ties.

Postulate 3 Environmental-level criminal opportunity context is a function of the convergence of resident motivated offender concentration, ephemeral motivated offender concentration, aggregated target vulnerability, aggregated target antagonism, aggregated target gratifiability, aggregated social control, and aggregated social ties.

Postulate 4 The likelihood of a criminal act occurring is the result of simultaneous direct effects at the individual and environmental levels of criminal opportunity contexts as well as individual-environmental-level interaction effects. (Wilcox et al., 2003, p. 65)

Postulate 1 identifies the foundation of the theory as focusing on the opportunity context, identified above as central to the successful integration of the two component theories. Postulate 1a identifies the spatial and temporal component of the theory, suggesting that the presence or absence of offenders, targets, and guardians at a particular place and time determines whether criminal opportunity exists. Postulate 1b identifies the multicontextual focus of the theory, stating that different levels of consideration are included. While research at multiple levels has been both advocated and previously attempted (see above review), this theory explicitly identifies the consideration of two levels as central to the understanding of criminal opportunity. Finally, Postulate 1c provides a specification for the aforementioned “environmental context” as consisting of a bounded locale.

Postulates 2 and 3 outline the components of individual- and environmental-level contexts that influence the existence of opportunity. Because of the classical stance

taken by Wilcox et al. on the motivation of offenders, in this theory, all individuals in a bounded locale are assumed to be motivated offenders. Thus, at the individual level, exposure and proximity to other individuals within a bounded locale is assumed to increase risk of individual victimization. At the environmental level, then, exposure to the motivated offender population is a function of population density, i.e., the higher the population density, the higher one's exposure to motivated offenders. The authors also distinguish between those motivated offenders who reside in an area ("resident motivated offender") and those who come to the area for other reasons, e.g., work, school, shopping, recreation ("ephemeral motivated offenders"). These populations can be thought of as functions of land use in the area, which was specified as a correlate of crime by previous researchers in the routine activities tradition.

Under this conceptualization, targets can be objects or individuals, and their suitability is characterized by the authors according to a target's vulnerability, antagonism, and gratifiability. By vulnerability, the authors are referring to the such elements of a target as accessibility and transportability. For example, all else being equal, small but highly valuable items, like expensive jewelry, would be considered very vulnerable. Antagonism refers to the level to which targets "engender reactions of opposition, hostility, and/or antipathy" (Wilcox et al, 2003, p. 62). For example, assault of an individual may be the result of hostility or antagonism directed at the target (in this case, an individual). Gratifiability refers to the ability of the target to provide some level of "material or corporal pleasure" (Wilcox et al, 2003, p. 62).

Finally, Postulate 4 recognizes the various effects that each element of the theory has on opportunity, stating that the elements can display both direct effects at different

levels and interaction effects within and between levels.

The authors also assert that their theory allows a more explicit consideration of temporal aspects; indeed the temporal element of opportunity is a key requirement to the creation of opportunity. However, the consideration of temporal aspects of the theory will not be addressed here, as this research takes a cross-sectional look at criminal opportunity contexts.

1.3.4 Application of the theory

After presenting their multilevel criminal opportunity theory, Wilcox et al. (2003) discuss the application of their theory, including appropriate methods for testing the theory and operationalization of the concepts in their theory. The specific operationalization of those concepts and methodologies employed for the current research will be discussed in the next chapter.

Because the theory was developed to address both individual and environmental aspects of criminal opportunity, it is natural that the authors advocate the use of statistical modelling methods that take that element into account. The authors also highlighted the temporal significance of the theory, and thus suggest that a consideration of temporal processes should also be included in testing the theory. Thus, the authors identify as the ‘gold standard’ a multilevel, longitudinal research design: “the most appropriate way to test our dynamic, multi-contextual, criminal opportunity theory is to use hierarchical regression modelling techniques on data derived from longitudinal research designs that frequently gather information on a sufficient number of individu-

als embedded in an ample number of well-defined spatial environments” (Wilcox et al., 2003, pg. 183). However, the authors also recognize the sheer undertaking that this kind of research design represents, and agree that their theory would lack much utility if that were the only way to test the model empirically. While the authors do spend a great deal of time discussing hierarchal modelling as their preferred method, even in a cross-sectional design, they do recognize the value of other methodologies. Specifically, they find value even in single-level, cross-sectional research designs: “a *single-level* exploration of a theory purported to be *multilevel* seems conspicuously inadequate. Yet, single-level designs could explore some of the concepts and propositions that we have advanced” (p. 184). The authors thus find value in this type of methodology and, though they would not offer a definitive test of the theory, cross-sectional, single-level designs “could provide evidence that could support or fail to support our perspective” (p. 184).

Accounting for space For several reasons, a single-level, cross-sectional design is employed in the present study. This dissertation aims to provide a better understanding of the spatial nature of crime—the geographic relatedness of crime in different communities. One major deficiency in the body of ‘communities and crime’ literature is attention to spatial relationships; while sophisticated methods to incorporate space into statistical models have been employed for some time in other fields, criminologists have not readily adapted them into their research, instead relying on other explanations for spatial patterns of criminological phenomena (Morenoff et al., 2000). Thus one of the main goals of this research is to investigate spatial relationships between

places, through the use of various statistical methods, including a modelling technique known as Geographically Weighted Regression (specific methodologies will be discussed in detail in Chapter 2).

Spatial dependence should be explicitly accounted for in studies of crime for four main reasons. First, most studies on crime and communities are reliant on official definitions of ‘neighborhoods.’ For this study, census geographies, including block groups and tracts, are used as units of observation. These boundaries can be arbitrary and do not always coincide with socially defined neighborhoods. However, the key elements under study may more closely follow the pattern of the socially-defined neighborhood and not the census-defined area. Thus, including a spatial term will account for the mismatch in definitions (Morenoff et al., 2000).

Secondly, from a social disorganization perspective considering structural determinants of crime, the argument is made that levels of crime in one place may be affected by structural characteristics of adjacent census units, and incorporating spatial dependence into statistical models can account for this (Morenoff et al., 2000).

Thirdly, taking spatial relationships into account recognizes that residents in present-day urban areas do not necessarily form their strongest ties with those who live in the same neighborhood. In fact, many urban residents are connected with individuals in different parts of the city. This fact becomes even more relevant when interpersonal crimes are considered—these types of crimes “are reliant on social interaction, and thus subject to diffusion processes” (Morenoff et al., 2000, pg. 4).

Finally, routine activity theory posits that a larger supply of one of the three main elements of criminal events will increase the risk of crime. Specifically, exposure to

a large supply of offenders can serve to increase risk of crime. It was Cohen et al. (1981) who first formalized this idea in their proposition: all else being equal, targets who live in closer proximity to areas with high rates of offending will have a greater risk of victimization than targets who live farther away. Research has shown that violent offenders often offend close to home (Reiss and Roth, 1993). Thus if one area is adjacent to another with high levels of violence, the argument is made that spillover effects of offenders into nearby areas can increase the risk of crime in those nearby areas. Likewise, characteristics of one area may serve to attract offenders who look for opportunity not only in the ‘attracting’ area but also in adjacent areas.

Two recent studies have addressed this deficiency in very different ways. Morenoff et al. (2000) incorporated spatial effects into their model of Chicago’s homicides, employing spatial autoregressive techniques. They employed several measures of collective efficacy and disadvantage and developed a hierarchical model that included a “spatial lag” term, a term that took into account the homicide levels in areas adjacent to each observation. They found that after disadvantage and collective efficacy were controlled, the spatial term was significant, and the spatial effects were large. Speaking specifically about homicide, the authors suggested that consideration of adjacent neighborhoods is necessary to an understanding of homicide processes. This conclusion can be applied to other forms of violence as well.

Holloway and McNulty’s recent study of crime in Atlanta’s public housing projects demonstrates that a simple design can nonetheless greatly improve the theoretical and empirical understanding of the spatial aspects of crime. Using weighted least squares regression models that included measures of distance and direction to a main housing

project, they found that certain housing projects displayed ‘spread effects’ whereby crime was increased in areas nearby the public housing. Other housing projects, however, did not display the same spread effects. Furthermore, the spread effects were different with varying directions from the main project under study. The authors thus asserted that “theoretical importance of a more sophisticated geographic reading of the communities and crime perspective should not be minimized” (2003, p. 206).

I thus argue that the utility of spatial models in testing this theory are unknown and that their development should first take place at a single level of analysis. This cautious implementation will allow a better understanding of the ramifications and implications of employing these types of models.

Finally, for a dissertation project, the resources and time are simply not available to complete the kind of research that is proposed by Wilcox et al. for a proper test of the theory. The required survey data for the study areas chosen were not available and gathering that data represented an unrealistic undertaking for this project. However, I feel that the research design employed here will indeed advance knowledge of the utility of this theory, and will contribute to the set of methodologies that are appropriate for testing the theory further.

1.3.5 Format of the dissertation

This dissertation is designed to include three papers submitted for publication. The methodology and a brief review of the results of each paper is presented in Chapter 2. Each paper is included as an appendix following the body of the dissertation.

This study is not part of a larger project; thus, the design of the present study was the work of the dissertation author. In addition, the dissertation author is the sole or first author on each of the papers submitted for the dissertation.

Chapter 2

PRESENT STUDY

The methods, results, and conclusions of this study are presented in the papers appended to this dissertation. This chapter reviews the methodology employed by each paper included in the dissertation and presents a summary of the most important findings of each paper.

This dissertation is centered around the idea that an understanding of the context of crime is of utmost importance in developing informed policy that will work to reduce crime rates in communities. The analyses of the crime contexts will be undertaken in three cities—Nashville, TN; Portland, OR; and Tucson, AZ—in an attempt to determine the generalizability of structural measures of crime across different urban areas.

2.1 A Review of the Cities Under Study

While selected for similar population sizes (each city has approximately half of a million residents) and crime levels, Nashville, Portland, and Tucson each have a distinct character, influenced by very different social and economic histories that may influence the level and type of crime that occurs there. In addition, each city is located in a different region of the country, another factor which may influence the crime patterns in each city. Thus, a brief introduction to each city and an identification of those unique characteristics that sets each city apart from the other two is warranted.

Located in middle Tennessee, Nashville is a city of approximately 546,000 people. Figure A.1 shows both the distribution of violence in the city and key geographic characteristics of the city. Violence rates are highest in the center city and on the eastern edges of the city. The downtown is located in the center of the city along interstate highway 65 and the western banks of the Cumberland River which divides the city on a roughly east-west line.

In the last decade, the city saw modest population growth of about 11.7%, slightly below the 17.3% growth rate of the South as a whole (Perry and Mackun, 2001). This is the lowest population growth of the three cities considered here. More than one-quarter of Nashville's population is African American, today representing a larger proportion of Nashville's population than it did in 1990. This also represents the largest African American population of the three cities included in the present study.

Nashville was a key location in the civil rights movement, hosting non-violent sit-ins that led to early desegregation efforts during the era. By 1970, highways had been built through downtown and during the subsequent years out-migration from the center of town created sharp divisions within the city along racial and economic lines. Demographically, the city's racial groups remain fairly segregated, with large African American populations downtown and north of the Cumberland River. Another key demographic feature of the city is its relatively small but growing Latino population; the city's nearly 26,000 Latinos now represent 4.7% of the city's population. In 1990, Latinos comprised only 1% of the city's population. Nashville has the smallest Latino population of the three cities in the present study.

The sprawl of the city outward has resulted in a downtown that today lacks strong

residential, retail or services sectors and fails to attract a large number of visitors from other parts of the city. While the city hosts an extensive bus system, the downtown lacks easy access via public transportation. One Nashville resident describes the city as “the quintessential bedroom community,” characterized by families and lacking a “young, hip, professional crowd” (Padgett, 2002). Development of the downtown is a key goal of city officials with extensive investment in the area planned.

Middle Tennessee has recently seen rapid growth in the last 15 years of the automobile manufacturing industry, especially near Nashville, and this growth has served to emphasize the automobile as the city’s chosen form of transportation. Indeed, development on the edges of town continues to shape the character of the city, emphasizing its suburban sprawl.

Portland, Oregon has had a much different social and economic development. Located in the Pacific Northwest, Portland is a city of approximately 529,000 people. The map of violence rates in Figure A.2 reveals that the highest levels of violence are clustered in the downtown area and along the northern edge of the city—an area known as near northeast. In addition, there are pockets of high violence on the eastern side of the city—the outer southeast.

The map in Figure A.2 also shows some key elements in the geography of Portland. Namely, there are several main highways, the Willamette River, and a light rail system that serve to divide the city into five distinct sectors (southwest, southeast, northeast, north, and northwest). The city’s downtown is located on the western banks of the Willamette River, encircled by Interstate Highways 5 and 405. The light rail system generally follows Interstate Highway 84, cutting west-east across the center of the city

and ending outside of Portland in the suburb of Gresham. The light rail also follows Interstate Highway 205 north in the eastern part of town. A new rail system following Interstate Highway 5 north of downtown is currently under construction.

Portland's population growth during the 1990s was larger than Nashville's; the city's population grew nearly 21% over the 10-year period. This represented much slower growth than that experienced in Southwestern states like Arizona, but represents only slightly higher growth than that experienced by the West as a whole (Perry and Mackun, 2001). In fact, since the mid-twentieth century, the city has grown relatively slowly and homogenously (Wollner et al., 2001); the population has only grown rapidly in the last fifteen years, following the boom in the city's high-tech industry.

The city's population is largely white, with small percentages of African Americans (6.6%) and Latinos (6.8%). The minority populations are clustered in distinct areas: the inner northeast is largely an African-American area while Latino residents tend to reside on the fringes of town, historically where migrant worker positions were available.

This demographic structure, along with the pattern of population growth in the city and because this minority population was, and remains, clustered in a small area of the city outside of downtown. Portland largely avoided experiencing "the high level of social conflict that occurred elsewhere at the same time in terms of the racial politics and social tensions of the era" (Wollner et al., 2001, p. 4).

As occurred in many cities in the U.S., the mid-1950s saw increasing movement of downtown residents to the edges of the city. Again, the demographic structure of the city meant that the movement of residents out of the downtown did not result in a clustering of intense poverty and minority populations in that area—a feature that

characterized many other center cities during that era, including Nashville. Portland is today solidly middle-class, lacking the “two-class” structure that characterizes most cities and the downtown is undergoing a high level of gentrification. This type of development is displacing lower-income residents in the downtown, and many are moving to the eastern fringes of the city. While gentrification in downtown areas is not uncommon, the development of such an affluent downtown as exists in Portland is fairly uncommon.

Today, Portland’s economy relies on growth in the high-tech industry, and the city also serves as a port for trade with other U.S. ports and especially with Asia. Development in the city has a unique character as a result of urban growth boundaries (UGB), a state-mandated growth control strategy that is based on expected urban growth (within a 20-year period). The UGB represents the geographic limits of city growth, preventing sprawl and emphasizing instead high density and infill development (Phillips and Goodstein, 2000). Portland’s development is thus focused inward, contributing to growth in employment in center city areas and more efficient use of existing facilities and infrastructure. Of the three cities in the study, Portland has the most vibrant downtown, easily accessible by public transportation and currently experiencing increased development.

The third city under study is Tucson, AZ, a city of approximately 487,000 people. Located 60 miles north of the U.S. border with Mexico in the sunbelt of the Southwest, Tucson’s population growth was actually less than that of the state as a whole. Over the ten year period from 1990-2000, the state of Arizona experienced a 40% growth in its population, while the city of Tucson itself grew by about 20%. This

rate of growth, however, fails to recognize the extreme growth occurring just outside of Tucson's boundaries. Indeed, Pima county, within which Tucson is located, grew at a rate closer to the state's rate of growth. It should also be noted that the study area includes South Tucson, an independent municipality of about one square mile located completely within the borders of Tucson and just south of that city's downtown.

Demographically, Tucson is unique compared to Nashville and Portland, with the largest Latino population of the three cities. Well over one-third of Tucson's population was Latino in 2000. Moreover, South Tucson's population is more than 80% Latino and that city serves as the area's Latino core. Most of the Latino population here is from Mexico. Much like Portland, however, Tucson has a very small African American population—less than 5% of the city's population was African-American in 2000. In addition, Tucson attracts so-called 'snow-birds' who converge on the city from colder climes during the winter months. These usually retired, older residents often don't change their permanent residence to Tucson and thus are largely not reflected in the census figures, but do have an impact on the demographic structure of the city.

Figure A.3 shows the geographic pattern of violence in the city and identifies some key features of the city. The map reveals that the highest levels of violence are located in the western-central part of the city, near South Tucson and downtown. There are no major bodies of water in Tucson, and the city is not divided by any major highways as both Portland and Nashville are. Interstate highways 10 and 19 run along the southern and western edges of the city. In addition, Davis-Monthan Air Force Base is located in the southeast of the city. Finally, while not identified on the map, Tucson is bordered on the west, north, and east by mountain ranges.

Unlike Portland, Tucson's growth is mainly outward, with the city's profile cut by very few high-rise buildings—most buildings are one- and two-story. The majority of the growth in the metropolitan area is taking place in the northwest, along Interstate 10, which leads to Phoenix, and the southeast, also along Interstate 10 leading to the eastern part of the state. On the east side of town, the mountain ranges have served to stop development in that direction, but to the north, development in the foothills of the Santa Catalina mountains represents growth of some of the most affluent portions of the metropolitan area. As these areas are outside the borders of the city, they have not been included in the statistical analysis.

While Nashville has experienced a decline in the economic activity of its downtown, Tucson's downtown is perhaps the least developed of the three cities. While the city historically was centered around the downtown, only a handful of bars, a historic hotel, and some small galleries are all that remain to attract Tucson's widespread population to the area. What is left of the downtown hardly serves as a social or economic center and the few business attractions in the area include the Tucson Convention Center and government buildings. Tucson can be described as lacking a center around which economic, retail, and recreational activities are focused. In addition, like Nashville, the city's public transportation system consists only of bus service. Industry in the city is focused on The University of Arizona, a state university of approximately 35,000 students, the Air Force Base, and Raytheon, a defense contractor and major employer in the region. In addition, tourism contributes a great deal to the economy of the city.

TABLE 2.1. Crime data collected as part of dissertation research

1. Criminal homicide
2. Sexual assault
3. Robbery
4. Aggravated assault
5. Domestic violence
6. Burglary
7. Larceny
8. Motor vehicle theft
9. Other assaults (also called 'simple assaults')

2.2 Data

An array of crime data was collected from the Metro Nashville Police Department, Portland Police Bureau, Tucson and South Tucson Police Departments for the years 1998-2002. The abbreviated list of crimes used in the current research is provided in Table 2.1.¹ A restricted number of crimes were available for South Tucson and Nashville; those restrictions are discussed in the appendices where appropriate. The location and date of each crime was collected, and those data were geo-coded and aggregated to block groups and census tracts. Frequencies of crime for each category were averaged over the five years in the study period to control for anomalous years when there may have been an unexplained spike or fall in crime levels. For several of the analyses, these data were aggregated into other measures, e.g., property crime. Those aggregations are discussed as part of the appendices. The data were also used to develop crime rates and location quotients.

It should be noted that rather than being reported as a separate crime category,

¹Data on approximately 25 crimes was collected from each police department; not all of it was used in the analyses presented in this dissertation.

domestic violence includes those aggravated assaults, simple assaults, and disorderly conducts that were also classified as domestic violence. Domestic violence data were unreliable for Nashville for the period 1998-1999 and were thus excluded from any analyses.

Based on the 2000 Census and the theoretical framework, several structural measures were collected for use in the regression modeling at the block group and census tract levels. While myriad structural measures were collected for possible use, only those actually used in the analyses presented in the appendices will be discussed here.

Following Morenoff et al.'s (2000) study of homicide in Chicago two disadvantage measures were employed, one measuring disadvantage and one the concentration of affluence. The mobilization of resources plays an important role in the exertion of social control and the ability of residents to organize to address problems, including violence. For the concentrated disadvantage index, a principal components analysis of the structural measures supported the combination of the following measures: percent of residents who are African American, percent of residents living below the poverty line, percent of families receiving public assistance, percent of residents who are unemployed, and percent of families headed by a single parent with children under 18. Each measure was equally weighted and the index created by averaging the z-scores of the five measures. The measure recognizes the often strong correlation between racial and economic segregation and the difficulty in empirically isolating the effects of either concept independent of the other (Morenoff et al., 2000).

Because of the unique demographic character of the cities under study, a slightly modified version of the concentrated disadvantage measure was employed in some of

the analyses. That index measured concentrated poverty only. The poverty, public assistance, and unemployment measures were equally weighted and the concentrated poverty index created by averaging their z-scores. This measure recognizes multiple facets of poverty while excluding those elements of the disadvantage measure which may not be relevant in certain urban contexts. In the cases where concentrated poverty was employed instead of concentrated disadvantage, a measure of family disruption was included separately. Family disruption was measured by either the percent of single parents or the percent of married family households. The choice between variables is noted in the appendices.

The second disadvantage measure was proposed by Massey (2001) in his discussion of the growing economic segregation of both poor and affluent families. Sociologists have recently turned more attention to concentrated affluence, investigating the idea that affluence is more significant than simply being ‘not disadvantaged.’ Instead, much as Wilson (1987) argued that living in a disadvantaged neighborhood compounds the effects of disadvantage, living in affluent neighborhoods can compound the effects of affluence (Brooks-Gunn et al., 1993; Massey, 1996). Affluent neighborhoods may produce protective characteristics based on access to and mobilization of various resources (Morenoff et al., 2000). The mobilization of resources plays an important role in the exertion of social control and the ability of residents to organize to address problems, including violence. Massey’s (2001) essay on the neighborhood effects literature suggested that concentrated disadvantage and affluence represent two ends of a continuum and thus are highly (negatively) correlated and should not be included in statistical models as separate measures. To accommodate this, he proposed the index of concen-

tration at the extremes (termed “ICE” by Morenoff et al.), calculated as (number of affluent families - number of poor families)/total number of families. For this research, affluence is defined as families with incomes over \$50,000 and poor is defined as families with incomes less than \$15,000. The index has a theoretical range of -1 to 1, where -1 identifies areas where all families are poor and 1 identifies areas where all families are affluent. A 0 value identifies areas with an equal share of poor and affluent families.

A third composite index measures Latino immigration and is comprised of the proportion of Latino residents and the proportion of foreign born residents. Like the concentrated disadvantage measure, the z-scores of the measures are equally weighted and averaged.

Other measures of the level of social control, or guardianship, in an area are residential stability, racial heterogeneity, and the proportion of single-person households (Wilcox et al., 2003). Stability is measured as the percentage of residents in 2000 who lived in the same residence in 1995. The heterogeneity index used here “takes into account both the relative size and number of groups in the population,” and is equal to $1 - \sum p_i^2$ where p_i is the proportion of each racial group in the population (Sampson and Groves, 1989, p. 784). The index ranges from zero to one, where one indicates maximum heterogeneity.

Other structural measures suggested by the opportunity framework indirectly measure the availability of targets and offenders. These are population density (persons per square kilometer), a land use measure which indicates the percentage of land put towards commercial or multiple uses (i.e., residential and commercial), and a distance to downtown measure which represents the distance of each block group to its city’s

downtown.

Dummy variables identifying a block group's location in a specific city were created for inclusion in some of the models. Interaction terms were created using the dummy variables and specific structural measures to determine whether the association between any of the structural measures and violence is conditional on its geographic location. For two cities, Portland and Nashville, local dummy variables were employed that measured a block group's position west of the Willamette River (Portland) or south of the Cumberland River (Nashville). These were included because in both cities, the rivers serve to divide the city and could therefore create physical regions with similar crime levels. The city of Tucson lacks any major bodies of water or other physical characteristics that serve to divide the city; therefore no local variables were created for that city. Finally, a dummy transportation variable was created for the Portland block groups indicating whether the block group contained a light rail stop, predicted to increase visitors to the area. Neither Nashville nor Tucson has an extensive rail system; both cities have only bus systems and those stops are too numerous to create much variation from block group to block group. Therefore, the transportation variable was only used in Portland analyses.

Descriptive statistics are included for all measures employed as part of the appendices. The following is a discussion of the aims and major findings of each appendix.

2.3 A global model of crime? Composing and decomposing interurban models of crime

With few notable exceptions (Rountree and Land, 2000; Velez, 2001; Smith and Jarjoura, 1988)² most studies consider neighborhoods or communities in one urban area at a time, implicitly assuming that variation across urban areas is unimportant. The most well-known of those studies that have considered more than one city is that of Smith and Jarjoura (1988) which considered victimization in 57 neighborhoods in St. Louis, Rochester, and Tampa-St. Petersburg. Based on those results, the authors concluded that the location of a neighborhood within a specific urban area did not influence the results. This tendency to ignore variation across urban areas has left the question of whether such models are generalizable across urban areas largely unanswered.

Thus, there still remains the question of whether a ‘global’ model of crime, generalizable across urban places, can be identified. This research asks: are structural associations with violence generalizable across all urban areas? This study attempts to further our understanding of whether such a global model exists by first developing a model of crime for all three cities, then replicating the results for each city individually. A comparison of the models for all three cities and for each city individually sheds light on the level of generalizability of structural measures.

The generalizability of the structural measures as covariates of crime is tested in Appendix A through the development of a set of global OLS regression models esti-

²Most crime studies that have focused on multiple cities have relied on the 1977 Police Services Study which provided data for the cities of St. Louis, MO; Rochester, NY; and Tampa-St. Petersburg, FL. A complete listing of studies based on that data is available from the Inter-University Consortium for Political and Social Research at the University of Michigan.

mated using the data for all three cities at once. That model is first estimated with the structural measures alone, then with the inclusion of dummy variables identifying the specific cities to determine whether there are unmeasured characteristics of any of the cities that influence the level of violence there. Finally, the model is estimated using the same measures for each city separately to determine how well the global model fits within each city.

The results of the global model and the sets of models developed for each city provide insight into the level of generalizability of different structural covariates of crime. The base OLS model, Model 1 in Table A.3, performs very well in explaining variation in crime across block groups, regardless of urban location. Two results from that model, however, are not in line with theoretical expectations: concentrated immigration and residential stability, but the subsequent models allowed a greater understanding of the relationships between these two variables and violence. Namely, the decomposition of the data into the three cities reveals that the concentrated immigration term is significant in Tucson only, supporting the suggestion that in the global model, the measure performs more as a locational variable than as a structural covariate of crime.

Not only is the residential stability coefficient not in the expected direction, but it is also inconsistent across models. In Model 1, the variable displays a significantly positive relationship with crime, and it is surmised that the concentration of extreme poverty may prevent residents in those areas from moving, in essence trapping residents there and resulting in the co-occurrence of stability and violence, both the cause of other processes. In the Portland model, however, the stability measure was negative, as expected.

From the global and individual model results can be drawn several conclusions. The structural measures other than concentrated immigration and residential stability are consistently significant and in the expected direction across the global OLS model and most of the individual models, lending support to the generalizability of these measures across different urban areas. The results of the dummy variables however, indicate that the model is perhaps not generalizable across all cases. Instead, there exist some local characteristics of places that should be considered in any study of crime. Namely, the demographic structure of each city under study should be considered in order to develop the appropriate measures of disadvantage. It is suggested that the global model proposed (Model 1 in Table A.3) is most appropriate for Nashville and Portland, and presumably for other cities similar in demographic and economic characteristics. In light of this finding, and the importance of the locational variable in Portland, it is suggested that the local geography of an urban area should be considered as part of any ecological study of crime. Even while explicit modeling of absolute location may not be necessary in all cases, exploration into geographic variation of crime and its covariates both within urban areas and across different urban areas should be undertaken.

2.4 Alternative measures of crime and crime profiles

The focus of the research presented here is identification of area crime profiles, or the particular mix of crimes that dominate different areas. This study first presents the crime profiles as determined by location quotients of crime (LQCs) within the city of Nashville, TN. After a discussion of the calculation of LQCs, a comparison of location

quotients and rates is provided. The location quotients are then used in a regression modeling framework to identify the characteristics of places that influence the crime profiles of places. The results demonstrate the efficacy of simple techniques that can be employed without sophisticated software. The results also demonstrate how location quotients can be incorporated into statistical models of crime and provide modest support for the opportunity framework.

The comparison of rates and location quotients in determining crime profiles provides some insight into the problems with using population-based rates, especially as measures of property crime levels in areas. The maps of crime rates and LQCs for three crime measures and the yearly maps (1998, 2000, 2002) for assault demonstrate that rate maps may not provide the best information to decision makers tasked with resource allocation. Rate maps can be misleading, as those areas with the highest rates are often not the areas with high LQs.

The correspondence between location quotients and rates is shown to be high for personal (violence, assault) crimes where the target is by nature an individual. The location quotients and rates for property crime, however, show little correspondence, and the result provides further evidence for the argument against using population-based property crime rates. This information can be used to determine what kinds of intervention and prevention programs would best target the main crime problems in each area. In addition, looking at change over time can help decision makers to predict where resources will be needed in the future.

The OLS models developed using LQCs demonstrate that this alternate measure represents a viable alternative to problematic crime rates, especially in statistical stud-

ies, where the results may be affected by the use of population as a base for independent and dependent variables and where crime rates are heavily skewed towards zero. Concentrated disadvantage, ICE, and heterogeneity were all significant in predicting property, violence, and assault LQs. The population density variable, which is included in most ecological studies of crime, is significantly negative in the violence and assault models. This finding can be interpreted in an opportunity framework, then, as a measure of guardianship. Other variables show less consistency across different models. The multiple/commercial land use measure is significant in two models, violence and assault, but is positive in the violence model and negative in the assault model. The distance to downtown measure is significant in both the property and violence models but again, has different signs on the coefficient in each model. Finally, the residential stability measure is not significant in any of the models, and is only in the expected direction in the property crime model. These are standard measures included in studies of crime in an opportunity framework and their insignificance in this model indicates the need to further investigate their relationship with crime using location quotients.

2.5 Geographically weighted regression in ecological studies of crime

The present study examines covariates of violent crime in Portland, OR, emphasizing the possible spatial variation in crime measures and their covariates by presenting a local analysis of crime using Geographically Weighted Regression (GWR). Those results are compared to the results of a 'base' global ordinary least squares model. While the global OLS model estimates one parameter for each term in the model and

assumes the parameter estimates to be stationary across the study area, the GWR method estimates parameters for all sample points in the data set, taking into account the nonstationarity of relationships.

The OLS model reveals several noteworthy insights to violence in Portland. Three measures of guardianship—concentrated poverty, heterogeneity, and single households—are all positively related to violence rates. Two other guardianship measures, residential stability and married families, are negatively related to crime rates as they indicate areas where residents might be more invested in their neighborhood and more able to mobilize resources. These relationships are all as expected given an opportunity framework. However, the ICE measure is positively related to crime in the OLS model, an unexpected result given the opportunity framework. The parameter estimate for population density in this model is significantly negative, in line with the interpretation of population density as a measure of guardianship. The coefficient for the multiple land use and light rail stop measures are both significantly positive, supporting both as measures of increased targets and offenders. Finally, the variable indicating location west of the Willamette River is significantly negative, indicating that the portion of the city west of the river is significantly different in terms of violent crime levels than the rest of the city.

In the context of the present study, the application of GWR is warranted for several reasons. The OLS model, while promising, leaves more than 50% of the variance in the violence measure unexplained. Furthermore, one parameter estimate (ICE) has a counter-intuitive direction. GWR offers an avenue of spatial data exploration in a regression modeling framework. GWR also allows a speculation on whether the

relationships between violence and the criminal opportunity measures are inherently spatial and can only be modelled accurately if space is explicitly accounted for, indicating directions for future work modeling crime in Portland, and more generally, modeling violent crime in urban areas.

Parameter estimate maps for the intercept and the ten independent variables are shown in Figures C.10-C.19 and provide the basis for most of the GWR results discussion. These maps confirm the results of the OLS model for the most part, and are especially useful in highlighting elements of the local model not evident from the OLS results. The results support a global (i.e., across the entire study area of Portland) inverse relationship between poverty and violence. At least one measure, the ICE variable, should be investigated more closely because the patterns of actual values and parameter estimates do not coincide. The results suggest that the model is not capturing some other relationship that could help explain the lack of correspondence between parameter values and concentrated affluence. The parameter estimate maps also allow visual inspection of areas where specific measures have a strong influence in the model (where the estimates are largest, or absolute values are highest). In several instances, both positive and negative values are estimated for a single measure by the GWR procedure. This highlights the importance of considering local context when modeling urban violence.

The exploratory utility of GWR parameters is extended by clustering together locations with similar parameter values for all variables, i.e., where whole models of locations are similar. This synthesizes the often huge amount of output created by the GWR model and aids interpretation of multiple parameter estimate maps. In the

present study, a hierarchical clustering method was applied to the block groups based on the nine parameter estimates and the intercept and seven clusters were created (see Figure C.20). The average values for each parameter within each group, provided in Table C.4, showed that the strongest (positive or negative) parameter estimates clustered together in groups one and five, where the average violence rates were in the low-to-mid range of all seven groups. Smaller values (positive or negative) clustered in groups six and seven, which surprisingly had the highest overall violence rates.

The results demonstrate the utility of such an analysis for exploring local processes that drive crime levels and examining misspecification of a global model of urban violence. GWR can be particularly useful in policy studies, for investigating local attitudes towards different types of interventions and the success of an intervention in different areas of a city.

2.6 Conclusion

Several conclusions can be drawn from the results of the analyses that all three appended papers provide. First, the various analyses, employing a range of statistical methods, provide solid support for the opportunity framework as a theoretical foundation in studying the context of crime. The neighborhood-level analyses presented in this dissertation support previous ecological studies of crime in identifying several structural covariates of crime. Specifically, concentrated disadvantage—both the composite measure including the minority and single parent measures, and the concentrated poverty measure—the heterogeneity index, population density, and multiple

land use are significantly related to crime and display the expected relationship with various crime measures across multiple analyses and within different urban contexts (i.e., in Nashville, Portland, or Tucson). Within Portland, two locational variables prove significant in explaining crime patterns in that city: the transportation (light rail stop) variable and the west of Willamette River variable. This support for the selected structural measures of crime contributes to our knowledge of crime context by demonstrating their invariance over place and across different methodologies.

This dissertation also makes a unique contribution to the communities and crime literature by providing a set of analyses that measure both a global model of neighborhood crime, attempting to remove absolute location from the model, and a highly local model of crime which relies heavily on absolute location of crime in estimating statistical relationships (GWR). Taken together, these analyses have provided insight into the importance of considering geography explicitly in studies of crime. The global modeling demonstrated that while a model may be appropriate for more than one city, e.g., Portland and Nashville, it will not necessarily be appropriate in all urban areas. At the very minimum, exploration of the geographic variation of crime across the study area should be considered. The local (GWR) model suggested that variation within an urban area can be very important, and that interpretation of model results can be improved if the local versions of the model are estimated.

The work presented here implies several avenues for improvement of the current work and for future undertakings. Improvements to the modeling results may be achieved through several means. First, adapting measures to local contexts where appropriate may help improve interpretation of structural covariates of crime. In this

work, both a concentrated disadvantage and concentrated poverty term are employed in different analyses. Appendix A concludes that decomposing the disadvantage measure to accommodate the existence of different minority populations in different cities would improve the interpretation of the that term and the understanding of the relationship between minority populations and violence.

Second, interactions between the structural measures should be investigated more thoroughly. Several interaction terms are presented in Appendix A, but involve only the location variables (dummy variables) and structural measures. That set of analyses suggests that a more complete investigation of the conditional effects of poverty on stability should be undertaken to determine whether poverty-related stability is indeed positively related to crime. This could provide further support to the suggestions by Warner and Pierce (1993) and others. Other interaction terms investigating the conditional effects of family disruption in the presence of extreme poverty would also be warranted.

Further critiquing the measures, those employed here may be too indirect and may not provide the best measures of targets, offenders, and guardians as suggested by the opportunity framework. Individual data collected from residents, whether averaged and included in an aggregate form or incorporated into a multilevel model, would improve measures of routine activities of residents and available targets, for instance, and better capture their affect on the three main elements of criminal opportunity. Methodologically, the theory might be better tested through multi-contextual modeling, as suggested by Wilcox (2003), which would be made possible with these individual data.

Understanding the context of crime is a key step in developing informed policy that will work to reduce crime rates in communities. The research presented here attempts to further our understanding of that context by testing the spatial relationships between crime and various neighborhood characteristics. These tasks are undertaken to improve our scientific understanding of the causes of crime, how to predict where high crime areas will develop, and how to prevent crime levels from rising. These are essential tasks in linking research with policy and practice.

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Appendix A

A GLOBAL MODEL OF CRIME? COMPOSING AND DECOMPOSING INTERURBAN MODELS OF CRIME

For submission to *Urban Studies*¹

The past two decades have seen a growing recognition by policy makers, policing agencies, and researchers that understanding the context of crime—the where and when of a criminal event—is key to understanding how crime can be controlled and prevented. Reinvigorated by Land et al.’s (1990) study of homicide covariates, many ecological studies of the last decade were driven by the search for structural covariates of crime “invariant” over space and time. Much work following in Land et al.’s footsteps, however, has been inconclusive on whether there exist such invariant structural covariates of homicide, or of violent crime more generally; the results of literature within the ‘communities and crime’ vein have been contradictory (Miethe and Meier, 1994; Warner and Pierce, 1993; Smith and Jarjoura, 1988, 1989).

With few notable exceptions (Rountree and Land, 2000; Velez, 2001; Smith and Jarjoura, 1988)² most studies consider neighborhoods or communities in one urban area at a time, implicitly assuming that variation across urban areas is unimportant.

The most relevant of those studies to the present work is that of Smith and Jarjoura

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²Most crime studies that have focused on multiple cities have relied on the 1977 Police Services Study which provided data for the cities of St. Louis, MO; Rochester, NY; and Tampa-St. Petersburg, FL. A complete listing of studies based on that data is available from the Inter-University Consortium for Political and Social Research at the University of Michigan.

(1988), which considered victimization in 57 neighborhoods in St. Louis, Rochester, and Tampa-St. Petersburg. Based on those results, the authors concluded that the location of a neighborhood within a specific urban area did not influence the relationships between victimization and its macrostructural covariates. That work represents an exception, however, and the tendency to ignore variation across urban areas has left the question of whether such models are generalizable largely unanswered.

Following recent larger trends in the social sciences, contemporary analyses of crime have begun stressing the local—recognizing the importance of local characteristics in influencing urban crime patterns. This communities and crime literature is moving toward multi-contextual studies that consider individuals' experiences with crime as nested within a larger contexts, usually the neighborhood or community. Such multi-contextual research proposes two-level analyses, modeling the individual and the neighborhood. This more individually-focused research, however (see Rountree and Land (2000)), suffers the same shortcoming as earlier, more structurally-focused work as the body of literature largely fails to consider how generalizable the findings are across urban areas.

Thus, there still remains the question of whether a 'global' model of crime, generalizable across urban places, can be identified. An understanding of the structural influences on crime and how the associations between those structural characteristics and crime may vary from city to city can inform more locally-focused studies. This research thus asks: are structural associations with crime generalizable across all urban areas? The study attempts to further our understanding of whether such a global model exists through an examination of neighborhood crime in three mid-size cities in

different regions of the United States: Nashville, TN; Portland, OR; and Tucson, AZ. The study first develops a model of crime for all three cities, then attempts to replicate the results for each city individually. A comparison of the models for all three cities and for each city individually will shed light on the level of generalizability of structural measures. Before discussing the statistical results, a discussion on the theory of structural covariates of crime is warranted.

A criminal opportunity framework

For most of the last two decades, ecological studies of crime have been informed by two somewhat different perspectives: (1) social control-disorganization theory and (2) routine activities theory. Although the two schools of thought are closely related, an important distinction can be made. Social control-disorganization theory focuses on the ability (or lack thereof) of residents of some geographic unit (e.g., a neighborhood) to come together to achieve a common goal, like reducing predatory crime. Alternatively, routine activities theory focuses on the presence of opportunities for crime in an area, as shaped by residents' daily activities. Much recent work in the communities and crime vein has drawn from both of these theories, but integration of the two theories provides the most robust theoretical foundation for ecological studies of crime. Wilcox, Land, and Hunt's (2003) recent articulation of the integration of social control-disorganization and routine activities theories into a criminal opportunity perspective provides perhaps the most successful attempt yet.

Social disorganization

Moving away from the well-known roots of social disorganization theory laid by Shaw and McKay (1929), recent theorists ((Sampson and Groves, 1989; Bursik and Grasmik, 1993)) have reformulated social disorganization into a systemic theory. These recent articulations of social ‘disorganization’ in fact emphasize the control and organizational aspects of places. The systemic model recognizes primary and secondary relational networks that control neighborhood crime, including the role of local neighborhood organizations as agencies of social control, and addressing the (power-based) ability of the neighborhood to acquire external resources to fight crime.

Empirical research testing this reformulated social disorganization theory demonstrate the importance of structural components of urban areas in explaining the crime that occurs there (Sampson, 1997). In particular, five exogenous structural components have been identified as main sources of social disorganization: low socioeconomic status, high residential mobility or population turnover, and high racial or ethnic heterogeneity, family disruption (e.g., divorce, single parent families) and urbanization (often measured with a density variable) (Shaw, 1929; Sampson and Groves, 1989; Stark, 1996).

Sampson (1986) identified the process by which these main causes work to increase disorganization. He described a breakdown in social integration due to population turnover, ethnic or racial heterogeneity, and broken families. In these areas, residents are not successful at organizing to address crime and other problems. The socialization of children becomes problematic due to the lack of social integration, and informal

control of youth in those areas is difficult. Adults are either not present to provide supervision or are hesitant to supervise children that are not their own—a level of supervision that is often observed in relatively stable neighborhoods. The result is that children are not socialized or supervised, leading to the acceptance, or at the very least, unawareness of deviant behavior. Levels of poverty and urbanization exacerbate the process of disorganization. Poverty affects the ability of an area to garner resources to address problems and can also have conditional effects on the other causes of disorganization. Higher levels of urbanization are often associated with large populations and a high level of visitors on a daily basis for work, recreation, etc. Large resident and visitor populations can decrease the level of control residents are able to exert within an area. The combination of these different characteristics in one area lead to growing “illegitimate opportunity structures and dysfunctional lifestyles” including violence and crime (Elliott et al., 1996, p. 394).

Routine activities

Routine activities theory is at its core a criminal opportunity theory focusing on the daily rhythms of life in a geographic area and how those rhythms, created by the activities of residents and visitors, create opportunities for crime. Central to the theory is the idea that the spatial and temporal variation of three key elements—offenders, targets, and guardians—creates criminal opportunities. Specifically, a motivated offender, a suitable target, and the absence of a capable guardian are necessary conditions for a criminal event. Because of the theory’s focus on criminal events and not individ-

ual criminality, the theory can be used to explain both offending and victimization in places. Place and structure thus take center stage in explanations of criminal events (Eck et al., 2000).

Structural changes in the routine activities of residents affect the convergence in space and time of the offender, target, and guardian, thus changing opportunities for crime and, in turn, a place's level of crime (Cohen, 1981). Contextual factors of a neighborhood, like sociodemographic characteristics and the temporal setting, affect routine activities of residents and non-residents alike. Residents' routine activities can thus also affect the attractiveness of an area to non-resident offenders. Those routine activities in turn affect the spatial distribution of offenders, targets, and guardians.

The existence of the three key elements of criminal opportunity is a function of the routine activities of an area's residents and visitors around such things as work, family, recreation, and education. "The prevalence and mix of different kinds of routine activities vary between communities" and in turn affect the levels of formal and informal social control that exist in an area (Wikstrom, 1998, p. 293). Sampson and Morenoff underscore how this structure of routine activities and criminal opportunity affects levels of crime and victimization in areas—not just for individuals or households—asserting that "motivated offenders may be influenced by the criminal opportunity structure of entire areas" (2000, p. 373).

Several aspects of routine activities theory as conceptualized by Cohen, Felson, and others emphasize the role of the household and family in determining routine activities and victimization risks. Cohen suggested that criminal victimization varied inversely with "the concentration of patterned or routine activities in or near households, par-

ticularly familial households,” (1981, p. 141). In other words, those who spend more time with family members and whose routine activities are focused around the home will have lower risks of victimization.

Family structure in particular plays a key role in influencing routine activities. Individuals will be at greater risk of victimization when they “disproportionately associate with, or come in contact with, members of demographic groups that contain a disproportionate share of offenders” (Sampson and Lauritsen 1994, p. 14). More time away from home means increased proximity to offenders and decreased guardianship of the home. Specifically, single and divorced persons are more likely to live in single-member households and to spend more time outside of the home, as partially determined by sociodemographic factors like age. For example, young, single, males tend to have lifestyles that put them away from the home and in closer proximity to offenders and they therefore have a greater risk of victimization.

These factors increase the likelihood of victimization for single and divorced individuals and also the likelihood of crime in the areas where they live. Areas with a large percentage of the population in such situations often provide or create anonymity for the residents, preventing social ties and effective guardianship. Even if single or divorced residents are at home, the level of guardianship in these areas tends to be lower than in households where more than one person resides. Thus, “regardless of one’s household family composition and even proximity to offenders, living in a community with low guardianship and surveillance may increase victimization risk” (Sampson and Wooldredge, 1987, p. 373).

Criminal opportunity

In recent work, Sampson, Bursik, and others who have made enormous contributions to the development of social disorganization theory have recognized the importance of routine activity measures in ecological or environmental studies of crime, and have advocated their inclusion in models of crime that consider so-called “neighborhood effects” (Bursik and Grasmik, 1993; Sampson and Morenoff, 2000; Sampson et al., 2002). Bursik’s (1993) systemic model of social disorganization integrates key elements from routine activities. Capowich (2003) describes Bursik’s idea of systemic controls, both formal and informal, as influencing the routine activities of residents which in turn affects the opportunities for crime. From social disorganization, Bursik drew the control ideas, and from routine activities theory came the framework for consideration of resident’s lifestyles. The two elements were brought together conceptually under a control model. Other authors have also advocated the integration of the two theories, although none has offered as complete an effort as Wilcox et al. (Kennedy and Forde, 1990; Miethe and Meier, 1994; Sampson and Wooldredge, 1987; Smith and Jarjoura, 1988; Wikstrom, 1998).

The criminal opportunity framework suggested by Wilcox et al. explicitly focuses on the opportunity context, which is a function of three necessary elements: motivated offenders, suitable targets, and (the lack of) capable guardians. In a criminal opportunity framework, all individuals in a bounded locale (place) are assumed to be motivated offenders. Thus at a macro level, exposure to the motivated offender population is a function of population density, i.e., the higher the population density, the higher one’s

exposure to motivated offenders. Visitors to an area also contribute to the supply of offenders; these populations can be thought of as functions of land use in the area.

Furthermore, under this conceptualization, targets can be objects or individuals. Thus all else being equal, areas with a larger supply of attractive material goods—e.g., small but highly valuable items like expensive jewelry or electronic equipment—can be seen as creating more opportunities for crime.

The relevance of social control theory to the opportunity framework is centered on the guardianship concept. Capable guardians are individuals, but guardianship is affected not only by the simple number of people in a place, but the ability of the population in that place to effect social control and prevent crime. The mobilization of resources plays an important role in the exertion of social control and the ability of residents to organize to address problems, including violence. In particular, disadvantage can decrease the level of social control operating in an area by restricting the ability of residents to mobilize resources.

In the search for a set of structural covariates of crime generalizable across different urban areas, the present study focuses only on the neighborhood level of analysis. Thus while not providing a complete test of theory, this study will nonetheless contribute to an understanding of ecological aspects of criminal events.

Three mid-size cities

While selected for similar population sizes (each city has approximately half of a million residents) and violence levels, Nashville, Portland, and Tucson each have a distinct

character, influenced by very different social and economic histories that may influence the level and type of crime that occurs there. In addition, each city is located in a different region of the country, another factor which may influence the crime patterns in each city. Before discussing the statistical results of the present study, then, a brief introduction to each city and an identification of those unique characteristics that sets each city apart from the other two is warranted.

Located in middle Tennessee, Nashville is a city of approximately 546,000 people. Figure A.1 shows both the distribution of violence in the city and key geographic characteristics of the city. Violence rates are highest in the center city and on the eastern edges of the city. The downtown is located in the center of the city along Interstate highway 65 and the southern banks of the Cumberland River, which meanders through the city on a roughly east-west line.

In the last decade, the city saw modest population growth of about 11.7%, slightly below the 17.3% growth rate of the South as a whole (Perry and Mackun, 2001). This is the lowest population growth of the three cities considered here. More than one-quarter of Nashville's population is African American, today representing a larger proportion of Nashville's population than it did in 1990. This also represents the largest African American population of the three cities included in the present study.

The role of the city during the civil rights movement and later, the growth of the highway system through downtown, combined to cement the sharp geographic divisions within Nashville along racial and economic lines. The city's racial groups remain fairly segregated, with large African American populations downtown and north of the Cumberland River. Another key demographic feature of the city is its relatively small

but growing Latino population; the city's nearly 26,000 Latinos now represent 4.7% of the city's population. In 1990, Latinos comprised only 1% of the city's population. Nashville has the smallest Latino population of the three cities in the present study.

The sprawl of the city outward has resulted in a downtown that today lacks strong residential, retail or services sectors and fails to attract a large number of visitors from other parts of the city. While the city hosts an extensive bus system, the downtown itself lacks easy access via public transportation. One Nashville resident describes the city as "the quintessential bedroom community," characterized by families and lacking a "young, hip, professional crowd" (Padgett, 2002). Development of the downtown is a key goal of city officials with extensive investment in the area planned.

Middle Tennessee has recently seen rapid growth in the last 15 years of the automobile manufacturing industry, especially near Nashville, and this growth has served to emphasize the automobile as the city's chosen form of transportation. Indeed, development on the edges of town continues to shape the character of the city, emphasizing its suburban sprawl.

Portland, Oregon has had a much different social and economic development. Located in the Pacific Northwest, Portland is a city of approximately 529,000 people. The map of violence rates in Figure A.2 reveals that the highest levels of violence are clustered in the downtown area and along the northern edge of the city. In addition, there are pockets of high violence on the eastern side of the city. The map in Figure A.2 also shows some key elements in the geography of Portland. Namely, there are several main highways, the Willamette River, and a light rail system that serve to divide the city into five distinct sectors (northwest, west, south, east, and north). The city's

downtown is located on the western banks of the Willamette River and encircled by Interstate Highways 5 and 405. A light rail system generally follows Interstate Highway 84, cutting west-east across the center of the city.

Portland's population growth during the 1990s was larger than Nashville's; the city's population grew nearly 21% over the 10-year period. This represented much slower growth than that experienced in Southwestern states like Arizona, but represents only slightly higher growth than that experienced by the West as a whole (Perry and Mackun, 2001). The city's population is largely White, with small percentages of African Americans (6.6%) and Latinos (6.8%). This demographic structure, along with the slow and homogenous population growth of the city and because this minority population was, and remains, clustered in a small area of the city outside of downtown, Portland largely avoided experiencing "the high level of social conflict that occurred elsewhere at the same time in terms of the racial politics and social tensions of the era" (Wollner et al., 2001, p. 4). As occurred in many cities in the U.S., the mid-1950s saw increasing movement of downtown residents to the edges of the city. Again, the demographic structure of the city meant that the movement of residents out of the downtown did not result in a clustering of intense poverty and minority populations in that area—a feature that characterized many other center cities during that era, including Nashville.

Today, development in Portland has a unique character as a result of urban growth boundaries (UGB), a state-mandated growth control strategy that is based on expected urban growth. The UGB represents the geographic limits of city growth, preventing sprawl and emphasizing instead high density and infill development (Phillips and Good-

stein, 2000). Portland's development is thus focused inward, contributing to growth in employment in center city areas and more efficient use of existing facilities and infrastructure. Of the three cities in the study, Portland has the most vibrant downtown, easily accessible by public transportation and currently experiencing increased development.

The third city under study is Tucson, AZ, a city of approximately 487,000 people. It should also be noted that the study area includes South Tucson, an independent municipality of about one square mile and less than 6,000 people located completely within the borders of Tucson. Located 60 miles north of the U.S. border with Mexico in the sunbelt of the Southwest, Tucson's population growth was actually less than that of the state as a whole. Over the ten year period from 1990-2000, the state of Arizona experienced a 40% growth in its population, while the city of Tucson itself grew by about 20%.

Demographically, Tucson is unique compared to Nashville and Portland, with the largest Latino population of the three cities. Well over one-third of Tucson's population was Latino in 2000. Moreover, South Tucson's population is more than 80% Latino; that city and the area around it serve as the Tucson's Latino core. Much like Portland, however, Tucson has a very small African American population—less than 5% of the city's population is African-American in 2000. In addition, Tucson attracts so-called 'snow-birds' who converge on the city from colder climates during the winter months. These usually retired, older residents often don't change their permanent residence to Tucson and thus are largely not reflected in the census figures, but do have an impact on the demographic structure of the city.

Figure A.3 shows the geographic pattern of violence in the city and identifies some key features of the city. The map reveals that the highest levels of violence are located in the western-central part of the city, near South Tucson and downtown. There are no major bodies of water in Tucson, and the city is not divided by any major highways as both Portland and Nashville are. Interstates 10 and 19 run along the southern and western edges of the city. In addition, Davis-Monthan Air Force Base is located in the southeast of the city. Finally, while not identified on the map, Tucson is bordered on the west, north, and east by mountain ranges.

Unlike Portland, Tucson's growth is mainly outward, with the majority of the metropolitan area's growth taking place in the northwest. The development is occurring along Interstate 10 which leads north to Phoenix and the southeast. To the north, development in the foothills of the Santa Catalina mountains represents growth of some of the most affluent portions of the metropolitan area. As these areas are outside the borders of the city, they have not been included in the statistical analysis.

While Nashville has experienced a decline in the economic activity of its downtown, Tucson's downtown is perhaps the least developed of the three cities. While the city historically was centered around the downtown, only a handful of bars, a historic hotel, and some small galleries are all that remain to attract Tucson's widespread population to the area. What is left of the downtown hardly serves as a social or economic center and the few business attractions in the area include the Tucson Convention Center and government buildings. Tucson can be described as lacking a center around which economic, retail, and recreational activities are focused. In addition, like Nashville, the city's public transportation system consists only of bus service. Industry in the city

is focused on The University of Arizona, a state university of approximately 35,000 students, the Air Force Base, and Raytheon, a defense contractor and major employer in the region. In addition, tourism contributes a great deal to the economy of the city.

Selected demographic characteristics for each city have been summarized in Table A.1.

Data and Methods

Violent crime data³ were collected from all three cities for the years 1998-2002. The location and date of each crime was collected, and that data was geo-coded and aggregated to the census block group level. Frequencies of crime for each category were averaged over the five years in the study period to control for anomalous years when there may have been an unexplained spike or fall in crime. Rates were then calculated using population figures from 2000. To account for the highly skewed nature of the crime rate variable, the natural logs of the violence rates were used. None of the independent variables is logged.

Several block groups were excluded from the analysis because they represented extreme cases in terms of crime. The extreme cases had either no instances of violence over the 5 year period, or had average rates in excess of 100,000 crimes/100,000 persons over the five year period. Together, these extreme cases represented less than 3% of the total block groups. The study thus included 1,282 block groups: 442 in Nashville, 441 in Portland, and 399 in Tucson.

³Includes homicide, sexual assault, robbery, and aggravated assault

Based on the 2000 Census and the theoretical framework, several structural measures were developed for use in the regression modeling at the block group level. Following Morenoff et al.'s (2000) study of homicide in Chicago two composite indices are employed, one measuring disadvantage and one measuring Latino immigration. Because the mobilization of resources plays an important role in the exertion of social control and the ability of residents to organize to address problems, including violence, a composite measure of disadvantage was employed. For the concentrated disadvantage index, a principal components analysis of the structural measures supported the combination of the following measures: percent of residents who are African American, percent of residents living below the poverty line, percent of families receiving public assistance, percent of residents who are unemployed, and percent of families headed by a single parent with children under 18. Each measure was equally weighted and the index created by averaging the z-scores of the five measures. The use of a composite measure recognizes the often strong correlation between racial and economic segregation and the difficulty in empirically isolating the effects of either concept independent of the other (Morenoff et al., 2000). While the concentration of disadvantage, especially poverty, is expected to be positively related to violence rates in all three cities, this measure is expected to have the strongest relationship with violence in Nashville, as that city has the largest African American population of the three cities.

The second composite index measures Latino immigration and is comprised of the proportion of Latino residents and the proportion of foreign born residents. Again, the z-scores of the measures are equally weighted and averaged. This measure is expected to have the strongest relationship with violence in Tucson, which has the largest Latino

population.

Other measures of the level of social control, or guardianship, in an area are residential stability, racial heterogeneity, and the proportion of single-person households (Wilcox et al., 2003). Stability is measured as the percentage of residents in 2000 who lived in the same residence in 1995. The heterogeneity index used here “takes into account both the relative size and number of groups in the population,” and is equal to $1 - \sum p_i^2$ where p_i is the proportion of each racial group in the population (Sampson and Groves, 1989, p. 784). While the index has a theoretical range from zero to one, where one indicates maximum heterogeneity, the extreme values are not observed in reality.

Other structural measures suggested by the opportunity framework indirectly measure the availability of targets and offenders. These are population density (persons per square kilometer) and a land use measure which indicates the percentage of land put towards commercial or multiple uses (i.e., residential and commercial). These measures are postulated to influence the number of motivated offenders and targets in an area; multiple land use especially can indicate areas that are more easily accessible and have more visitors. It should be noted, however, that population density can be interpreted differently within the same theoretical framework; it can be understood to increase the number of *guardians* in an area, thus having a negative relationship with crime rates. The evidence in the literature regarding population density has been mixed but the variable has been included here because of its theoretical justification.

Dummy variables identifying a block group’s location in a specific city were created for inclusion in some of the models. Finally, interaction terms were created using the

dummy variables and specific structural measures to determine whether the association between any of the structural measures and violence is conditional on its geographic location. Descriptive statistics for the structural measures are shown in Table A.2.

A global model of crime

The generalizability of the structural measures as covariates of crime is tested here through the development of a set of global OLS regression models estimated using the data for all three cities at once. That model is first estimated with the structural measures alone, then with the inclusion of dummy variables identifying the specific cities to determine whether there are unmeasured characteristics of any of the cities that influence the level of violence there. Finally, the model is estimated using the same measures for each city separately to determine how well the global model fits within each city.

The standardized coefficients of the four global models of crime are provided in Table A.3. Model 1 includes only the structural covariates, all of which were significant and, with two exceptions (immigration and residential stability), in the expected direction. Concentrated disadvantage has a positive coefficient indicating that when concentrated disadvantage increases, so does violent crime. Disadvantage can foster violent crime by impeding a neighborhood's ability to mobilize resources for addressing crime problems and to develop social control. The heterogeneity index has a positive coefficient, supporting the idea that greater heterogeneity of residents can impede the development of social ties and, following that, social control. The coefficient for pop-

ulation density, which has provided conflicting results in previous work, is negative here. This is in line with the guardianship interpretation of the measure, indicating that when the density of persons in an area is higher, guardianship is also higher, driving down crime rates. The percent of total area dedicated to multiple or commercial land use is positively associated with violent crime. In an opportunity framework, multiple and commercial land use can be seen to increase visitors to an area, increasing the number of potential offenders and victims. The positive coefficient was therefore expected. In this model, concentrated disadvantage and the heterogeneity index have the largest parameter estimates, indicating that they have the greatest influence, of the structural measures included, on the level of violence across the three cities.

The parameter estimate for concentrated immigration, expected to be positively related to crime, particularly due to the similarity in geographic patterns of high crime and Latino populations in Tucson, is actually negative. The model thus indicates that areas with large immigrant populations have lower levels of crime. The inclusion of dummy variables in subsequent models is expected to provide more insight into the relationship between the immigration and violence measures. The coefficient for the residential stability term here is positive, while the opportunity framework suggests that it has a negative relationship with crime. Recent studies have shown positive relationships between residential stability and crime (Patterson, 1991; Warner and Pierce, 1993; Miethe and Meier, 1994). Warner and Pierce (1993), for example, suggest that extremely poor families may be unable to move out of “public housing and urban ghettos” where they are socially and economically isolated from mainstream society. Because of these families’ inability to garner adequate resources to remove themselves

from those areas, the neighborhoods themselves are relatively stable but remain prone to high levels of violence because of other social conditions in the area. Such a situation may be occurring in the cities under study, and the decomposed models, i.e., the models developed for each city separately, will provide insight into the relationship of stability and violence.

Model 2 includes the structural covariates and the dummy variables for Tucson and Nashville; Portland was chosen as the reference city as demographically, the city appears as the median between Tucson and Nashville. The inclusion of the dummy variables provides several notable results. First, the dummy variables are both significant, although the Nashville estimate is only significant at the 0.10 level while the Tucson estimate is highly significant. This result is important in that it indicates that there are unmeasured characteristics of each city that influence the crime rates but that are not included in the present model. This contradicts the findings of Smith and Jarjoura (1988) whose also employed dummy location variables in their study of victimization in 57 neighborhoods of St. Louis, Rochester, and Tampa-St. Petersburg. Their work indicated that the specific urban location of a neighborhood did not influence the results of the analysis. With larger samples from each city, the present study likely provides more accurate results than the Smith and Jarjoura study. The results of the present study indicate that relative to block groups in Portland, block groups in Tucson have significantly lower levels of crime. The opposite is true for Nashville, although the parameter estimate on the Nashville variable is very small, and again, the estimate is only weakly significant. Finally, the inclusion of the city-specific variables changed the estimates of the structural variables. Most notably, the concentrated im-

migration variable fell out of the model. While small and non-significant, the estimate for the measure is positive, as was originally expected. The remaining variables in Model 2 are significant and, except for residential stability which remains positive, in the expected direction.

Because the concentrated disadvantage index contains a measure of African American population and Nashville has the largest African American population, further investigation is needed to determine if the strength of this estimate in the global model is influenced by the inclusion of Nashville in the model. This will be accomplished through an interaction term measuring disadvantage in Nashville alone. The results of this effort are shown in Model 3.⁴ Indeed, the significance at the 0.05 level of the Nashville disadvantage term indicates that the influence of the measure is most pronounced in that city. The strength of the other structural measures in the Model 2 is supported as those results did not change with the inclusion of the interaction terms.

It is suspected that the very small Latino populations in Nashville and Portland may have influenced the results of Models 1 and 2. To determine whether the influence is in fact strongest in Tucson, an interaction term measuring immigration in Tucson alone is included in Model 4. The results indicate, however, that the concentrated immigration measure is not more influential in Tucson. The coefficient is non-significant and very small.⁵ The results of the other structural variables did not change from Model 2.

⁴The introduction of interaction terms to a model often increases the collinearity of the measures in the model. To ensure that collinearity was not a problem, the variance inflation factor (VIF) for each parameter was calculated. The VIFs of the parameters in Model 3 all remained below 3 except for the disadvantage and Nashville disadvantage terms whose VIFs were 4.6 and 3.8 respectively. This indicates that collinearity of the measures is fairly low in this model.

⁵The VIFs for this model remained low except for the Tucson and Tucson immigration variables, with VIFs of 5.8 and 4.1 respectively. Collinearity is thus a greater concern in this model than in the previous models.

The non-significance of the immigration variable with the inclusion of the city variables and interaction terms indicates that this measure may be acting more as a Tucson identification variable more than as a structural covariate of crime. That is, almost all block groups in Tucson have higher Latino populations than any block group in the other two cities,⁶ which may be causing this variable to perform much like the dummy variable does—locating those block groups in Tucson—instead of as a structural measure that influences crime. This is an unexpected result, as Morenoff et. al's (2001) work provided some support for the immigration measure as a covariate of crime. Because this was the only structural variable that was non-significant and because of the variable's suspected performance as a dummy variable, the variable was excluded from Model 5. The results in Model 5 reveal that the performance of the other structural variables was not affected by the exclusion of the immigration measure. The Tucson variable also remains significant. The Nashville variable, however, falls out of the model and indicates that the association between crime and the structural variables is similar in Portland and Nashville, but unique in Tucson. The relationship between concentrated immigration and crime is expected to become more apparent with the development of the model for Tucson alone.

⁶An examination of frequency tables for the proportion Latino in each city revealed that in 90% of Nashville's block groups, Latinos comprise less than 10% of the population; in 83% of Portland's block groups, the same is true. In Tucson, however, Latinos comprise less than 10% of the population in fewer than 7% of the city's block groups.

Decomposing the global model

The results of the global model of crime will be strengthened if the model performs similarly when the data is divided into three groups. The following sections thus present the results of models developed for each city individually. While no formal testing on the effect sizes was conducted, there exist several expectations regarding the direction of the effect size differences between models. Based on knowledge of crime in each city and the demographic characteristics of each city, for several measures the Portland model is expected to have coefficients that are higher than those in the Tucson model and lower than those in the Nashville model. Those measures are concentrated disadvantage, residential stability, and single households. Tucson is expected to have the largest effect sizes for the concentrated immigration and multiple land use measures, while Portland is expected to have the largest effect sizes for population density. These expectations will be explored below with each city's individual model.

Portland

Table A.4 provides the results of several models for Portland alone. These models are based on data for 442 block groups within Portland and include the same covariates as were included in Model 1 of the global models. Model 6 reveals, not surprisingly, that the concentrated immigration term is non-significant and in the opposite of the expected direction. The concentrated disadvantage and heterogeneity index measures were again significant and the strongest estimates in the model, as was the case in Model 1. The single-person households term, however, is non-significant in Model

6, indicating that in Portland, single-person households are not very important in determining crime levels.

The results of the initial Portland model are reassuring in that, excluding the concentrated immigration and single-person households term, the structural covariates performed similarly to the global models. In fact, the negative coefficient on the residential stability term indicates that in Portland, stability has the theoretically expected relationship with violence.

Additional work on violence in Portland revealed that some neighborhoods may have crime levels that are explained by their location within the city (see Appendix C, this volume). Specifically, a location variable was included that indicated whether the area was west of the Willamette River. The river divides the city into two parts (see Figure A.2) and may thus be acting as a barrier to the spread of both violence and its correlates. This measure was shown to be highly significant and negative in the previous model of crime in Portland and was therefore introduced in this model to determine how it affected the results of the model developed here. Model 7 provides the results of that exercise and reveals that the West of Willamette term is indeed highly significant. With the inclusion of the term, the single-member households measure is also significant and the performance of the model is improved: the explained variance in the dependent variable increased by 5.5%.

Because the concentrated immigration term has been consistently nonsignificant, excluding Model 1, and because it was suggested that the term was performing as a dummy variable for location in Tucson, the model was tested in Portland without the immigration term. Model 8 provides the results, and demonstrates that exclusion

of the variable does not change the performance of the other structural or locational variables. The exclusion of the term in Model 8 also does not significantly change the level of explained variance in the dependent variable. Finally, the strongest predictors of violence in Portland the heterogeneity index and the multiple land use terms are the strongest predictors of violence in Portland, which is consistent across Models 6, 7 and 8. In all the global models, however the disadvantage measure was the strongest while either heterogeneity or multiple land use was the second strongest. The weakness of the disadvantage term in Portland may be a result of its very small minority population.

Nashville

Model 5 above revealed that without the influence of the concentrated immigration term, the Nashville dummy variable was nonsignificant, indicating that the association between structural variables and the violence measure was not significantly different in Portland and Nashville. Based on that finding, similar results are expected in the Nashville models as were obtained in the Portland models. Table A.5 provides the results for the models developed for Nashville alone. These models are based on data for 441 block groups within the city of Nashville. Model 9 reveals results very similar to Portland's Model 6; all structural covariates are significant with the exception of the concentrated immigration term. In Nashville, however, the residential stability measure is again positive, suggesting that in the global model, Nashville block groups may have influenced the model to create the positive coefficient there. The results from Tucson will further highlight the relationship of this measure with violence.

Similar to the geographic layout of Portland where the Willamette River divides the city, Nashville's Cumberland River divides the city along a roughly east-west line (see Figure A.1). To investigate whether this feature significantly divides the city into low and high violence areas, a location variable is included in Model 10, indicating whether a block group is located south of the Cumberland River. Unlike the results in Portland, where the location variable was highly significant, in Nashville location south or north of the river does not significantly affect the level of crime in a block group. Inclusion of the variable does not change the results of the other structural models, nor does it significantly increase the amount of variance in the dependent variable described by the model. The variable is thus excluded from subsequent models.

Following Model 8 in Portland, the concentrated immigration variable was excluded in Model 11 for Nashville. The results indicate that exclusion of that variable, which was insignificant in the other two Nashville models, has virtually no effect on the other structural variables and does not significantly change the amount of variance in the dependent variable explained by the model. It should also be noted that the strongest predictors of violence in the Nashville models are concentrated disadvantage and the multiple land use term, as was the case in global models and the Portland models.

Tucson

A final model is developed for Tucson, where the concentrated immigration term is expected to be significant and positively related to crime. This indeed is the case, as shown in Model 12, Table A.6. The results show that concentrated immigration is

positively related to crime rates in Tucson. The residential stability measure in Tucson was non-significant but positive, which could be a factor of concentrated poverty as discussed above. More likely in the case of Tucson, however, it is the result of rapid population growth that the region has experienced in recent years. Along with the population growth comes a large rental housing market to accommodate new residents. The influx of new residents to the city means that few areas have a significant level of residential stability, and that general lack of stability across the city can influence the expected relationship between violence and stability. The performance of this variable in the present study was not wholly surprising, as previous work in Tucson revealed a similar result (Cahill and Mulligan, 2003).

The heterogeneity index and the multiple land use terms are the strongest predictors of crime in Tucson, indicating that the Tucson block groups were most likely influencing the performance of the heterogeneity index in Model 1, the first global model. Of the three cities, however, Tucson's standard model, using the same constellation of variables introduced in Model 1, explains the least amount of variance in violence across the city. Finally, because Tucson has no major physical characteristics that serve to divide the city as the rivers in Portland and Nashville do, no locational variables were included in the Tucson model.

Comparing the base model for each city—i.e., the model with the original seven measures used in model 1—the effect sizes differences between models for the most part followed expectations. One notable departure from expectations includes the heterogeneity index, where Portland had a larger effect size than either Tucson or Nashville. This could be the result of the inclusion of the concentrated immigration

term, which is likely accounting for the minority population in Tucson and rendering the heterogeneity index in that city less important. Other unexpected results were the residential stability and population density terms, which were both largest in Nashville. In future research, significance testing of the effect sizes will allow a more detailed examination of these differences.

Discussion

The results of the global model and the sets of models developed for each city have provided insight into the level of generalizability of different structural covariates of crime. The base OLS model, Model 1, performed very well in explaining variation in crime across block groups, regardless of urban location. Two results were not in line with theoretical expectations—concentrated immigration and residential stability—but the subsequent models allowed a greater understanding of the relationships between these two variables and violence. Namely, the separation of the data by city revealed that the concentrated immigration term was significant in Tucson only, supporting the suggestion that in the global model, the measure performed more as a locational variable than as a structural covariate of crime. The significance of the measure in Tucson, however, suggests that areas in the city with larger Latino populations are expected to have higher levels of violence. The relationship between proportion Latino and violence may be similar to the relationship identified by Morenoff et al. (2001) between proportion African American and violence. The argument for including the racial measure as an element of concentrated disadvantage in that study was justified

due to the similar social processes which serve to concentrate poverty, minorities (particularly African Americans) and single parent households into the same geographic areas. Following that, it can be argued that Tucson's Latino population may be subject to similar processes that concentrate minorities in poor areas and thus that a disadvantage measure accounting for Latinos instead of African Americans may be more appropriate in models of Tucson violence.

Not only was the residential stability coefficient not in the expected direction, but it was also inconsistent across models. In Model 1, the variable displayed a significantly positive relationship with crime, and it was surmised that the concentration of extreme poverty may prevent residents in those areas from leaving, in essence trapping residents there and resulting in the co-occurrence of stability and violence, both the cause of other processes. In the Portland model, however, the stability measure was negative, as expected. In both the Nashville and Tucson models, the coefficient for the measure was positive, but was only significant in the Nashville model. This finding prompted a revisiting of the global model to test an interaction between the Nashville term and the stability term. While the results of that model are not shown here, the Nashville stability term was positive but not significant, and the residential stability term remained positive and significant in the presence of the interaction term. Stability, then, does not have an effect that is conditional on location; i.e., there is not a unique relationship between stability and violence that exists only in Nashville.

The city location variables in the global models, introduced in Model 2, were significant, indicating that there are specific characteristics of each city that serve to influence the level of crime there. Specifically, relative to Portland levels of violence are lower in

Tucson and higher in Nashville. Interaction terms using the location variables in the global models also indicated that disadvantage had a unique relationship with violence in Nashville whereby its positive relationship was stronger there than in either of the other two cities. This result was not wholly unexpected as the disadvantage model included a measure of the proportion of African Americans and Nashville by far has the largest African American population of the three cities. Decomposing the disadvantage measure for cities like Portland and Tucson into a concentrated poverty measure, as was done in previous work in Portland (see Appendix C, this volume), may improve the understanding of the relationship between poverty and violence in those cities.

The results of the city location variables and the concentrated immigration variable indicate that there are actually two models that can explain the levels of violence across the three cities: a model that best explains violence in Portland and Nashville, and a model that best explains violence in Tucson. The Tucson dummy variable alone was significant in the global model once the concentrated immigration term was removed. Further, the individual Portland and Nashville models performed similarly while the Tucson model was unique on several counts.

Conclusion

Several conclusions can be drawn from the global and individual model results. The structural measures other than concentrated immigration and residential stability were consistently significant and in the expected direction across the global OLS model and most of the individual models, lending support to the generalizability of these measures

across different urban areas. The results of the dummy variables, however, indicate that the model is perhaps not generalizable across all cases. Instead, there exist some local characteristics of places that should be considered in any study of crime. Namely, the demographic structure of each city under study should be considered in order to develop the appropriate measures of disadvantage. It is suggested that the global model proposed (Model 1 in Table A.3) is most appropriate for Nashville and Portland, and presumably for other cities similar in demographic and economic characteristics. In light of this finding, and the importance of the locational variable in Portland, it is suggested that the local geography of an urban area should be considered as part of any ecological study of crime. Even while explicit modeling of absolute location may not be necessary in all cases, exploration into geographic variation of crime and its covariates both within urban areas and across different urban areas should be undertaken.

Improvements to the modeling results may be achieved through several means. First, decomposing the disadvantage measure to accommodate the existence of different minority populations in different cities would improve the interpretation of the disadvantage term and the understanding of the relationship between minority populations and violence. Second, the decomposition into poverty alone would allow a more complete investigation of the conditional effects of poverty on stability. Namely, an interaction term to test whether poverty-related stability was indeed positively related to crime could provide further support to the suggestions by Warner and Pierce (1993) and others.

Finally, applying the same methodology of developing a global model and decomposing the model into individual city models is a useful exercise that further advances

the understanding of generalizability of theory across urban areas. The models would be improved with the application of this approach to multi-level modeling, such as those models that consider the individual and neighborhood contexts at once. While this study advances knowledge of structural generalizability, the test of generalizability would be strengthened if the model results hold true with multi-level modeling.

While it does appear that some standard elements of violence models are indeed generalizable, that conclusion is made cautiously. A consideration of local contexts is warranted in any ecological study of crime. More studies that model crime across urban areas, whether at the neighborhood level or in multiple nested contexts, will strengthen the findings presented here.

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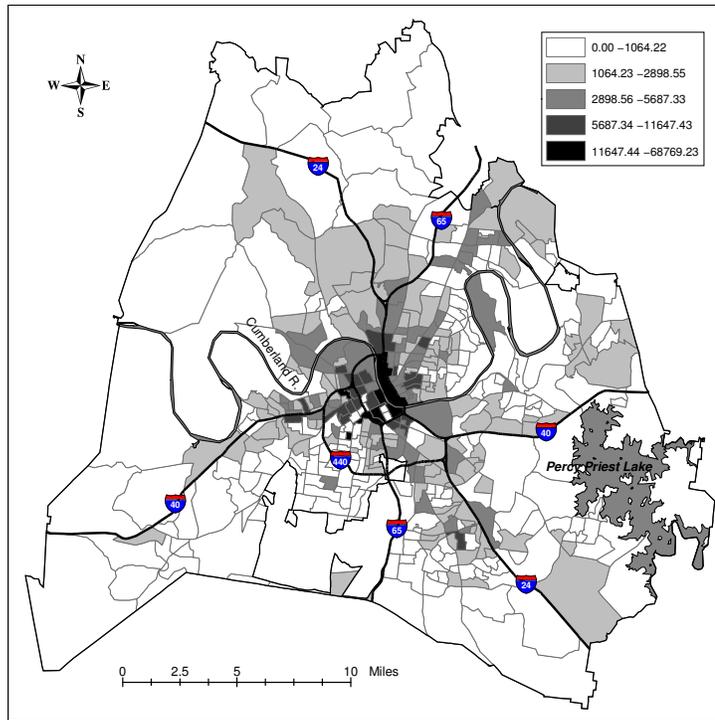


FIGURE A.1. Nashville, TN: Violent Crime Rates per 100,000 persons

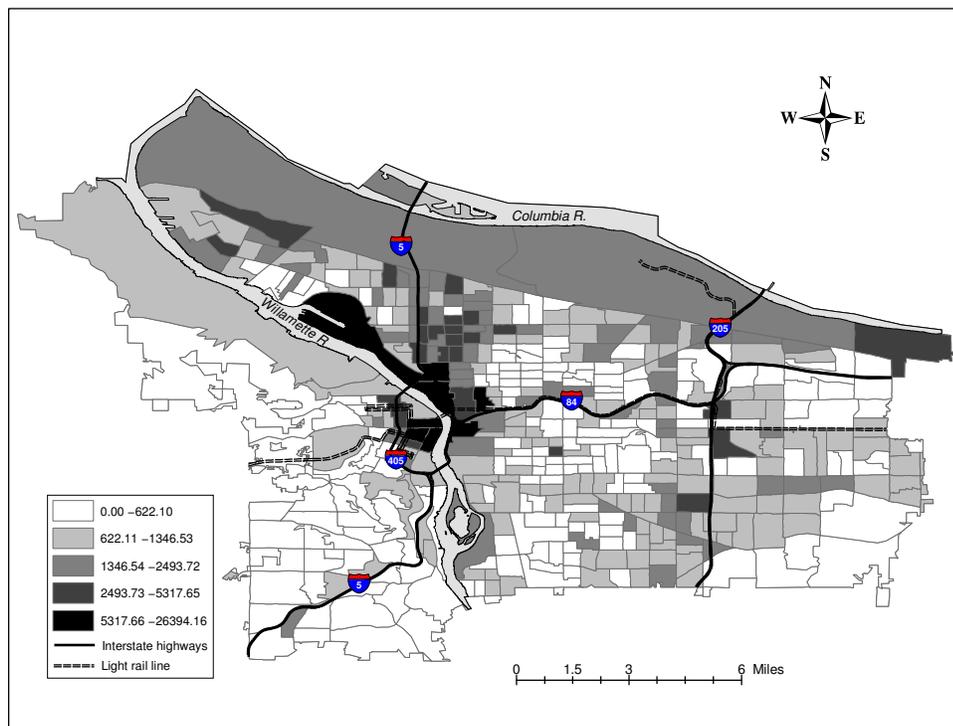


FIGURE A.2. Portland, OR: Violent Crime Rates per 100,000 persons

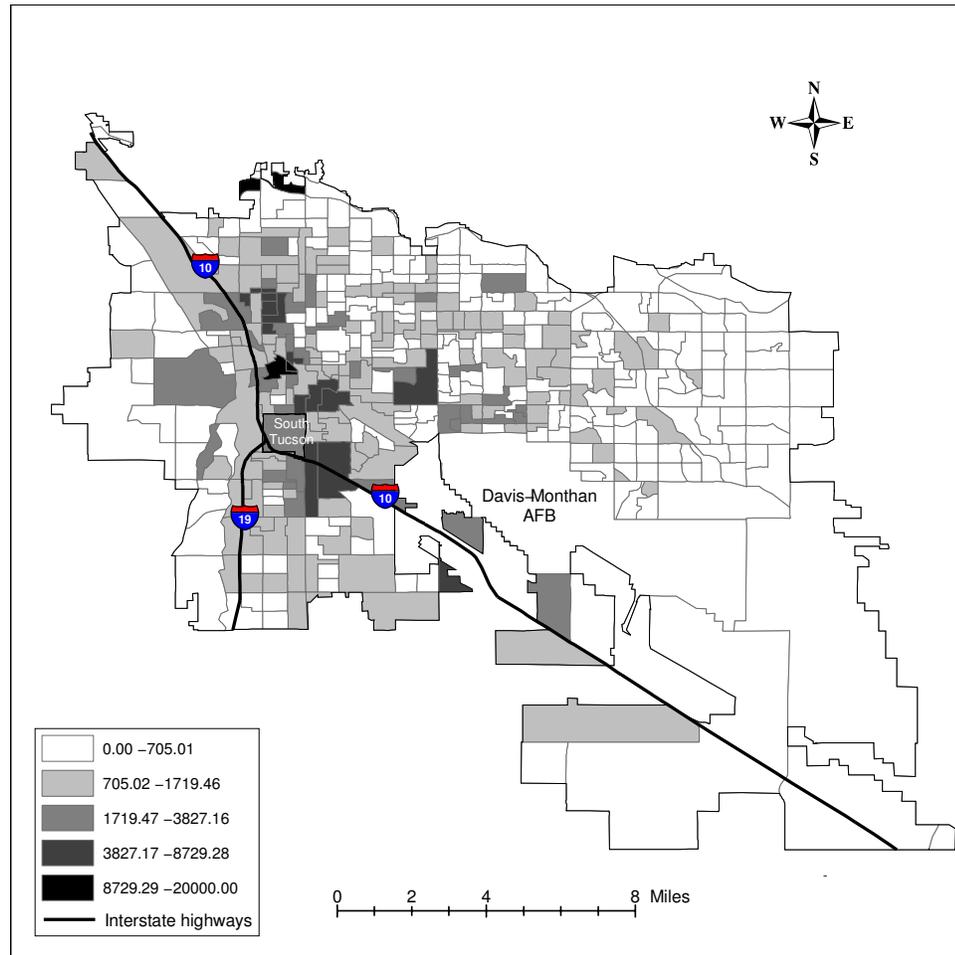


FIGURE A.3. Tucson, AZ: Violent Crime Rates per 100,000 persons

TABLE A.1. Selected demographic characteristics of Nashville, Portland, and Tucson

	Nashville	Portland	Tucson
Total population	545,524	529,121	486,699
Pop. as a percentage of Metro Area*	44.3	27.6	57.7
Population change, 1990-2000 (%)	11.7	21.0	20.1
White (%)	65.9	77.9	70.1
African-American (%)	26.8	6.6	4.3
Hispanic (%)	4.7	6.8	35.7

*Metropolitan Statistical Area; for Portland, the Primary MSA was used, including Portland and Vancouver, WA

TABLE A.2. Descriptive statistics for measures used in OLS models by city

	Variable	Min	Max	Mean	Std. Dev.
Nashville	Violence Rate*	19.23	68769.23	2245.41	4533.46
	Concentrated disadvantage	-1.00	4.98	0.13	1.01
	Concentrated immigration	-0.92	3.18	-0.49	0.59
	Heterogeneity Index	0.00	0.70	0.30	0.18
	Residential stability	5.16	87.19	48.58	15.71
	Single households	0.00	84.86	32.16	13.15
	Population density**	18.35	9890.00	1351.21	1192.48
	Multiple land use	0.00	100.00	12.15	18.84
Portland	Violence Rate*	13.82	26394.16	1107.54	1716.26
	Concentrated disadvantage	-0.99	2.35	-0.12	0.53
	Concentrated immigration	-0.86	2.20	-0.13	0.49
	Heterogeneity Index	0.06	0.74	0.34	0.16
	Residential stability	5.84	79.34	46.08	13.19
	Single households	8.33	91.66	32.12	14.13
	Population density**	29.18	11126.71	2721.34	1378.62
	Multiple land use	0.00	86.00	12.77	15.61
Tucson	Violence Rate*	23.92	11150.44	995.97	1326.82
	Concentrated disadvantage	-0.97	1.88	0.00	0.54
	Concentrated immigration	-0.79	3.49	0.70	1.08
	Heterogeneity Index	0.04	0.72	0.41	0.16
	Residential stability	2.38	86.71	45.08	17.31
	Single households	3.45	84.36	31.80	14.32
	Population density**	20.00	7932.59	1980.67	1058.52
	Multiple land use	0.00	100.00	18.70	18.54

*Rate per 100,000 persons

**Persons per square kilometer

TABLE A.3. Global OLS models, Standardized coefficients, $N = 1282$

(Standard errors in parentheses)

Variable	Model				
	1	2	3	4	5
Intercept	6.584*** (0.025)	6.726*** (0.044)	6.717*** (0.044)	6.732*** (0.045)	6.721*** (0.044)
Con. disadvantage	0.482*** (0.037)	0.458*** (0.037)	0.380*** (0.068)	0.462*** (0.038)	0.457*** (0.037)
Con. immigration	-0.135*** (0.037)	0.024 (0.041)	0.040*** (0.042)	0.056 (0.064)	
Heterogeneity index	0.312*** (0.034)	0.282*** (0.033)	0.295*** (0.034)	0.278*** (0.034)	0.293*** (0.028)
Residential Stability	0.088*** (0.031)	0.089*** (0.030)	0.083*** (0.030)	0.095*** (0.031)	0.089*** (0.030)
Single household	0.093*** (0.033)	0.105*** (0.032)	0.113*** (0.032)	0.105*** (0.032)	0.101*** (0.031)
Population density	-0.167*** (0.027)	-0.178*** (0.029)	-0.182*** (0.029)	-0.178*** (0.029)	-0.176*** (0.029)
Multiple land use	0.261*** (0.030)	0.279*** (0.029)	0.278*** (0.029)	0.280*** (0.029)	0.281*** (0.028)
Tucson		-0.225*** (0.068)	-0.230*** (0.068)	-0.222*** (0.069)	-0.217*** (0.063)
Nashville		0.045* (0.067)	0.051* (0.067)	0.049* (0.068)	0.042 (0.067)
Nashville x Disad.			0.085** (0.078)		
Tucson x Immig.				-0.035 (0.070)	
R^2	0.448	0.490	0.491	0.490	0.490
Std. error of estimate	0.883	0.849	0.848	0.850	0.849

***($p < 0.01$) **($p < 0.05$) *($p < 0.10$)

TABLE A.4. Portland OLS models, Standardized coefficients, $N = 442$
(Standard errors in parentheses)

Variable	Model		
	6	7	8
Intercept	6.628*** (0.043)	6.783*** (0.044)	6.787*** (0.042)
Con. disadvantage	0.238** (0.100)	0.218*** (0.093)	0.218*** (0.093)
Con. Immigration	-0.032 (0.088)	-0.012 (0.083)	
Heterogeneity index	0.423*** (0.059)	0.328*** (0.057)	0.322*** (0.052)
Residential Stability	-0.096** (0.058)	-0.115*** (0.054)	-0.112*** (0.053)
Single household	0.059 (0.050)	0.148*** (0.049)	0.152*** (0.047)
Population density	-0.101** (0.036)	-0.146*** (0.034)	-0.147*** (0.034)
Multiple land use	0.270** (0.052)	0.290*** (0.049)	0.289*** (0.048)
West of Willamette R.		-0.274*** (0.099)	-0.275*** (0.099)
R^2	0.568	0.623	0.624
Std. error of estimate	0.712	0.665	0.664

***($p < 0.01$) **($p < 0.05$) *($p < 0.10$)

TABLE A.5. Nashville OLS models, Standardized coefficients, $N = 441$
(Standard errors in parentheses)

Variable	Model		
	9	10	11
Intercept	6.785*** (0.064)	6.852*** (0.110)	6.740*** (0.056)
Con. disadvantage	0.648*** (0.052)	0.642*** (0.054)	0.633*** (0.051)
Con. Immigration	0.061 (0.095)	0.069 (0.099)	
Heterogeneity index	0.229*** (0.050)	0.217*** (0.054)	0.254*** (0.045)
Residential Stability	0.125*** (0.057)	0.119*** (0.058)	0.107*** (0.054)
Single household	0.093** (0.056)	0.096** (0.057)	0.085*** (0.056)
Population density	-0.244*** (0.060)	-0.243*** (0.060)	-0.234*** (0.048)
Multiple land use	0.320*** (0.047)	0.321*** (0.048)	0.321*** (0.059)
South of Cumberland R.		-0.029 (0.112)	
R^2	0.521	0.521	0.520
Std. error of estimate	0.923	0.923	0.924

***($p < 0.01$) **($p < 0.05$) *($p < 0.10$)

TABLE A.6. Tucson OLS model, Standardized coefficients, $N = 399$
(Standard errors in parentheses)

Variable	Model 12
Intercept	6.073*** (0.059)
Con. disadvantage	0.163*** (0.126)
Con. immigration	0.182** (0.073)
Heterogeneity index	0.287*** (0.091)
Residential Stability	0.080 (0.051)
Single household	0.188*** (0.059)
Population density	-0.197*** (0.059)
Multiple land use	0.214*** (0.048)
R^2	0.353
Std. error of estimate	0.846
***($p < 0.01$) **($p < 0.05$) *($p < 0.10$)	

Appendix B

ALTERNATIVE MEASURES OF CRIME AND CRIME PROFILES

For submission to *Security Journal*¹

Introduction

The past two decades have seen a growing recognition by policy makers, policing agencies, and researchers that understanding the context of crime—the where and when of a criminal event—is key to understanding how crime can be controlled and prevented. This focus fits into the rubric of environmental criminology, a field concerned with the characteristics of places and times that create opportunities for crime or attract offenders (Brantingham and Brantingham, 1981, 2000) Considerations include “the legal, social, psychological, and physical backcloth against which crime occurs.” (Brantingham and Brantingham, 1998, p. 31).

The focus of the research presented here is identification of area crime profiles, or the particular mix of crimes that dominate different areas. Concurrent with the rising interest in the environments or contexts of crime have been advances in computing that have allowed extensive crime mapping in an effort to better understand spatial aspects of criminal events (Murray et al., 2001). The methods are increasingly sophisticated,

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with the development of new techniques for identifying crime “hot spots” (Ratcliffe and McCullagh, 1999) or taking into account the relationships between and among different places and the crime that occurs there. Techniques do exist, however, that improve upon simple point maps (that display crime locations) or rate maps (that display levels of crime standardized by population or another measure) and identify an area’s crime profile. One technique employed here is the development of location quotients, a technique used mainly by economists and regional scientists that has recently been proposed for spatial analyses of crime (Brantingham and Brantingham, 1995, 1997; Carcach and Muscat, 1998). This technique for identifying an area’s crime profile has been overlooked despite its simplicity and utility to planners and police agencies.

This study first presents the crime profiles as determined by location quotients within the city of Nashville, TN. A comparison of location quotients and rates is also provided. The location quotients are then used in a regression modeling framework to identify the characteristics of places that influence the crime profiles of places. The results demonstrate the efficacy of simple techniques that can be employed without sophisticated software. The results also demonstrate how location quotients can be incorporated into statistical models of crime. Before discussing those methods, however, a brief review of the theoretical perspectives employed is warranted.

Crime and communities perspective

Key to the understanding of crime context is understanding the ‘community crime profile’ or ‘local crime profile’ (Bottoms and Wiles, 1986; Davidson and Locke, 1992;

Schuerman and Kobrin, 1986)—the mix of crimes in an area. Also important are characteristics of places—including physical and social measures—that affect the number of targets and offenders in an area. Theoretically, studies of this nature have been informed by two somewhat different perspectives: (1) social control-disorganization theory and (2) routine activities theory. Although the two schools of thought are closely related, an important distinction can be made. Social control-disorganization theory focuses on the ability (or lack thereof) of residents of some geographic unit (e.g. a neighborhood) to come together to achieve a common goal, like reducing predatory crime (Sampson, 1997, 1999). Alternatively, routine activities theory focuses on the presence of opportunities for crime in an area, as shaped by residents' daily activities (Cohen and Felson, 1979; Miethe and Meier, 1994). Wilcox et al. (2003) integrate the two theories into an 'multicontextual opportunity theory' that recognizes the context of crime as essential to an understanding of crime patterns. Founded on the idea that the presence or absence of offenders, targets, and guardians at a particular place and time determines criminal opportunity, the framework considers both individual and structural influences on criminal opportunity. Social structures affect criminal opportunity by influencing the routine activities of residents and visitors, and by affecting the sociodemographic makeup of places, such as income and education levels, family stability, employment patterns, and age and demographic structures. The structural characteristics and routine activity patterns of individuals and areas in turn influence the crime profile of a place, which can vary over time with changes in structure and activity.

Crime data

Crime data was collected from the Metro Nashville (TN) Police Department for the years 1998-2002. The location and date of each crime was collected, and that data was geo-coded and aggregated to block groups. In addition, crimes were aggregated into assault,² property crime,³ and violent crime.⁴ Frequencies of crime for each category were averaged over the five years in the study period to control for anomalous years when there may have been an unexplained spike or fall in crime rates.

Location Quotients

Location quotients have been used extensively in economic studies, but can be successfully applied to other activities. Location quotients of crime (LQCs) are used to determine “the relative mix of different types of crimes for a particular area compared to the mix in surrounding areas” (Brantingham and Brantingham, 1997, p. 264). LQCs use crime counts to identify those areas that may have a disproportionately high level of certain types of crime compared to a reference area; the method compares proportions of crime in two areas, often a sub area and a larger reference area. This method compares the proportion of crime in one area to the proportions in another existing area as opposed to an assumed ideal proportion of crime, as is used by other methods for determining crime profiles (Smith, 1975). When LQCs are calculated for a small area embedded within a larger area, they take into account the embeddedness

²Includes aggravated and simple assaults

³Includes burglary, larceny and motor vehicle theft

⁴Includes homicide, sexual assault, robbery, and aggravated assault

of neighborhoods in a larger context that, in studies of crime, should be accounted for. In addition, LQCs can be studied over time, and can thus take into account the changing contexts within which crime occurs.

LQCs are calculated using Equation B.1 below (Brantingham and Brantingham, 1997):

$$LQC_{i_n} = \frac{C_{i_n}}{C_{t_n}} \bigg/ \frac{\sum_{n=1}^N C_{i_n}}{\sum_{n=1}^N C_{t_n}} \quad (\text{B.1})$$

where n is the subarea under study, N is the total number of areas, C_i is the count of crime i and C_t is the total count of all crimes. The reference area for LQCs calculated as part of this research was the city of Nashville; the subareas were either block groups or census tracts. LQCs with a value of 1 indicate a subarea has the same level of crime as the reference area. Below or above 1, LQCs can be interpreted as a percentage above or below the expected level based on the reference area. An LQC of 0.4 can be interpreted as being 60% below the city level, and an LQC of 1.4 can be interpreted as being 40% above the city level. An LQC of 2.3 can be interpreted as being 130% higher than the city level.

Statistical studies of crime often use crime rates based on population. This can present problems, however, especially in cases where the areas under study are small and may have zero or a very small population even while crimes occur there. Harries (1981) discussed this problem extensively and suggested that alternative denominators related to each specific crime be employed in calculating rates; e.g., for motor vehicle theft, rates could be based on the number of vehicles in an area. Harries (1995) also suggested that, at the very least, the use of frequencies instead of population-based

rates was more intuitive. Because they are not based on population, LQCs avoid the zero population problems. In addition, explanatory variables are usually calculated based on population, which can cause problems in statistical analysis because both dependent and independent variables are based on the same denominator. By allowing the independent and dependent variables to be based on different denominators, LQCs remove that particular bias (Brantingham and Brantingham, 1997).⁵

Mapping LQCs can reveal geographic clustering of unusually high or low levels of specific crimes. One must be aware, however, that LQCs can be misleading in areas where the total level of crime is low. In this case, when all or most of a small amount of crime is of one type, large LQCs can result and misidentify areas with disproportionately high levels of certain crimes when in fact the level of crime is quite low. To address this issue, LQCs were mapped only for those block groups with a total crime frequency of greater than twenty crimes; approximately four percent of the block groups were excluded.

Several LQCs for the city of Nashville were mapped; because of space limitations, only the most noteworthy at the block group level will be discussed here. The LQCs were mapped as those more than 20% below or above levels for the whole of Nashville. LQCs within 20% of the city level of crime are considered 'normal' and are shown in white. The lightest gray block groups are areas where there is an unexpectedly low level of property crime—more than 20% less than the expected level—and the darkest block groups are areas at least 20% above the expected level of property crime. For comparison purposes, the rate map for each crime is also shown. The property crime

⁵see Carcach and Muscat (1998) for a complete discussion of the statistical properties of LQCs.

rates and location quotients are mapped in Figures B.1 and B.2. These maps show some starkly different geographic patterning. The highest property crime rates are found in the center city area and in a weak sectoral pattern, with zones of high rates moving outwards from the center towards the northeast, northwest, and southeast. The map of property crime LQCs, however, shows the disproportionately low and ‘normal’ areas in the center city—the very areas where higher property crime *rates* are clustered. The darkest areas are of most interest; the map shows block groups with disproportionately high levels of property crime are located on the outer edges of the city where property crime rates appear low to moderate. A notable difference appears to exist in the southwest, where property crime rates are low but location quotients are high.

Figures B.3 and B.4 display the rates and location quotients for violent crime. Violence rates are highest in the center city and on the eastern edges of the city. The map of LQCs shows a similar pattern, with most of the city experiencing disproportionately low levels of violence. In addition, there are a few large block groups, especially on the eastern side of the city, with extremely high violence rates that actually have low LQCs. Thus while they have high rates of violence, compared to the city as a whole, those areas have low levels of violence.

Figure B.5 displays the assault rates. The pattern of assault rates is similar to the pattern for property crime and violence rates in that the highest rates cluster in the center city. Assault rates are also high directly north of the center city. There are also some scattered high rates in the eastern and northeastern parts of the city. The map of LQCs displays a similar pattern—LQCs highest where rates are highest. The exceptions

are that there are a disproportionately high number of assaults on the western edge of the city where assault rates are low and in the southeast part of the city, where rates are low to moderate.

While visual inspection of both rate and location quotient maps does allow some comparison of the differences, because the scales of each measure (location quotients and rates) are different, it is hard to make any formal statements about the differing patterns based on those maps alone. At a basic level, correlation coefficients between each crime rate and its associated LQC shed some light on the relationship between the two measures. The correlations between the assault and violence pairs are significant at the 0.01 level. The correlation between the two assault measures is 0.344 and between the violence measures is 0.449. The correlation between the property crime measures equals -0.122, significant at the 0.05 level. These basic measures indicate that the correspondence between the personal crime measures (violence and assault) is stronger than between the property crime measures. In addition, the very low and negative value for the property crime correlations reveals an extremely low correspondence between the two types of measures. From these results, it is suggested that location quotients may provide the most insight into area crime profiles in the case of property crime because the difference between rates and LQCs is greatest for those crimes.

To more formally examine the differences between the rates and location quotients in block groups, a categorization scheme was applied to the block groups, the results of which were mapped. For each of three crime types—assault, violence, and property crime—block groups were categorized by percentile rank for location quotients and rates. That is, each block group was assigned a percentile rank based on its assault

location quotient, assault rate, violence location quotient, violence rate, and so on. The rankings for LQCs and rates for each crime type were then compared. An arbitrarily selected cut-off point of 20% was chosen to create categories within each crime type; e.g., those block groups in the lowest twentieth percentile on both assault location quotient and assault rate were categorized as low-low and those in the highest twentieth percentile on both measures were categorized as high-high. The categories were then graphed to determine the similarity between rates and location quotients and mapped to determine the areas of congruence (and incongruence) between location quotients and rates.

The scatter plots for the assault and violence measures are shown in Figures B.7 and B.9. These charts demonstrate the strong congruence between location quotients and rates for these two crime types; i.e., those block groups with the highest location quotients also tend to have the highest rates. This confirms the findings from the simple correlation analysis. The gray boxes in the lower left and upper right hand corners of each graph identify those block groups which were categorized as both low-low (lower left) or high-high (upper right). Very few fall into the low-high or high-low categories, but all four categories were mapped in Figures B.8 and B.10. The maps show that most block groups fall into the mid-range of values for both location quotients and rates for both measures. In both maps, the high-high categories are not surprisingly clustered downtown where levels of crime are higher. The low-low categories are clustered south of downtown. These maps are fairly intuitive and have confirmed the findings from the mapped rates and location quotients above—that there is a fair amount of correspondence of the geographic patterns of the two types of

measures for both assaults and violence.

The scatter plot for property crimes is shown in Figure B.11 and shows a much different relationship between location quotients and rates. There is much less correspondence between location quotients and rates for this type of crime and the scatter plot shows no discernable pattern. In this situation, the more interesting cases are those where there is extreme incongruence between LQCs and rates—the high-low and low-high categories, which have been shaded gray on the graph. The block groups in the gray area in the upper left hand corner have low property crime LQCs and high property crime rates, while those in the lower right hand corner have high LQCs and low rates. This result is not as counter-intuitive as it may initially seem, however, and it provides strong evidence for the need to carefully consider the denominator in any rates used for crime studies. The property crimes included here—burglary, motor vehicle theft, and larceny—do not require an individual as a target. Instead, targets for this type of crime are material objects, like cars, bicycles and other valuable items. The map of the categorizations, Figure B.12, shows that block groups with extreme incongruence are located mainly southwest and northeast of downtown. These are perhaps areas of low population, which creates high rates, but a low number of targets in the form of material goods, or areas of high population and therefore low rates, but a large number of suitable targets and thus higher property LQCs. The results indicate that population-based rates are not very accurate representations of the level of property crime in an area.

LQCs can be mapped for different time periods to show changing specializations as well. This was done for assaults during three time periods: 1998, 2000, and 2002,

shown in Figures B.13, B.14, and B.15. The map for 1998 shows that areas more than 20% lower than the expected level of assault are scattered across the city and not clustered in one clear location. Areas with high values are clustered in the center city and also scattered in the northwest, northeast, and southeast. Two years later, the areas with the highest proportional violence are clustering in the center city again, but outside the center city, high assault levels seem to be moving eastward, with greater clustering of high values on the eastern edge of the city. One obvious exception to this is the block group on the southwestern edge of town that was previously in the normal range and over the two year period increased to over 20% more violence than expected. Finally, in 20002, the cluster of high values in the center city appears to be breaking up, with more block groups there falling into the normal category. Outside of the center city, higher values appear to be clustering more strongly on the east, and the southwestern block group still remains in the high category. Thus, over the five year period, high values were strongly clustered in the center city and scattered in the outer parts of the city. This pattern changed as the center city cluster became weaker and high values moved toward the eastern part of the city.

The maps of crime rates and LQCs for three crime measures and the yearly maps for assault demonstrate that rate maps may not provide the best information to decision makers tasked with resource allocation. Rates maps can be misleading, as those areas with the highest rates are often not the areas with high LQs. This information can be used to determine what kinds of intervention and prevention programs would best target the main crime problems in each area. In addition, looking at change over time can help decision makers to predict where resources will be needed in the future. The

descriptive exercise of mapping LQCs is in itself useful, but LQCs can also be used in predictive modeling to determine what is driving the geographic patterns. The next section discusses three models that were developed to explain variation in LQCs.

Modeling location quotients

Multivariate models were developed to estimate three LQCs:⁶ property crime, violent crime, and assault. The models were developed at the block group level using ordinary least squares. Based on the 2000 census and the theoretical framework, several structural measures were examined for use in regression modeling. Two measures of disadvantage are employed. Following Morenoff et al.'s (2000) study of homicide in Chicago, a concentrated disadvantage index measure was developed. A principal components analysis of the structural measures supported the combination of the following measures: percent of residents who are African American, percent of residents living below the poverty line, percent of families receiving public assistance, percent of residents who are unemployed, and percent of families headed by a single parent. Each measure was equally weighted and the index created by averaging the z-scores of the five measures. The measure recognizes that racial and economic segregation are often highly correlated and that effects of either concept are often difficult to isolate (Morenoff et al., 2000).

The second measure was proposed by Massey (2001) in his discussion of the growing economic segregation of both poor and affluent families. Sociologists have recently

⁶The LQCs used in the OLS models were calculated using frequencies averaged over the 1998-2002 time period

turned more attention to concentrated affluence, investigating the idea that, much as Wilson (1987) argued that living in a disadvantaged neighborhood compounded the effects of disadvantage, living in affluent neighborhoods can compound the effects of affluence (Brooks-Gunn et al., 1993; Massey, 1996). Affluent neighborhoods may produce protective characteristics based on access to and mobilization of various resources (Morenoff et al., 2000) which play an important role in the exertion of social control. Massey (2001) proposed the index of concentration at the extremes (termed “ICE” by Morenoff et al.), calculated as (number of affluent families - number of poor families)/total number of families. For this research, affluence is defined as families with incomes over \$50,000 and poor is defined as families with incomes less than \$15,000. The index has a theoretical range of -1 to 1, where -1 identifies areas where all families are poor and 1 identifies areas where all families are affluent. A 0 value identifies areas with an equal share of poor and affluent families.

Other structural measures suggested by the opportunity framework include those that affect the level of social control, or guardianship, in an area. These measures include residential stability, racial heterogeneity, proportion of unemployed males in an area, and proportion of single-person households (Wilcox et al., 2003). Stability is measured as the percentage of residents who lived in the same residence in 1995. The heterogeneity index used here “takes into account both the relative size and number of groups in the population,” and is equal to $1 - \sum p_i^2$ where p_i is the proportion of each racial group in the population (Sampson and Groves, 1989, p. 784). The index ranges from 0 to 1, where one indicates maximum heterogeneity. Also included are population density (persons per square kilometer), a land use measure which indicates

the percentage of land put towards commercial or multiple uses (i.e., residential and commercial), and the location's distance from downtown in miles. These measures are postulated to influence the number of motivated offenders in an area: population density increases the number of potential offenders, commercial or multiple use areas increase the number of visitors to an area and the number of targets, and close proximity to downtown usually means those areas are more easily accessible, denser, and have more visitors. In addition, total population was included as a control variable.

The results of the three models are shown in Table B. The model for property crime LQs is the strongest model of the three, as five predictor variables and the control variable (population) were significant. Of all of the predictor variables, five coefficients have the expected directional relationship with property crime: residential stability, single-member households, population density, multiple land use, and distance to downtown. Generally, disadvantage is expected to have a positive relationship with levels of crime but in this model, the coefficient on the concentrated disadvantage variable is negative. This result, however, is understandable within an opportunity framework through the concept of target suitability or attractiveness. For property crimes, target attractiveness includes the value of an target, e.g., expensive jewelry or a DVD player are more attractive to potential offenders. In disadvantaged areas, high value items are less likely to be found. Property thieves may target more affluent areas where valuable items are more readily available. The index of concentration at the extremes (ICE) is significant with a positive coefficient. When ICE increases, i.e., more affluent households are clustered together, property crime also rises, but this again is understandable in terms of target attractiveness.

Affluent areas are more likely to provide suitable targets to potential thieves. Residential stability was not significant but did have a negative sign on the coefficient, as predicted by the opportunity framework. Residential stability can foster social control; instability can impede social control and allow more crime to occur. The variable measuring distance to downtown indicates that crime decreases with increasing distance from downtown. The result is suggested by opportunity theory under the assumption that downtown areas tend to see more visitors (and therefore more potential offenders) than outer residential areas of the city.

Two other variables were significant with counterintuitive signs on the coefficients. The opportunity framework suggests that heterogeneity and a greater percent of unemployed males will impede social control by inhibiting the development of social ties. Both of those variables, however, have negative coefficients in this model, indicating that they are associated with lower levels of crime. In an opportunity framework, the relationship between percent of unemployed males and crime can be understood in terms of guardianship; if there are more nonworking persons in the area, those persons are likely to spend more time in the home as opposed to employed persons, who spend more time out of home. Those nonworking persons can then act as guardians in the area, preventing crime. A better measure for this concept might have been *young* males who did not work, as younger males would have a greater negative effect on the development of social ties and are more likely to be offenders than older males. Their presence could thus serve to increase crime in an area.

While not significant, the coefficient on the population density variable in the property crime model was positive, indicating that when population densities go up, so does

the level of property crime. This is in line with the interpretation of density as a measure of targets. In light of the discussion above regarding using population as a measure of targets for property crime, however, caution is warranted, and because the coefficient was not significant, this result cannot be seen as a strong support of the increased targets interpretation.

In the model predicting violence LQs, five predictor variables are significant and all have the expected directional relationship with crime. Concentrated disadvantage has a positive coefficient and the ICE measure has a negative coefficient, both indicating that when concentrated disadvantage increases, so does violent crime. Disadvantage can foster violent crime by impeding a neighborhood's ability to mobilize resources for addressing crime problems and to develop social control. The heterogeneity index has a positive coefficient, supporting the idea that greater heterogeneity of residents can impede the development of social ties and, following that, social control. Finally, the percent of total area dedicated to multiple or commercial land use is positively associated with violent crime. This variable was not significantly associated with property crime but the coefficient in that model was positive. In an opportunity framework, multiple and commercial land use can be seen to increase visitors to an area, increasing the number of potential offenders and victims. The positive coefficient was therefore expected.

The third model, for assault LQs, is the strongest model of the three with seven significant coefficients, six of which have the expected directional relationship with assault. The coefficients for concentrated disadvantage, ICE, heterogeneity index, the percent of males not working, population density, and multiple land use measures all

have parameter estimates in the expected directions. The coefficient for the distance to downtown variable is significant and positive, indicating that with increased distance from downtown, assault rates increase. Figure B.6 shows that there are several block groups on the outer edges of the city with high location quotients, explaining the result. Furthermore, in terms of the opportunity framework, most interpersonal crimes occur between people who know each other; in the center city there may be fewer residents or visitors who know others in the area. There may thus be fewer opportunities for this type of interpersonal violence to take place.

Several variables were highly significant in more than one model, providing some evidence for the generalizability of the structural aspects of opportunity theory across crime types. Concentrated disadvantage, ICE, and heterogeneity were all significant in predicting property, violence, and assault LQs, and while the signs on the coefficients were not stable across models, they were the same in the violence and assault models. These crime types are similar, while a theoretical argument can be made for the different relationships between those three variables and property crime. The population density variable, which is included in most ecological studies of crime, was found to be significantly negative in two of the three models—violence and assault. The interpretation in an opportunity framework, then, is that density is a measure of guardianship, and is thus negatively related to crime levels. In addition, the control variable, total population, was small but significant in two of the three models, indicating that the size of an area does affect crime rates. Additional variables included in the models were also significant, but some unexpected signs diminish the strength of those results. The multiple/commercial land use measure was significant in two models, violence and

assault, but was positive in the violence model and negative in the assault model. The distance to downtown measure was significant in both the property and violence models but again, had different signs on the coefficient in each model. The relationship between distance to downtown and the personal (violence) LQs should be further investigated, as the models indicate a positive relationship between the distance variable and the LQCs, an unexpected result in an opportunity framework. Finally, the residential stability measure was not significant in any of the models, and was only in the expected direction in the property crime model. These are standard measures included in studies of crime in an opportunity framework and their insignificance in this model indicates the need to further investigate their relationship with crime using location quotients.

Conclusion

The comparison of rates and location quotients in determining crime profiles provided some insight into the problems with using population-based rates, especially as measures of the property crime level in an area. The correspondence between location quotients and rates was shown to be high for personal (violence, assault) crimes where the target is by nature an individual. The location quotients and rates for property crime, however, showed little correspondence, and the result provided further evidence for the argument against using population-based property crime rates.

The OLS models demonstrate the utility of LQs as compared to crime rates. LQs are a viable alternative to problematic crime rates, especially in statistical studies where

the results may be affected by the use of population as a base for independent and dependent variables and where crime rates are heavily skewed towards zero. The results provided modest support for the opportunity framework and suggested that further investigation be done into the relationship between LQCs and population density, land use measures, the distance to downtown and residential stability.

This paper reviewed one method that avoids the problems encountered with the commonly-employed crime rates. The method is based on proportions of crime and compared to a relative proportions of crime in a reference area. The results demonstrate that determination of crime profiles is an important activity that can reveal a very different geographic picture of high crime areas than might be provided by crime rate maps. Instead of relying on problematic measures to guide decision making and resource allocation, LQCs can be used to determine what areas have disproportionate levels of certain crimes and where different interventions should be put into place. This can save resources by making the decision making process more effective.

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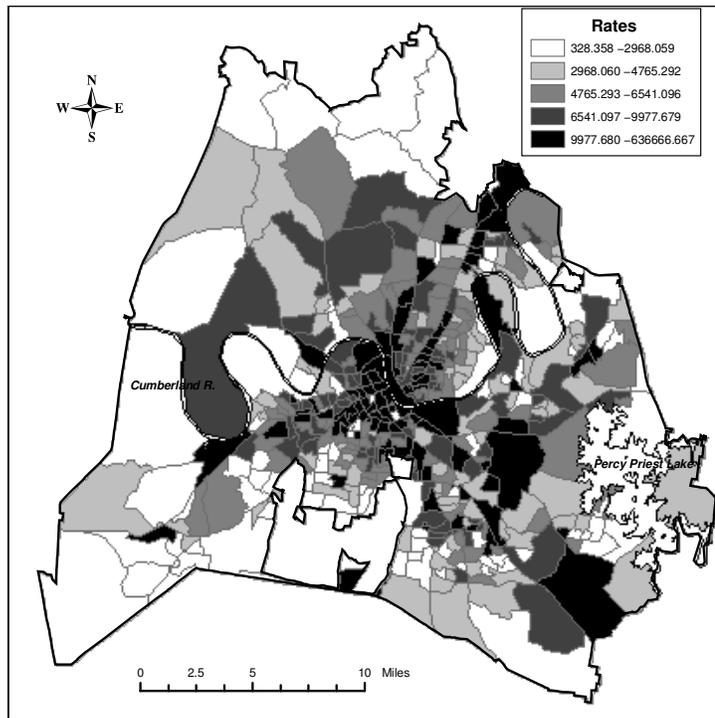


FIGURE B.1. Nashville property crime rates per 100,000 persons, 1998-2002 average

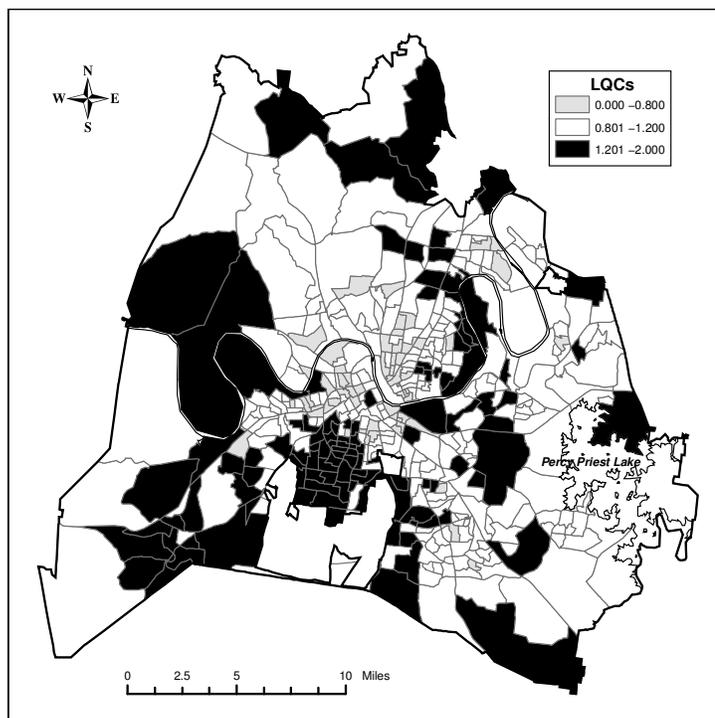


FIGURE B.2. Nashville property crime LQs, 1998-2002 average

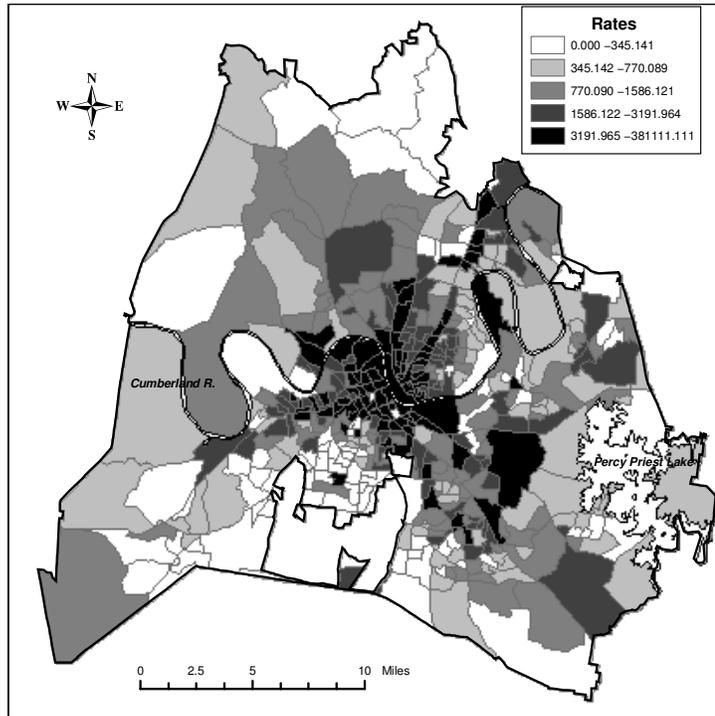


FIGURE B.3. Nashville violence rates per 100,000 persons, 1998-2002 average

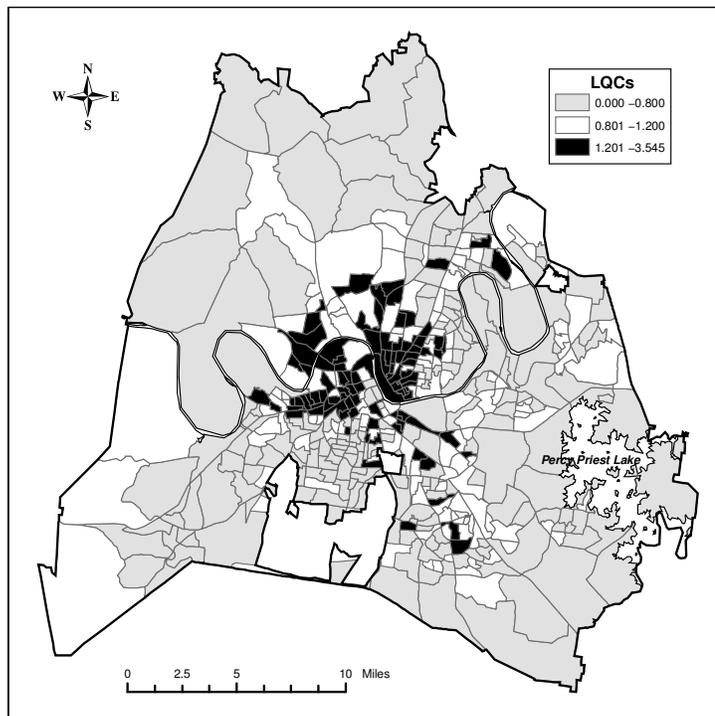


FIGURE B.4. Nashville violence LQs, 1998-2002 average

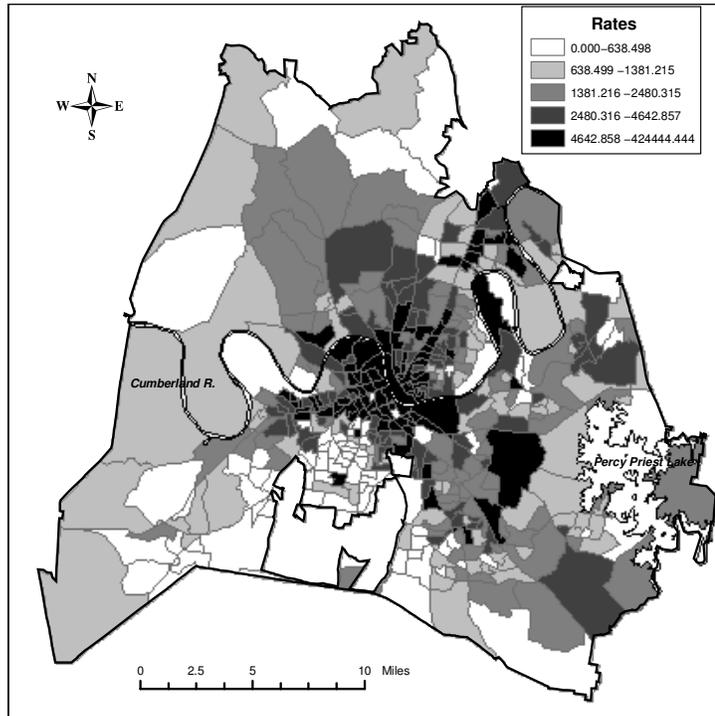


FIGURE B.5. Nashville assault rates per 100,000 persons, 1998-2002 average

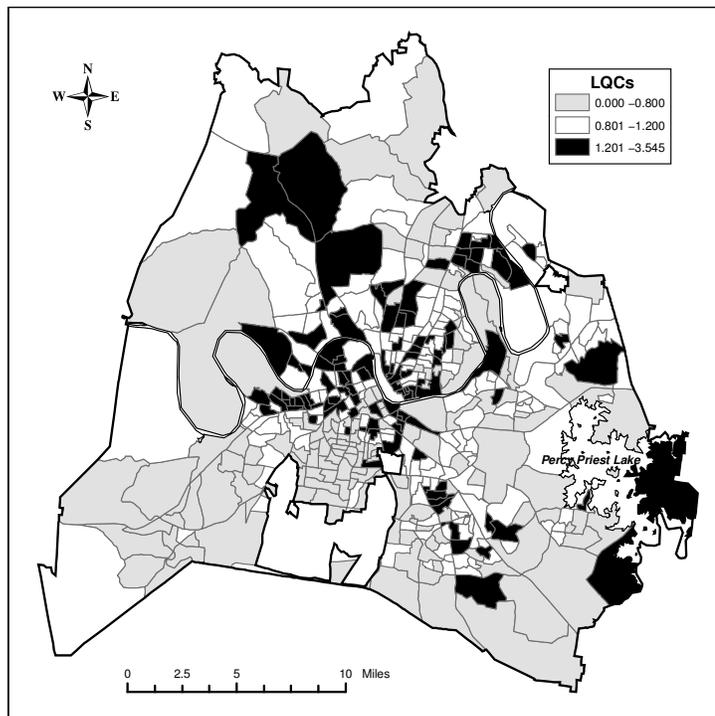


FIGURE B.6. Nashville assault LQs, 1998-2002 average

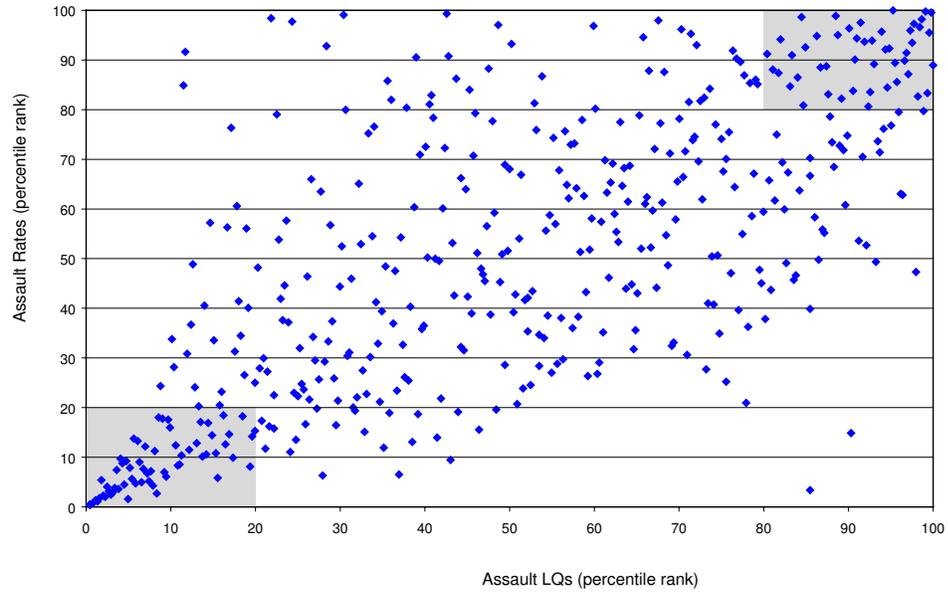


FIGURE B.7. Percentile ranks: average assault LQs vs. rates, $r = 0.344$

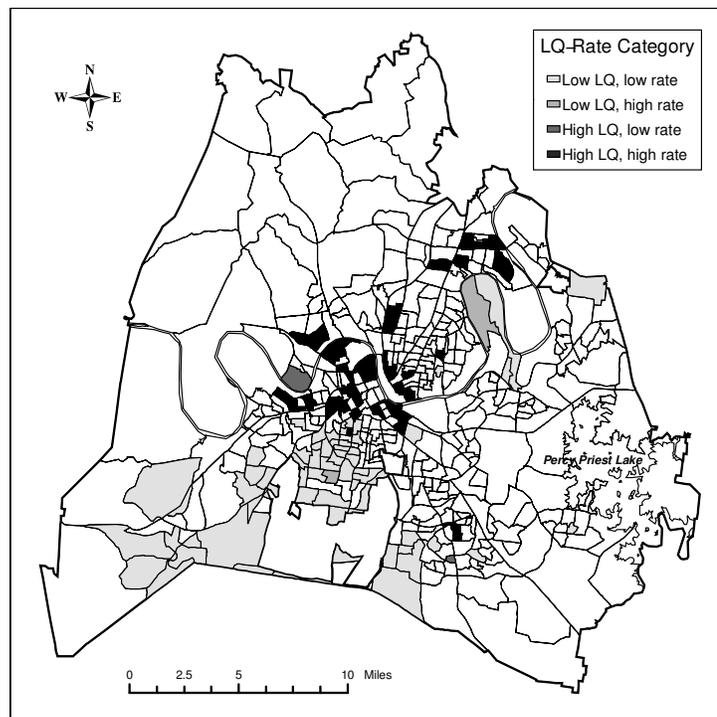


FIGURE B.8. Nashville, average assault LQs and rates

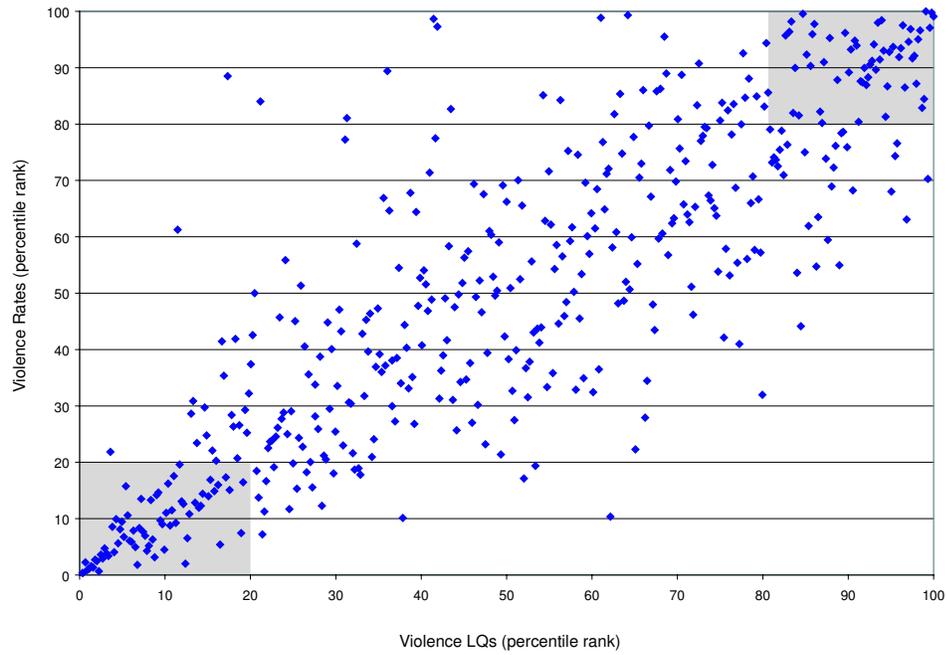


FIGURE B.9. Percentile ranks: average violence LQs vs. rates, $r = 0.449$

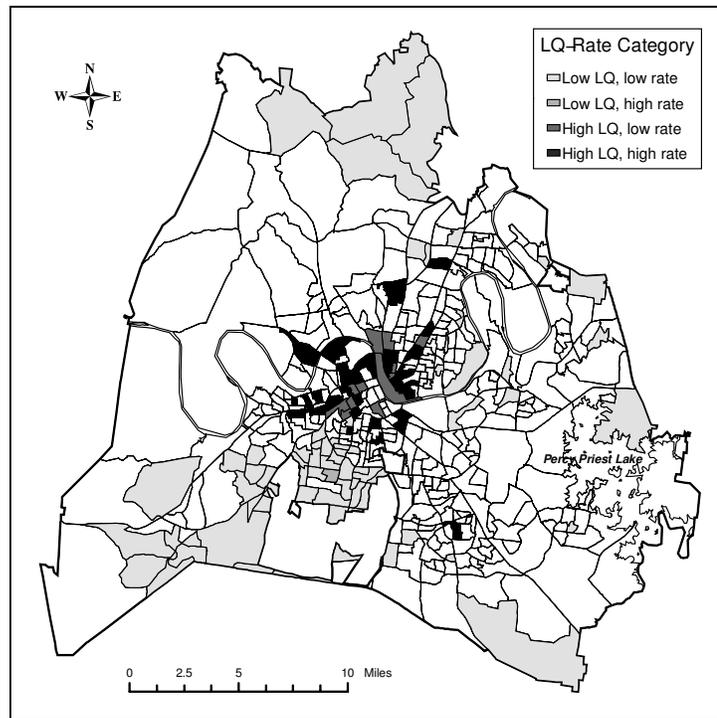


FIGURE B.10. Nashville, average violence LQs and rates

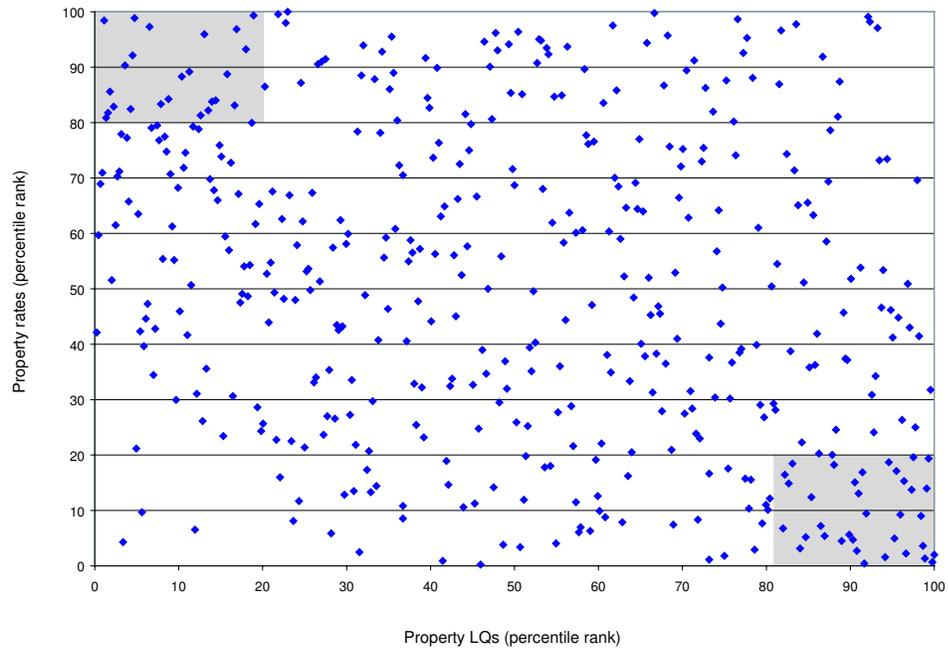


FIGURE B.11. Percentile ranks: average property LQs vs. rates, $r = -0.122$

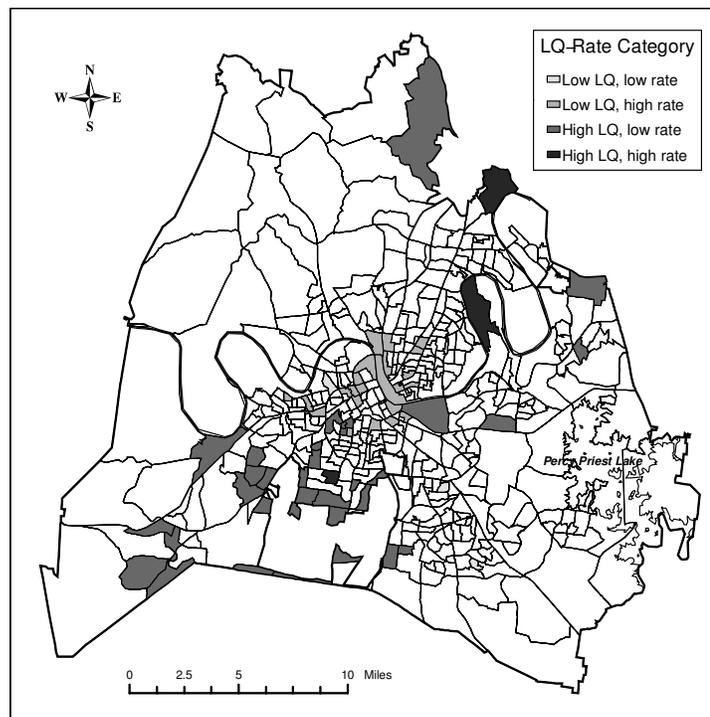


FIGURE B.12. Nashville, average property LQs and rates

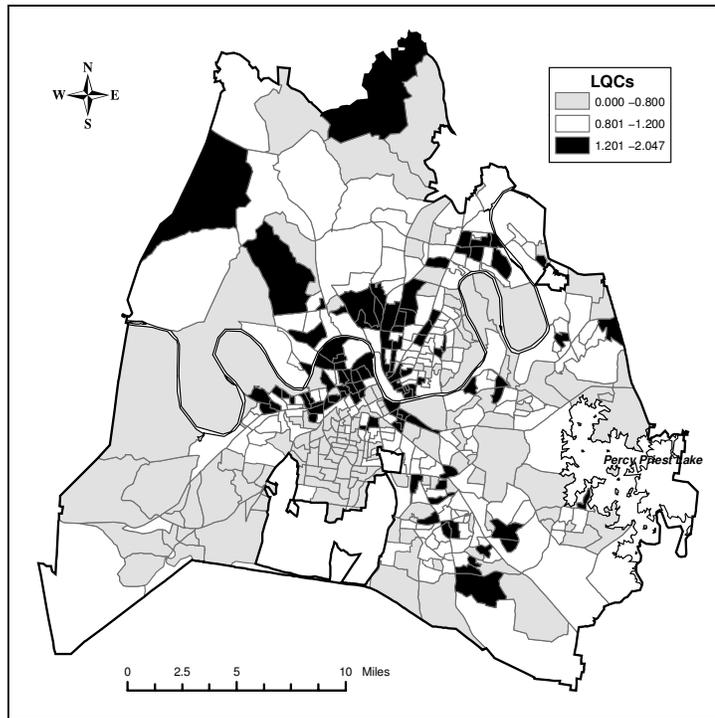


FIGURE B.13. Nashville assault LQs, 1998

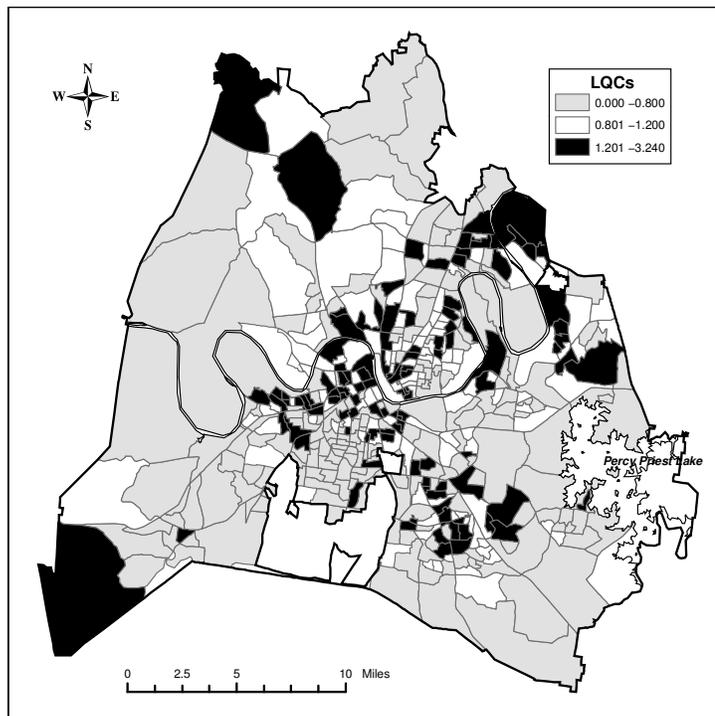


FIGURE B.14. Nashville assault LQs, 2000

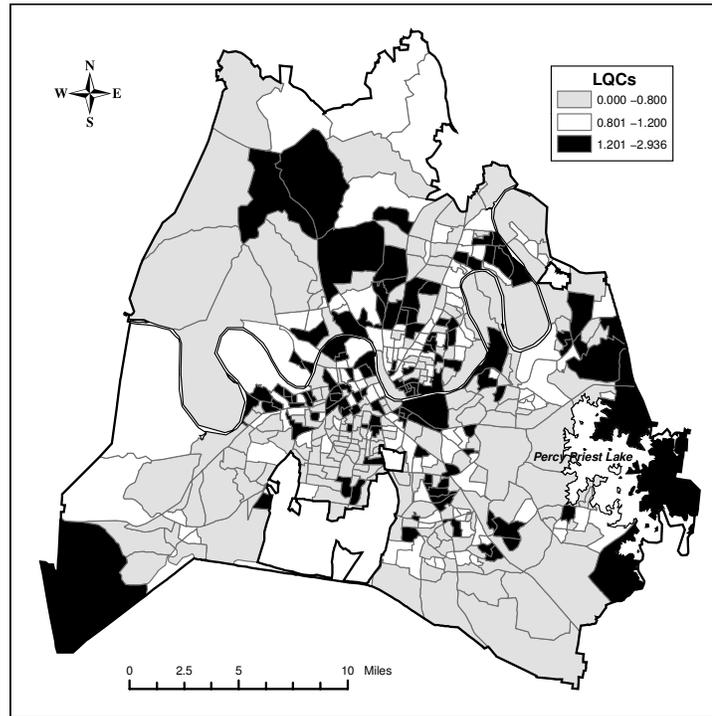


FIGURE B.15. Nashville assault LQs, 2002

TABLE B.1. OLS Regression Models, LQCs

Variables	Standardized Coefficients		
	Assault LQ	Violence LQ	Property LQ
Intercept	0.838***	0.783***	1.089***
Con. disadvantage	0.294***	0.346***	-0.414***
ICE	-0.436***	-0.386***	0.383***
Residential stability	0.072	0.075	-0.053
Heterogeneity Index	0.168***	0.139***	-0.171***
Single households	-0.033	0.028	0.079*
Males not working	0.089**	0.027	-0.048
Population density	-0.089**	-0.104**	0.055
Multiple land use	-0.073*	0.084**	0.059
Distance to downtown (mi.)	0.219***	0.058	-0.196***
Total population	-0.089**	-0.065	0.064*
Adj. R^2	0.445	0.471	0.541
Standard error of the estimate	0.279	0.330	0.160

***($p < 0.01$) **($p < 0.05$) *($p < 0.10$)

Appendix C

GEOGRAPHICALLY WEIGHTED REGRESSION IN ECOLOGICAL STUDIES OF CRIME

For submission to *Journal of Quantitative Criminology*¹

Introduction

Ecological studies of crime have long demonstrated the tendency of criminal events to cluster in space. The search for ecological covariates of crime has been aided in recent decades by the development of multivariate statistical techniques and guided by ecological theories, especially social disorganization and routine activities theories. Led by Land et al.'s (1990) study of homicide covariates, many ecological studies are driven by the search for structural covariates of crime that are "invariant" over space and time. The approach, however, fails to recognize the possibility of important local differences between predictor variables and crime levels, assuming processes between the two operate identically over space, i.e., assuming the processes are stationary. Only recently have criminological researchers begun to recognize the importance of considering the nonstationarity of spatial processes and turned more attention to local studies of crime.

Both substantively and empirically, an exploration of the spatial patterns of crime

¹This project was supported by Grant No. 2003-IJ-CX-1007 awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. Findings and conclusions of the research reported here are those of the author and do not reflect the official position or policies of the U.S. Department of Justice.

in any study is warranted. A theoretical argument can be made that causal processes driving crime activity may vary over space; i.e., predictor variables may operate differently in different locations, even within an urban area (Fotheringham et al., 2000; Baller et al., 2001). This may be especially relevant in policy studies, where there is growing recognition that understanding the context of crime—the where and when of criminal events—is key to understanding how crime can be controlled and prevented. Crime studies that highlight local variations—local contexts of crime—will likely have more relevance to ‘real world’ policy applications. Empirically, if these variations in causal processes do exist and are not accounted for, the statistical model will be inaccurate (Baller et al., 2001).

Finally, exploring spatial data in ecological studies of crime can be useful even if the existence of local processes is not theoretically supported. Recognizing that localized trends in spatial data can affect the accuracy of a global model by reducing its explanatory power in some areas provides an impetus for exploration of the spatial patterns. Assuming a global model does exist, an exploration of spatial patterns in the data can help determine whether a global model is misspecified—whether the model is missing important predictor variables, or if a spatial term should be included in the model—which would improve the accuracy of the global model in explaining crime levels across the study area.

The present study examines covariates of violent crime in Portland, OR. In doing so, this study is not unique; examples of this type of research abound in the literature.² Instead, the present study emphasizes the possible spatial variation in crime

²For examples, see Ackerman (1998); Cahill and Mulligan (2003); Harries (1995); Messner and

measures and their covariates by presenting a local analysis of crime using Geographically Weighted Regression (GWR) and comparing the results to a global ordinary least squares model. The GWR method estimates parameters for all sample points in the data set, taking into account the nonstationarity of relationships.

The results demonstrate the utility of such an analysis for exploring local processes that drive crime levels and examining misspecification of a global model of urban violence. Before discussing both the ‘global’ OLS model and the GWR results, however, a brief review of the theoretical perspectives employed is presented.

Crime and communities perspective

Ecological research is founded on the idea that understanding the characteristics of places—including physical and social measures—that affect the number of targets and offenders in an area is necessary to an understanding of the causes of crime. Theoretically, studies of this nature have been informed by two somewhat different perspectives: (1) social control-disorganization theory and (2) routine activities theory. Although the two schools of thought are closely related, an important distinction can be made. Social control-disorganization theory focuses on the ability (or lack thereof) of residents of some geographic unit (e.g. a neighborhood) to come together to achieve a common goal, like reducing predatory crime (Sampson, 1997, 1999). Alternatively, routine activities theory focuses on the presence of opportunities for crime in an area, as shaped by residents’ daily activities and determined by the spatial and temporal intersection of three key elements: suitable targets, motivated offenders, and the lack of any capable

Tardiff (1985) and Sampson and Groves (1989).

guardians (Cohen and Felson, 1979; Miethe and Meier, 1994). Wilcox et al. (2003) integrate the two theories into an ‘multicontextual opportunity theory’ that recognizes the context of crime as essential to an understanding of crime patterns.

The opportunity framework considers both individual and structural influences on criminal opportunity. Social structures affect criminal opportunity by influencing the routine activities of residents and visitors, and by affecting the sociodemographic makeup of places, such as income and education levels, family stability, employment patterns, and age and demographic structures. The structural characteristics and routine activity patterns of individuals and areas in turn influence the crime profile of a place, which can vary over time with changes in structure and activity.

Taking a classical stance on motivation, Wilcox et al. (2003) assume all individuals in a bounded locale (place) to be motivated offenders. Thus, at the individual level, exposure and proximity to other individuals in a particular place is assumed to increase risk of individual victimization. At the environmental level, exposure to the motivated offender population is a function of population density, i.e., the higher the population density, the higher one’s exposure to motivated offenders. The authors also distinguish between those motivated offenders who reside in an area (“resident motivated offender”) and those who come to the area for other reasons, e.g., work, school, shopping, recreation (“ephemeral motivated offenders”). These populations can be thought of as functions of land use in the area. Furthermore, under this conceptualization, targets can be objects or individuals. Capable guardians are also individuals, but guardianship is affected not only by the simple number of people in a place, but also the ability of the population in that place to effect social control and prevent crime. In

particular, disadvantage can decrease the level of social control operating in an area by restricting the ability of residents to mobilize resources. The mobilization of resources plays an important role in the exertion of social control and the ability of residents to organize to address problems, including violence.

In light of the GWR application in the present study, only the environmental contexts of crime in Portland, OR will be considered. Thus while not providing a complete test of theory, this study will nonetheless contribute to an understanding of ecological aspects of criminal events. The main postulates of the theory are operationalized into several structural measures, discussed below.

Crime data and structural measures

Violent crime data³ were collected from the Portland, OR Bureau of Police for the years 1998-2002. The location and date of each reported crime was collected, and those data were geo-coded and aggregated to the census block group level. Frequencies of crime for each category were averaged over the five years in the study period to control for anomalous years when there may have been an unexplained spike or fall in crime rates. Rates were calculated per 100,000 persons, and the log of violent crime rates is used as the dependent variable in both the OLS and GWR models.

The spatial distribution of violence rates is shown in Figs. C.1. The highest rates are clustered in the downtown area and along the northern edge of the city. In addition, there are pockets of high rates on the eastern side of the city. The map of violence rates in Figs. C.1 also shows some key elements in the geography of Portland. Namely,

³Includes homicide, sexual assault, robbery, and aggravated assault

there are several main highways, the Willamette River, and a light rail system that serve to divide the city into five distinct sectors (northwest, west, south, east, and north). The city's downtown is located on the western banks of the Willamette River and encircled by Interstate Highways 5 and 405. A light rail system generally follows Interstate Highway 84, cutting west-east across the center of the city.

Based on the 2000 Census and the theoretical framework, several structural measures were examined for use in the regression modeling at the block group level. Two measures of disadvantage are employed. Morenoff et al.'s (2000) study of homicide in Chicago used a concentrated disadvantage measure that included percent of residents who are African American, percent of residents living below the poverty line, percent of families receiving public assistance, percent of residents who are unemployed, and percent of families headed by a single parent with children under 18. The measure recognizes the often strong correlation between racial and economic segregation and the difficulty in empirically isolating the effects of either concept independent of the other (Morenoff et al., 2000). For this work however, a modified index was developed which measured concentrated poverty only. Racial segregation in Portland doesn't appear to be as extreme as in Chicago where the disadvantage index was originally employed. In initial modeling for this study, the African American and single parent measures explained very little of the variation in violent crime in Portland and the decision was thus made to exclude them. The poverty, public assistance, and unemployment measures were equally weighted and the concentrated poverty index created by averaging their z-scores. This measure recognizes multiple facets of poverty and the difficulty in empirically separating their effects in a statistical model.

The second measure was proposed by Massey (2001) in his discussion of the growing economic segregation of both poor and affluent families. Sociologists have recently turned more attention to concentrated affluence, investigating the idea that affluence is more significant than simply being ‘not disadvantaged’. Instead, much as Wilson (1987) argued that living in a disadvantaged neighborhood compounded the effects of disadvantage, living in affluent neighborhoods can compound the effects of affluence (Brooks-Gunn et al., 1993; Massey, 1996). Affluent neighborhoods may produce protective characteristics based on access to and mobilization of various resources (Morenoff et al., 2000). Massey’s (2001) essay on the neighborhood effects literature suggested that concentrated disadvantage and affluence represent two ends of a continuum and thus are highly (negatively) correlated and should not be included in statistical models as separate measures. To accommodate this, he proposed the index of concentration at the extremes (termed “ICE” by Morenoff et al.), calculated as $(\text{number of affluent families} - \text{number of poor families}) / \text{total number of families}$. For this research, affluence is defined as families with incomes over \$50,000 and poor is defined as families with incomes less than \$15,000. The index has a theoretical range of -1 to 1, where -1 identifies areas where all families are poor and 1 identifies areas where all families are affluent. A 0 value identifies areas with an equal share of poor and affluent families.

Other measures of the level of social control, or guardianship, in an area are residential stability, racial heterogeneity, proportion of single-person households, and level of family disruption (Wilcox et al., 2003). Stability is measured as the percentage of residents who lived in the same residence in 1995. The heterogeneity index used here “takes into account both the relative size and number of groups in the population,”

and is equal to $1 - \sum p_i^2$ where p_i is the proportion of each racial group in the population (Sampson and Groves, 1989, p. 784). The index has a theoretical range of 0 to 1, where 1 indicates maximum heterogeneity. Family disruption (or lack thereof) is measured by the proportion of married families in the area.

Other structural measures suggested by the opportunity framework indirectly measure the availability of targets and offenders. These are population density (persons per square kilometer), a land use measure which indicates the percentage of land put towards commercial or multiple uses (i.e., residential and commercial), and dummy variables that indicate whether there is a light rail stop in the area and whether the block group is located west of the Willamette River. These measures are postulated to influence the number of motivated offenders in an area: population density increases the number of potential offenders, commercial or multiple use areas increase the number of visitors to an area, and the existence of a light rail stop in the area can mean that the area is more easily accessible and has more visitors. It should be noted, however, that population density can be interpreted differently within the same theoretical framework; it can be understood to increase the number of *guardians* in an area, and thus have a negative relationship with crime rates. The evidence in the literature regarding population density has been mixed, but the variable has been included here as GWR will be applied in an exploratory manner, allowing a more thorough examination of the relationship between density and violent crime.

Descriptive statistics for the structural measures are shown in Table 1 and the geographic patterning of these variables is shown in Figs. C.2-C.9.

A Global Model of Violence in Portland

A multivariate model was developed to estimate average levels of violence in Portland over the 1998-2002 time period. The model was developed at the block group level using ordinary least squares regression. The model is considered to be ‘global’ as one parameter is estimated for each variable included in the model. The relationships between predictor variables and the violence measure are assumed to be the same at all locations within Portland. The results of the model are shown in Table 2. The table includes both unstandardized and standardized parameter estimates and collinearity statistics.

Table 2 shows that all ten parameter estimates are significant and all but one estimate is in the expected direction. Three measures of guardianship—concentrated poverty, heterogeneity, and single-person households—were all positively related to violence rates. These measures are hypothesized to foster violent crime by impeding a neighborhood’s ability to mobilize resources for addressing crime problems and to develop social control. Two other guardianship measures, residential stability and married families, were negatively related to crime rates as they indicate areas where residents might be more invested in their neighborhood and more able to mobilize resources. These relationships are all as expected given an opportunity framework. The measure of concentrated affluence, ICE, was positively related to crime, indicating that areas with higher affluence have higher levels of violence. This result was unexpected and it is unclear why this would be the case. The parameter estimate for population density in this model was significantly negative, in line with the interpretation of pop-

ulation density as a measure of guardianship. The coefficient for the multiple land use and light rail stop measures were both significantly positive, supporting both as a measures of increased targets and offenders. Finally, the variable indicating location west of the Willamette River was significantly negative, indicating that the portion of the city west of the river is significantly different in terms of violent crime levels than the rest of the city.

The results of the global model are fairly solid, and the model explained 46% of the variance in violence rates. The variance inflation factors (VIF) indicate that collinearity among the coefficients is low. While the results of the model are promising, more than 50% of the variance in the violence measure is unexplained. There are several reasons for this level of unexplained variance. Some obvious determinants of violence that are missing from this model could improve the results. Specifically, the measures employed here may be too indirect, and may not provide the best measures of targets, offenders, and guardians. Individual data collected from residents, whether averaged and included in an aggregate form or incorporated into a multilevel model, would improve measures of routine activities of residents and available targets, for instance, and better capture their affect on the three main elements of criminal opportunity. Furthermore, it is likely that local variations in the relationships between the predictor variables and the violence measures do exist, and failing to include this variation can reduce the explanatory power of the model. The effects of either type of misspecification (failing to include appropriate predictors or failing to model spatial patterns in the model) are compounded by the fact that the global OLS model is masking any variations in relationships between the independent and dependent variables. In any case, GWR can

be utilized in an exploratory manner to examine the model's performance over space and speculate on possible improvements, whether that be including other measures in a global model or deciding that an explicitly spatial model is more appropriate.

Geographically Weighted Regression

One of the problems with estimating global regression models for spatial data is that variations over space that might exist in the data are suppressed. In the example given above, the relationship between a violence measure and violence predictors are assumed to be equal at every point in the study area, Portland. To explore whether this is an accurate representation of violence in the study area, a GWR model is useful.

The starting point for development of a GWR model is the basic linear regression model:

$$y_i = a_0 + \sum_k \beta_k x_{ik} + \varepsilon_i \quad (\text{C.1})$$

Calibration of the model in Eq. (C.1) results in one parameter estimate for each variable included. A variation of the traditional linear regression model shown in Eq. (C.1) was developed by Brunson et al. (1996), called geographically weighted regression (GWR). Instead of estimating one parameter for each independent variable, GWR estimates local parameters—a parameter is estimated for each data location in the study area. The GWR model is thus expressed as

$$y_i = a_{0i} + \sum_k \beta_{ki} x_{ik} + \varepsilon_i \quad (\text{C.2})$$

where β_{ki} is the value of β_k at point i (Brunson et al., 1996; Fotheringham et al., 2001, 2002). For the present study, then, for each variable in the model a parameter is

estimated for each block group in Portland. GWR thus allows a “continuous surface of parameter values” (Fotheringham et al., 2002, p. 52) that can be mapped for visual inspection.

In a GWR model, parameters are estimated using a weighting function based on distance so that locations closest to the estimation point have more influence on the estimate. The GWR parameter estimates are solved using the following equation, given in matrix form:

$$\hat{\mathbf{b}}_i = (\mathbf{X}^t \mathbf{W}_i \mathbf{X})^{-1} \mathbf{X}^t \mathbf{W}_i \mathbf{y} \quad (\text{C.3})$$

where $\hat{\mathbf{b}}_i$ is the estimate of \mathbf{b}_i , the location-specific parameters and \mathbf{W}_i is an n by n spatial weighting matrix “whose off-diagonal elements are zero and whose diagonal elements denote the geographical weighting of observed data *for point i*,” as shown below (Fotheringham et al., 2001, p. 52):

$$\mathbf{W}_i = \begin{matrix} & w_{i1} & 0 & 0 & \dots & 0 \\ & 0 & w_{i2} & 0 & \dots & 0 \\ & 0 & 0 & w_{i3} & \dots & 0 \\ & \cdot & \cdot & \cdot & \dots & \cdot \\ & 0 & 0 & 0 & \dots & w_{ij} \end{matrix} \quad (\text{C.4})$$

In the spatial weighting matrix, w_{ij} is a weight of the data in block group j for estimation of the model around point i ; for the present study, the point of estimation is each block group centroid.⁴ The weights can be calculated using a variety of methods; for this research, a Gaussian weighting function is employed. The use of a continuous weighting function such as this dictates that locations closest to the point of estimation are more strongly weighted in the calibration of the model. The weighting function

⁴While for the present study, parameters were estimated for the data points, this need not be the case, as GWR can estimate parameters for a set of points other than those for which data is provided.

employed here takes the form:

$$w_{ij} = \exp(d_{ij}^2/h^2) \quad (\text{C.5})$$

where d_{ij} is the distance between a block group i where the model is being calibrated and another data point j , which in this case is another block group, and h “is a bandwidth that affects the distance-decay of the weighting function” (Fotheringham et al., 2001, p. 52). While previous work with GWR has shown that the use of different continuous weighting functions does not have much influence on the model (Fotheringham et al., 2001, 2002), selection of the bandwidth can significantly affect the model calibration. If the bandwidth is too large, the spatial variation will be low and the model at each point will tend toward the global model. If the bandwidth is too small, the number of data points used in estimation may become too low and result in instability in the parameter estimates.⁵

The local regression model for this study was calibrated using GWR software developed by Fotheringham et al. (2003). Along with providing the parameter estimates and t -statistics for each parameter at each data point (block group centroid), the software performs a Monte-Carlo test for assessing the spatial variation in the relationships between the violence measure and explanatory measures. The test is an iterative process that involves randomly rearranging the data to different locations, recalculating parameter estimates and variances, and comparing those variances with the original model’s variance (where the data was in the correct location). The result is a p -value for each parameter that indicates whether significant spatial variation in the relation-

⁵For a more complete description of bandwidth calibration, see Brunson et al. (1996) and Fotheringham et al. (2002).

ship between that parameter and the violence measure exists. There are other tests for spatial variation, but the Monte-Carlo process provides the most robust results. This type of test is important for determining whether a local regression model is indeed appropriate.

A local model of violence in Portland

In the context of the present study, the application of GWR is warranted for several reasons. The OLS model, while promising, left more than 50% of the variance in the violence measure unexplained. Furthermore, one parameter estimate (ICE) had a counter-intuitive direction. GWR offers an avenue of spatial data exploration in a regression modeling framework. GWR also allows a speculation on whether the relationships between violence and the criminal opportunity measures are inherently spatial and can only be modeled accurately if space is explicitly accounted for, indicating directions for future work modeling crime in Portland, and more generally, modeling violent crime in urban areas.

The same independent and dependent variables used in the above OLS model were used to develop a GWR model with one exception. The dummy variable indicating location west of the Willamette River was excluded from the GWR model because it was a location variable and the GWR framework explicitly accounts for location. Therefore, it was decided that the variable was inappropriate for this type of statistical modeling. The resulting set of parameter estimates for each variable are best interpreted visually, allowing spatial patterns to be identified. Parameter estimate maps for

the intercept and the ten independent variables are shown in Figs. C.10-C.19. These maps confirm the results of the OLS model for the most part, although there are some interesting geographic variations that should be noted as they highlight elements of the model not evident from the OLS results.

First, the concentrated poverty estimate in the OLS model was positive, as predicted by the opportunity framework. The parameter map for this variable, however, shows several areas where the measure has a negative relationship with the crime measure. In these areas, concentrated poverty may actually be associated with lower levels of violence. The negative estimates are located in small pockets in the center of town and in the northwest section of town. Comparison of the parameter estimates to the the pattern of actual values for the measure, shown in Fig. C.2, is useful in understanding the GWR results. A pocket of very low poverty exists in the center of town while the areas just west and south of that pocket are characterized by high levels of poverty. The negative parameters are located in areas of low to moderate poverty. In addition, the estimates for this measure are strongest where poverty is lowest, in the southwest corner of the city. The patterns are not surprising given the range of values for this measure, and this measure demonstrates the utility of GWR in violence models. Because the concentrated poverty variable is an average of z-scores, negative values are possible and occur where poverty is lowest. The local model indicates that even where poverty is low, it contributes to higher levels of violence because in these areas, the parameter estimates are also negative. In areas where concentrated poverty is high, the values for the measure are negative, and the parameter estimates are in turn positive. These results support a global inverse relationship between poverty and violence.

The parameters for the other measure of disadvantage, ICE, in Fig. C.12, display a different geographic pattern. This measure had a positive parameter estimate in the OLS model, a counter-intuitive result that was difficult to explain in the opportunity framework. The parameter map for the measure shows that most of the estimates are actually small but negative and located mainly in areas east of the Willamette River. The strongest estimates are positive and located on the western and eastern edges of the city. These are areas where actual ICE values are high, indicating that affluence is concentrated in those areas. The local model thus suggests that the model performs as expected—with concentrated poverty contributing to higher levels of crime—only in areas of concentrated poverty. In areas of concentrated affluence, however, the results are counter-intuitive, as the positive parameters indicate that affluence contributes to higher levels of violence. While the pattern of estimates for this variable are counter-intuitive, they do illuminate the relationship between the measure and violence, and provide more information on the relationship than is provided by the OLS model. The results also suggest that the model is not capturing some other relationship that could help explain the lack of correspondence between parameter values and concentrated affluence.

The residential stability parameters also display some variation from the OLS model, where the estimate was negative. The parameter estimates appear evenly split between positive and negative values, with positive values forming a ring around a center of low but negative values in the center of town. The map of actual values of this area, shown in Fig. C.4, reveals a fairly random pattern of values outside of the downtown, where values are low. The parameter estimates, however, appear to

be higher and positive where stability is lowest. The geographic pattern of parameter estimates for the heterogeneity index, shown in Fig. C.14, loosely follows the pattern of actual values for this parameter, shown in Fig. C.5. There are also few negative parameter estimates, lending support to OLS model that provided a positive estimate for racial heterogeneity. The variable appears to have the strongest influence on the model where heterogeneity is lowest.

The parameter estimates for single-person households and married families (Figs. C.15 and C.16) generally follow the patterns of actual values for those measures (Figs. C.6 and C.7). The single person household parameter estimates do not display much variation over space, but are high and positive in the downtown area, where the actual values for the variable are highest. This supports the finding in the OLS model that single person households serve to increase the number of targets and reduce guardianship, therefore contributing to higher levels of crime.

The Monte-Carlo tests for significant spatial variation provide evidence for the importance of exploring spatiality in statistical models. The tests revealed that the relationships between the violence measure and six of the nine independent measures display significant variation across the city of Portland. Those measures include ICE, residential stability, heterogeneity index, single-person households, population density, and multiple land use. The spatial insignificance of the dummy variable ‘Light rail stop’ is not surprising as it is a location variable. The lack, however, of spatial variation in the violence-concentrated poverty relationship is surprising, especially given the spatial significance of the ICE measure. This result provides an indication that the effects of extreme poverty operate similarly in all parts of the city while the effects of affluence

vary within the city of Portland. Indeed, this conclusion is supported by the results of the local model discussed above.

The GWR results for the most part supported the results of the OLS model, even while providing more insight into structural influences on violence in Portland. The GWR results did, however, identify at least one measure, ICE, that should be investigated more closely in an attempt to determine why the patterns of actual values and parameter estimates do not coincide. The parameter estimate maps also allowed visual inspection of areas where specific measures have a strong influence in the model (where the estimates are largest, or absolute values are highest). In addition, the GWR parameter maps allowed local variations not captured by the OLS model to be discovered. In several instances, both positive and negative values were estimated for a single measure. This highlights the importance of considering local context when modeling urban violence. The spatial significance tests provided further support for the application of GWR modeling when studying crime.

GWR clusters

The exploratory utility of GWR parameters can be extended by clustering together locations with similar parameter values for all variables, i.e. where whole models of violence are similar. This synthesizes the often huge amount of output created by the GWR model and aids interpretation of multiple parameter estimate maps. In the present study, a hierarchical clustering method was applied to the block groups based on the nine parameter estimates and the intercept. Experimentation with a range of

clusters (between four and nine) revealed that the optimal choice in terms of number of clusters was seven. When producing six or fewer clusters, a large cluster with more than 90% of the block groups was extracted. More than seven clusters, however, produced clusters with less than five block groups. The seven clusters, shown in Fig. C.20, are fairly geographically coherent, even while latitude and longitude variables were not included in the clustering calculations.⁶ Unfortunately, the data clustered into six relatively small clusters and one large cluster (Group 6) that dominates the eastern part of the city.⁷

To characterize each cluster group, summary statistics are provided in Tables 3 and 4. Table 3 provides the descriptive statistics of the *actual* variable values. The table also provides information on the different components of violence to examine whether different types of violence are dominant in different areas. Table 4 is provided to characterize the *model* for each cluster group. These statistics are provided for descriptive purposes only; the values are simply the average parameter estimates by cluster group for each variable in the GWR model. While significance tests are not appropriate here, the average values are useful for describing models in different parts of the city and can be compared to a reference model—the global OLS model. Also included in the table are the number of block groups in each cluster (N). Table 3 thus provides information on the actual structural characteristics of each group while Table

⁶Discriminant analysis confirmed that approximately 74% of the cluster members were identified correctly based on their location; i.e., 74% of the members in all clusters were geographically near other members of the same cluster. 74% of the members in the largest group, Group 6 were accurately assigned based on location while only 22% of the members in group 4 were accurately assigned based on location.

⁷Even when extracting a larger number of clusters from the data, this large group remained while other groups were split into even smaller groups.

4 provides information on the relationships between structural measures and violence in each group. Together, these data allow an investigation of differences in whole models and the characteristics of the different places within the study area.

Not surprisingly, aggravated assault is the largest component of violence in all groups and homicide is the smallest. The largest group with 289 block groups, Group 6, dominates the city east of the Willamette River. This group has the highest homicide rate, even while it has only mid-range values for the other three violence measures. Group 6 also has a very high overall violence rate. Recalling the geographic pattern of violence rates shown in Figure C.1, Group 6 contains most of the high violence areas, but that level of violence is muted in the mean value for the group because the group is so large. The second largest group with 94 block groups, Group 7, has the highest means for the violence measures excluding homicide, and the highest overall violence rate. The cluster is not geographically coherent and is made up of small pockets of block groups across the city. At the opposite end of the spectrum, Group 1, a small group in the southwestern tip of the city, has the lowest means for each of the individual violence measures and overall violence rate. This is a more affluent area of the city and an area of very low violence rates, as shown in Figure C.1. The rest of the city is divided into other small low-violence groups. This pattern of clustering may be masking some of the variation of violence across the city, but because the clusters were created on the *parameter values*, the grouping indicates that the higher violence areas of Portland respond similarly to structural characteristics.

Because it is so large, Group 6 appears to be the ‘average’ group with mid-range values on the structural measures. The descriptive statistics do reveal that Group 7, in

addition to having high levels of violence, also contains areas with the highest levels of concentrated poverty, little concentration of affluence, low residential stability, racial heterogeneity, and high levels of multiple land use. The other five clusters are affluent areas with low densities, high residential and family stability, and a more homogeneous population.

Considering the average parameter estimates for each group in Table 4, with few exceptions, Group 7 no longer dominates as it did in Table 3. Instead Group 5, a small group in the southwestern tip of the city (south of Group 1) contains five of the strongest average parameter estimates out of the nine variables. This group had a relatively low average violence rate. The high parameter estimates in Group 5 include a strong positive value for the concentrated poverty term. Recalling the above discussion on concentrated poverty, this result is unsurprising given that the area is one of the most affluent in town. Group 1 has an average parameter for the heterogeneity term that is much higher than for the other groups. The map of actual values and the map of parameter values for this measure reveal that racial heterogeneity has the largest influence on the model where it is lowest; i.e., changes in heterogeneity where it is low affect violence greater than changes in heterogeneity where it is high. Group 1 is an area with very low racial heterogeneity, which explains the high parameter estimate.

The lowest parameter estimates are found in Groups 6 and 7—the groups with the highest overall violence rates. This finding indicates that in general, the violence model is most sensitive to changes in structural measures where theory indicates that violence should be low, i.e., where poverty, densities, multiple land use, and heterogeneities are low while stability, married families, and affluence are high.

Another noteworthy result is that the signs for seven of the nine average parameter estimates are both positive and negative across groups. That is, some groups may have negative values for a specific coefficient while another group has a positive value for the same coefficient. Only the married families and multiple land use terms are consistently positive across all groups. In most cases, however, the range of means across groups is small and the switch from negative to positive values represents a very small change in absolute value. Also noteworthy is the number of average parameters which are close to zero; the heterogeneity index, single-person households, married families, and population density terms all display very low average parameter estimates and a very low range of values. This may indicate that while statistically significant, these measures have a small affect on violence levels relative to the other structural measures in the model. The average parameter values allowed a consideration of groups with similar values on all the parameters, which highlights some of the main differences in structural measures and violence across the city of Portland.

Discussion

The application of GWR to a model of violence rates and its comparison to an OLS base model has yielded several striking results. Theoretically, the OLS model, while not as robust as hoped, did provide support for the criminal opportunity theory. All ten measures of the three elements of opportunity—targets, offenders, and guardians—were significant and nine were in the expected direction. The ICE measure was the only variable with a counter-intuitive result—a negative coefficient. The GWR results,

however, provided insight to the model and revealed that most areas indeed did have a negative parameter estimate; these tended to be areas of concentrated disadvantage. A smaller number of areas were affluent and had positive parameter estimates. While this result is still unexplained, the OLS model masked important variation in the parameter. The GWR results allow the researcher to focus an investigation on those areas where the model is not performing as expected. The GWR results also revealed positive and negative parameter estimates for the concentrated disadvantage measure, but examination of the pattern of concentrated poverty itself revealed that the negative values still supported the theoretical expectations.

Other GWR results for the most part strengthened the OLS findings. However, the spatial significance tests revealed that six of nine parameters demonstrated significant variation over space; i.e., the relationship between those parameters and the violence measure varied across the study area. One way to model this result statistically is to develop a mixed model where some parameters are allowed to vary over space, and are estimated using the GWR methods described above while other parameters in the model are fixed. The fixed parameters would have only one estimate, a global estimate that assumed the relationship between that measure and violence to be equal across space. This type of model would also allow dummy location variables, like the ‘west of the Willamette River’ variable to be included in the model without creating uninterpretable results.

The hierarchical clustering exercise resulted in seven geographically coherent groups with similar overall models based on the GWR parameter estimates. The average values for each parameter within each group showed that the strongest (positive or negative)

parameter estimates clustered together in groups 1 and 5, where the average violence rates were in the low-to-mid range of all seven groups. Smaller values (positive or negative) clustered in groups six and seven, which surprisingly had the highest overall violence rates.

While in support of opportunity theory, the OLS model was not as robust as was hoped, explaining only 46% of the variance in Portland's violent crime rates. The results, especially those for the ICE and heterogeneity variables, indicate that measures not included in the above models could improve the performance of both models. These measures were included as proxies for control or guardianship, and thus reconsidering the measures of guardianship employed in the present study could afford a stronger model. In addition, several of the measures, while significant, had very low parameter estimates, especially single-person households, married families, and population density. These guardianship measures might be too indirect and the model might be improved with more direct measures of control. Introducing alternate or additional measures of opportunity may also improve the model. Specifically, the opportunity theory draws from routine activity theory; a measure of individual behavior that better captures aggregate routine activities in each area would likely improve the model.

Conclusion

Generally, the results support the application of GWR in this context as the results provided insight into the spatial patterns of parameter relationships. The GWR model-

ing exercise thus demonstrated the efficacy of this method for descriptive purposes—for exploring spatial relationships between predictor variables and the dependent variable. In addition, the spatial significance Monte-Carlo tests strengthened the argument for at least considering space in studies of violence, if not explicitly including it; here most of the variables did indeed have locally-varying relationships with the violence measure.

GWR can be useful in different types of crime studies. Here, applied in a test of opportunity theory, the exploration of space can help account for differences between communities not captured by standard measures and thus explain causes of crime in different areas. GWR can also be particularly useful in policy studies. Different interventions for crime reduction or prevention may be appropriate in different areas; local attitudes towards types of interventions can vary across an urban area and affect the success of an intervention. Alternatively, GWR can be used to evaluate the success of an intervention already in place by determining areas where the intervention was more successful and why. The method is thus applicable in a range of contexts within the field of criminology.

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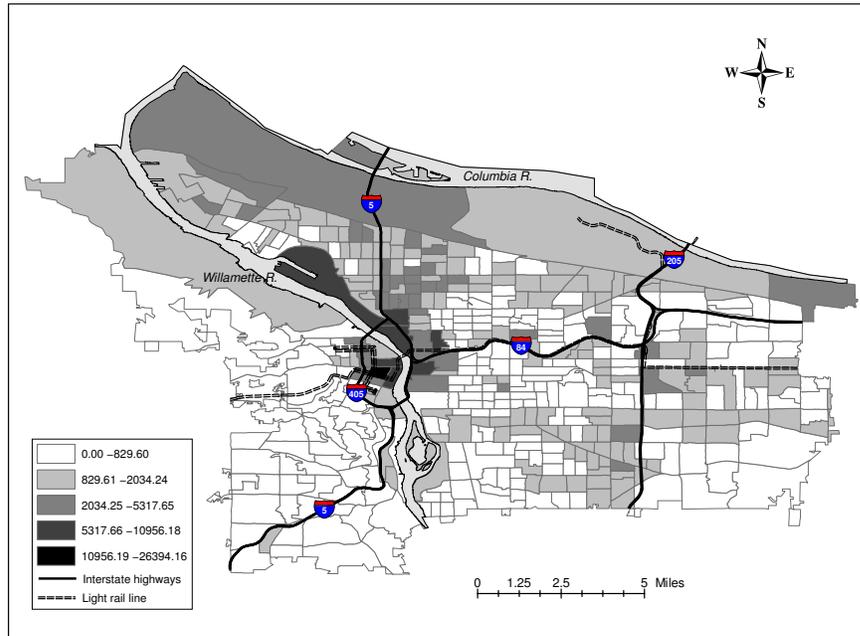


FIGURE C.1. Portland, Average violent crime rates per 100,000 persons, 1998-2002

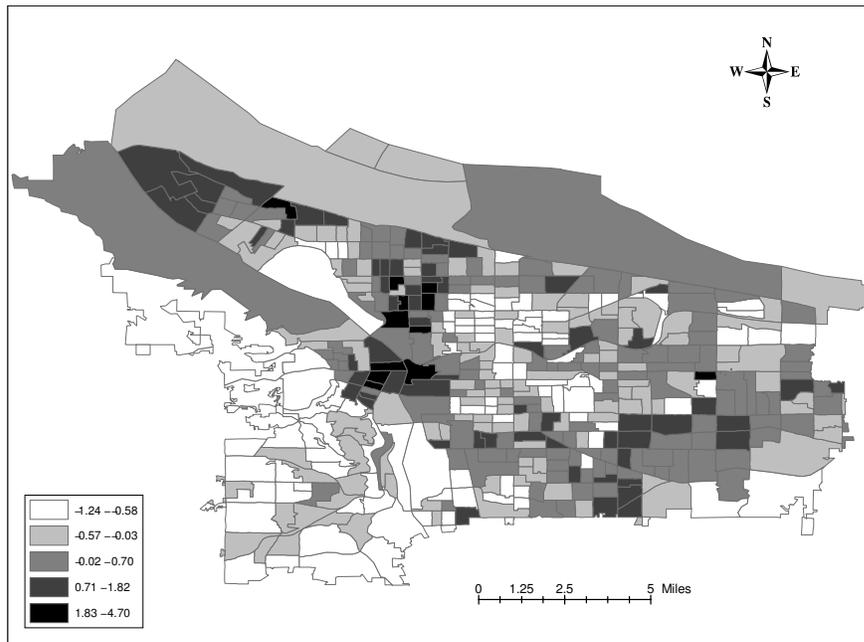


FIGURE C.2. Concentrated poverty by block group

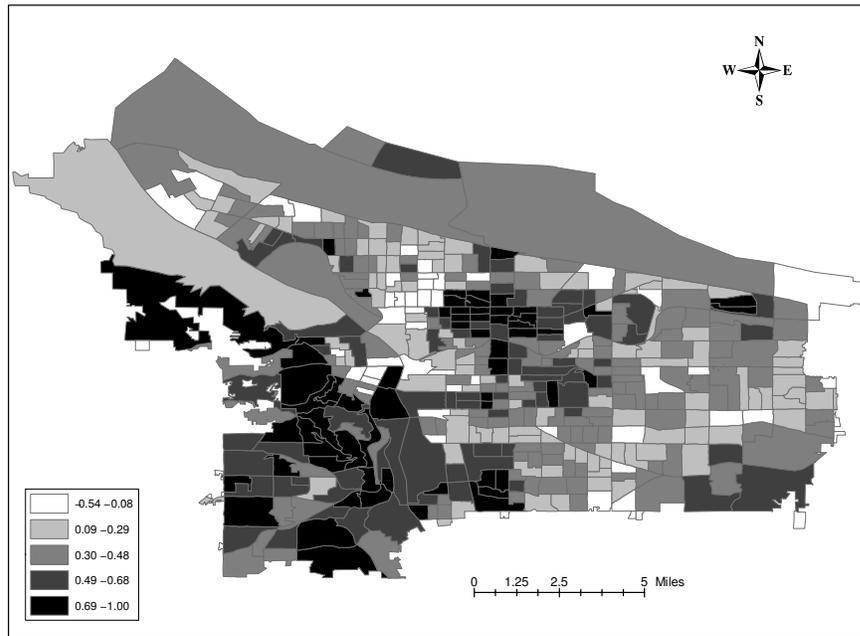


FIGURE C.3. Index of Concentration at the Extremes (ICE) by block group

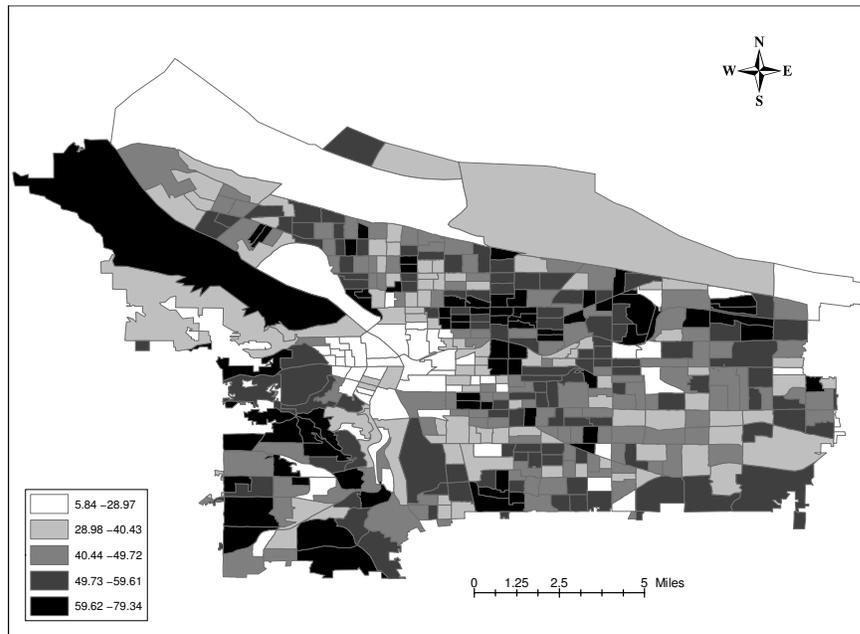


FIGURE C.4. Residential stability by block group

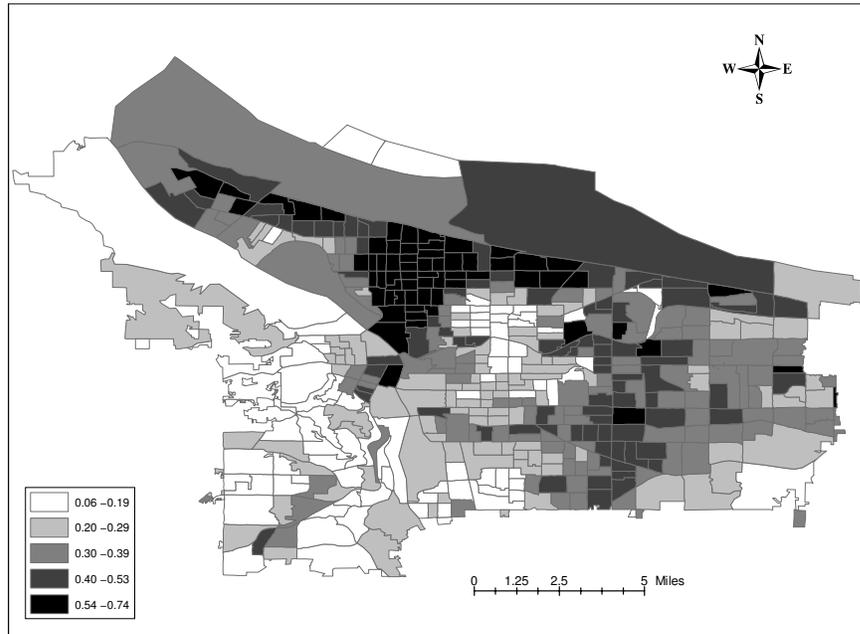


FIGURE C.5. Heterogeneity index by block group

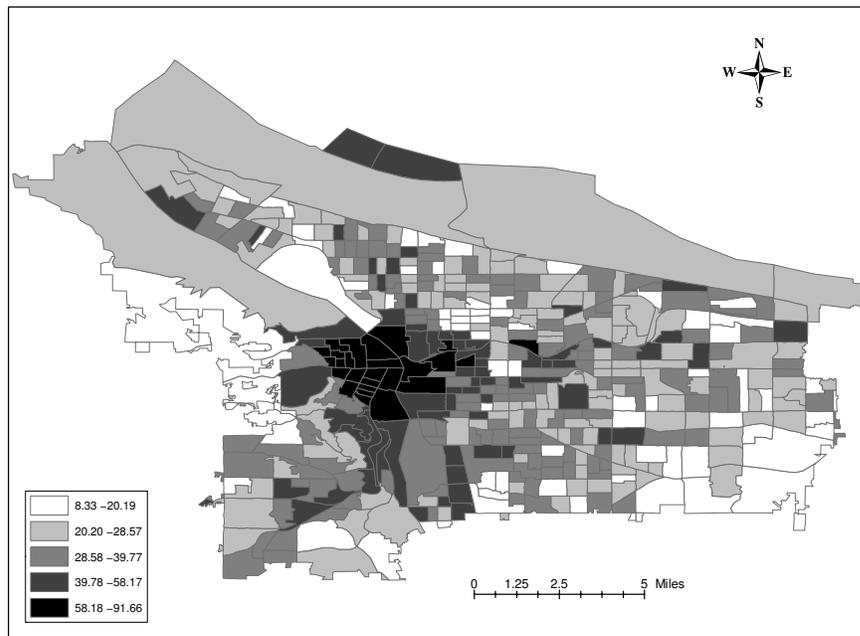


FIGURE C.6. Single-person households by block group

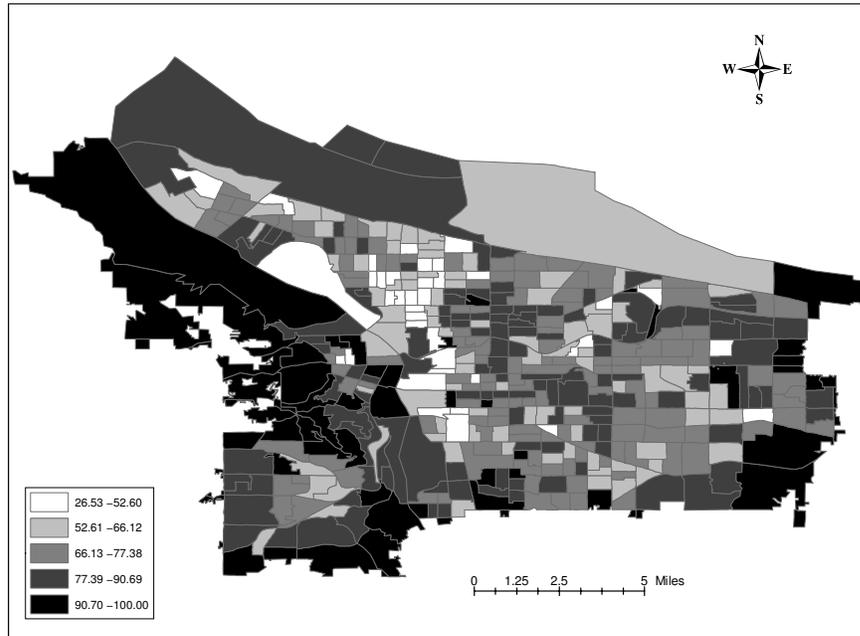


FIGURE C.7. Married families by block group

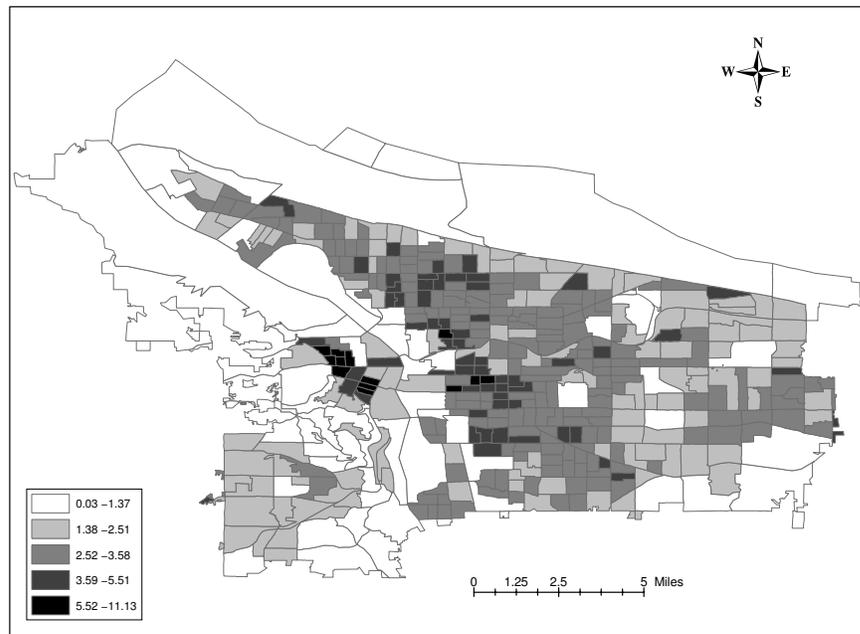


FIGURE C.8. Population density by block group

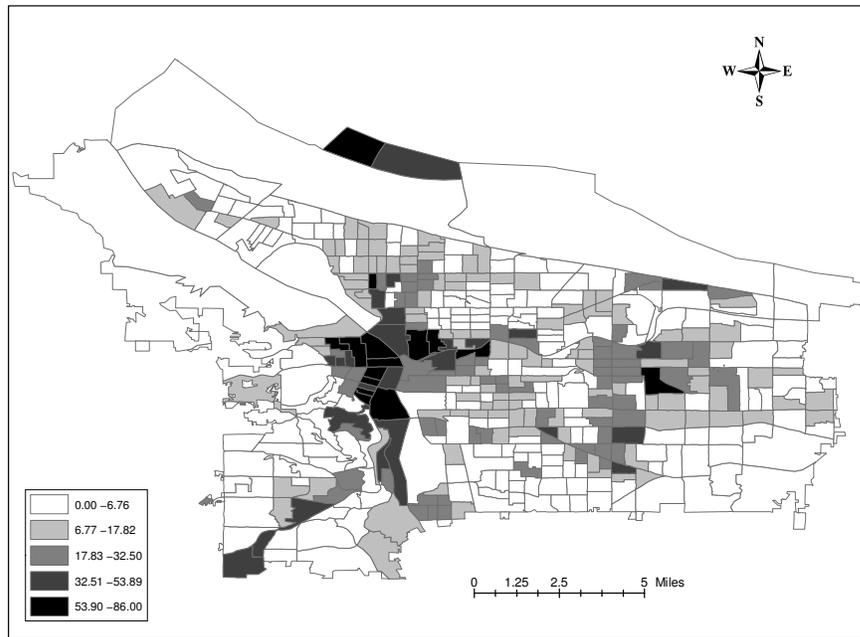


FIGURE C.9. Multiple land use by block group

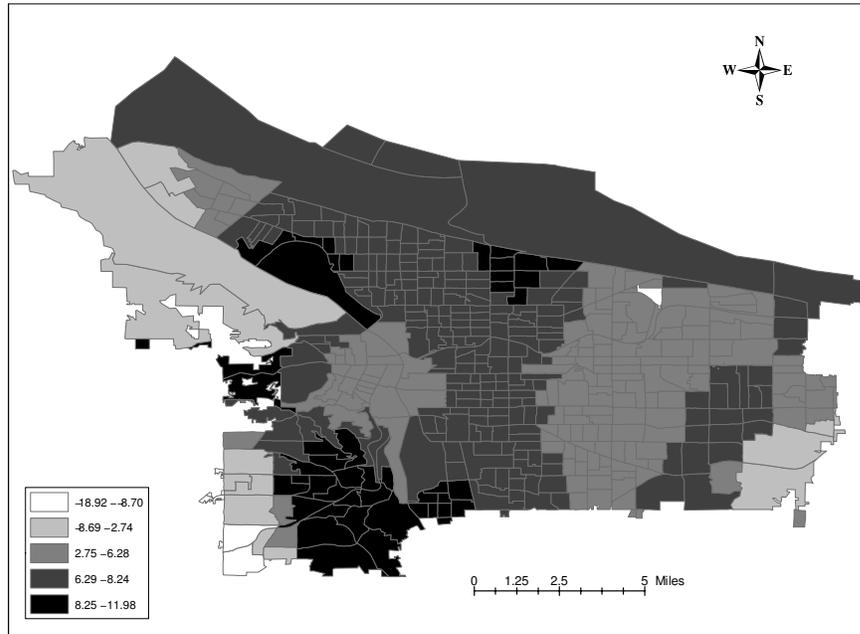


FIGURE C.10. Intercept estimates by block group

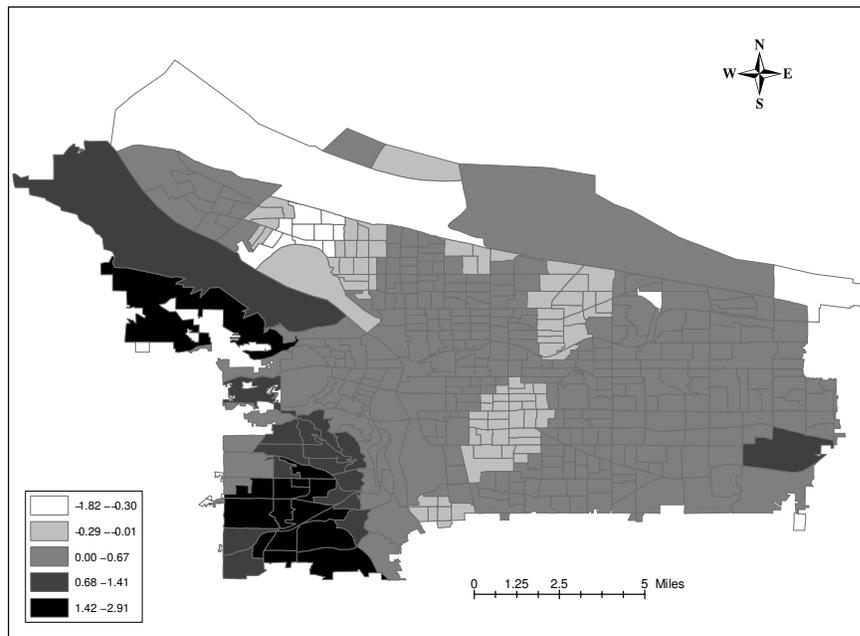


FIGURE C.11. Concentrated poverty parameter estimates by block group

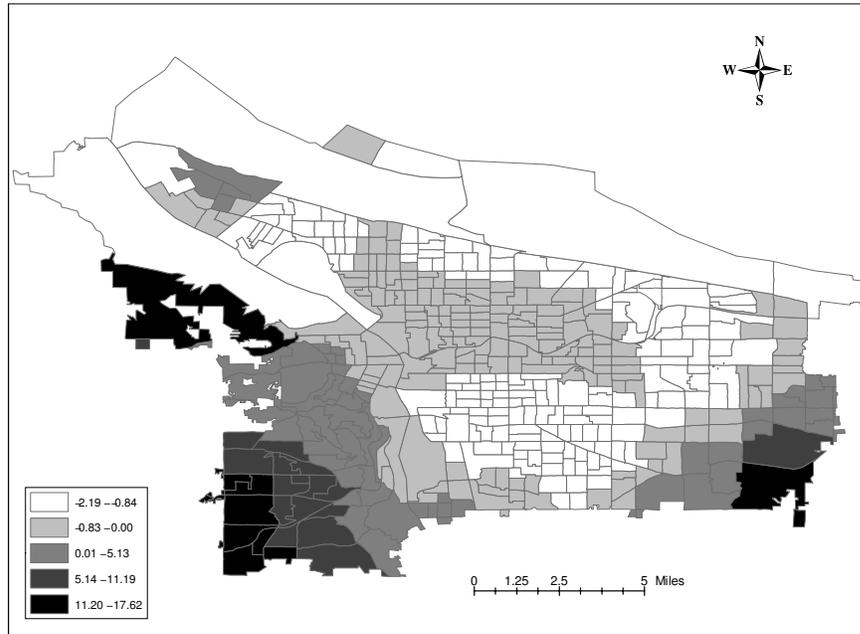


FIGURE C.12. ICE parameter estimates by block group

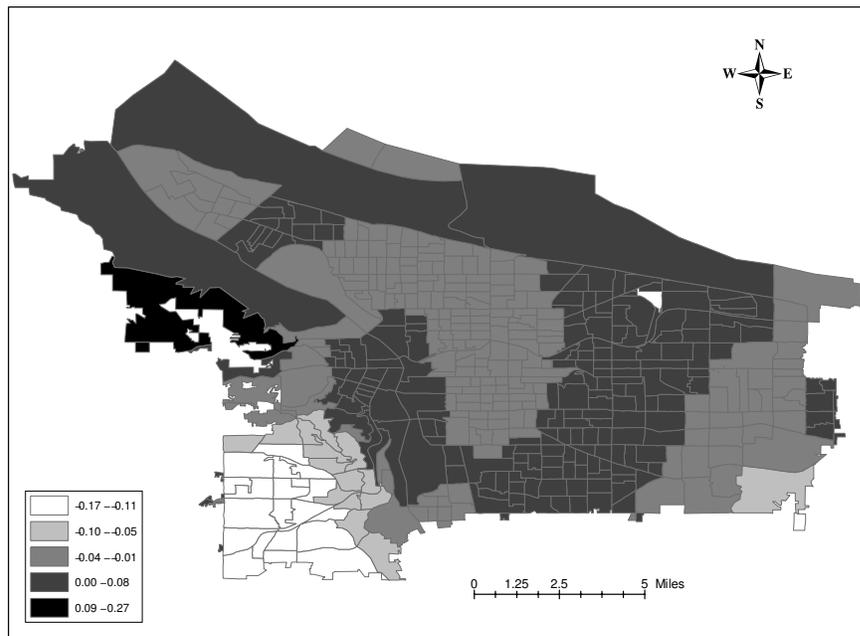


FIGURE C.13. Residential stability parameter estimates by block group

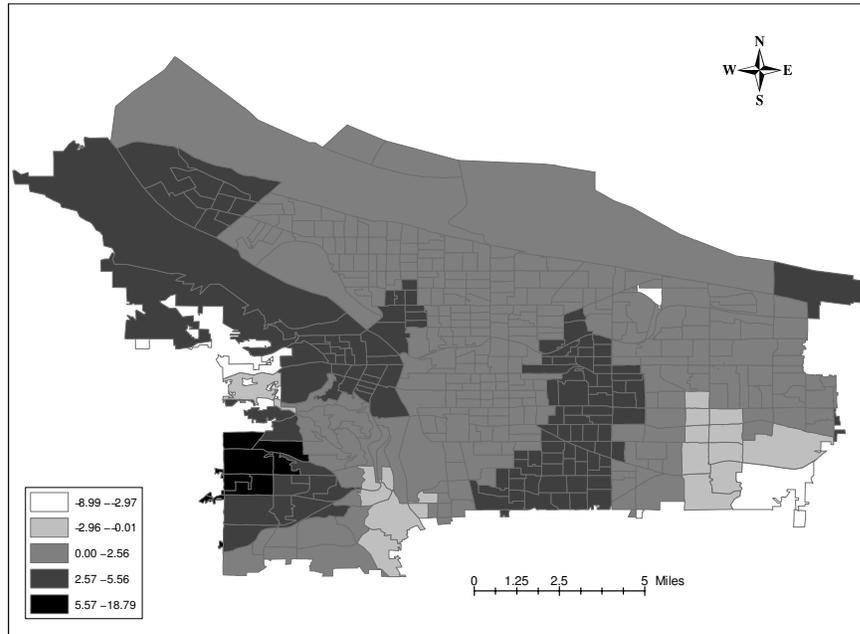


FIGURE C.14. Heterogeneity index parameter estimates by block group

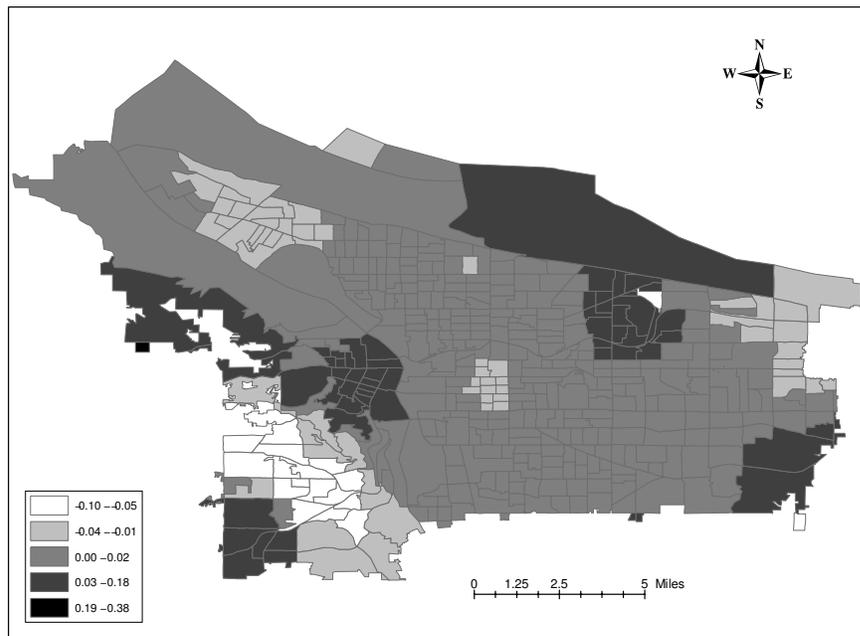


FIGURE C.15. Single-member households parameter estimates by block group

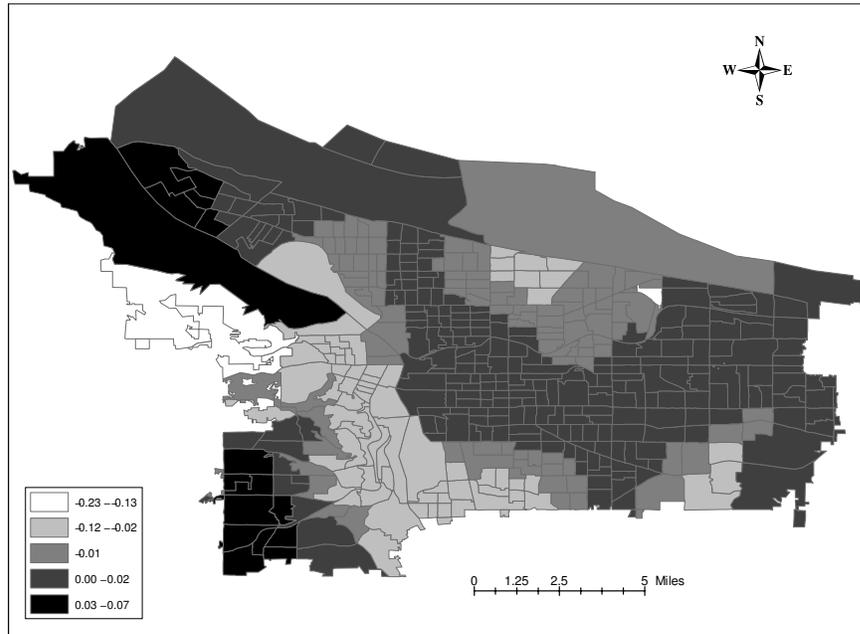


FIGURE C.16. Married families parameter estimates by block group

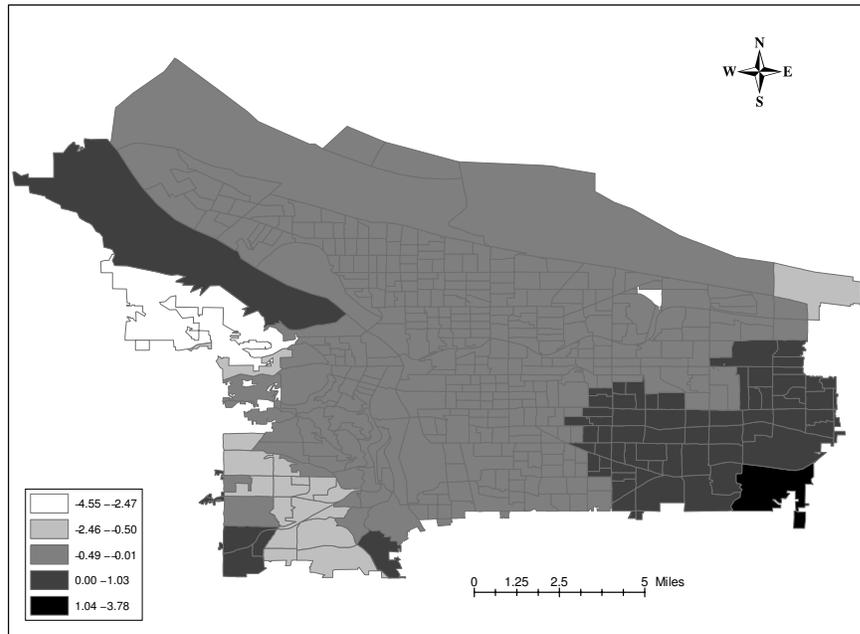


FIGURE C.17. Population density parameter estimates by block group

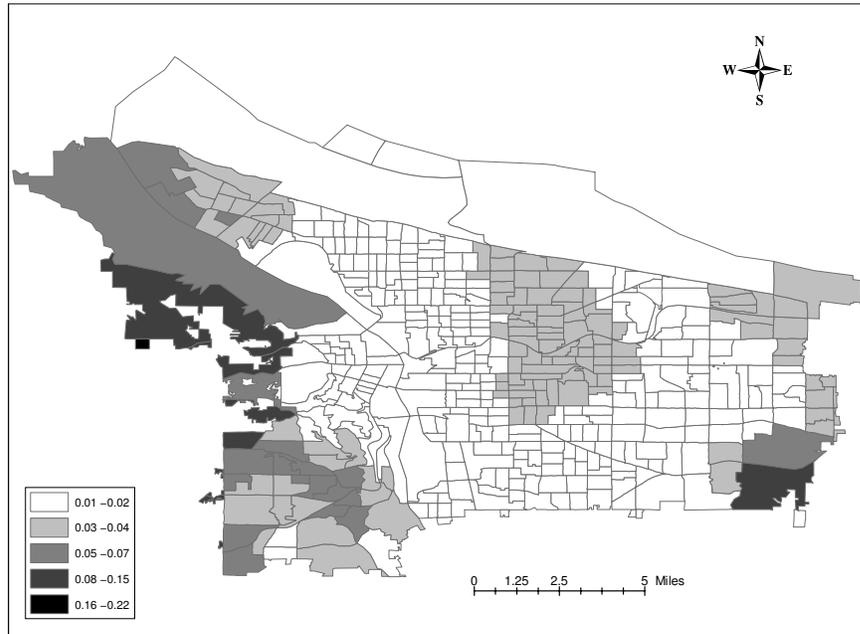


FIGURE C.18. Multiple land use parameter estimates by block group

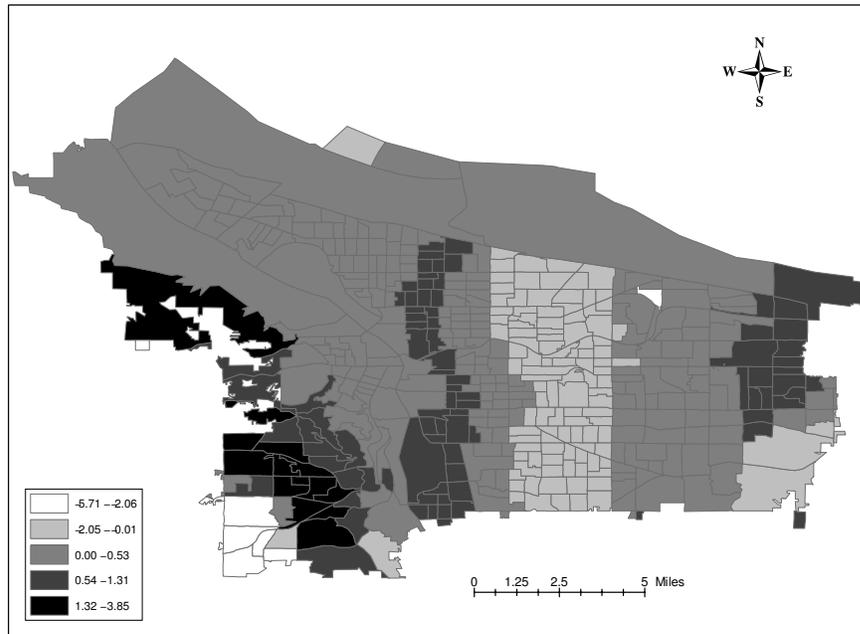


FIGURE C.19. Light rail stop parameter estimates by block group

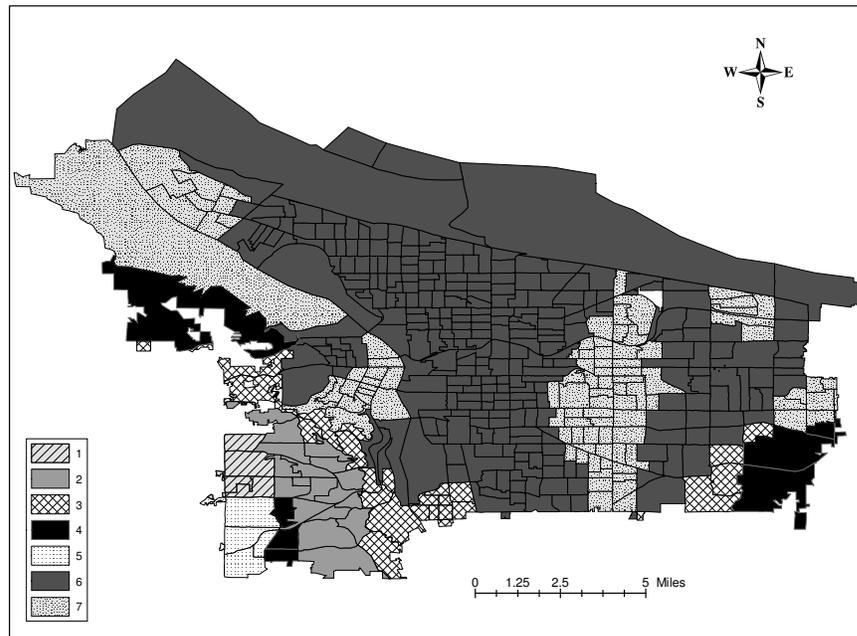


FIGURE C.20. GWR clusters on parameter estimates by block group

TABLE C.1. Descriptive statistics, structural data and violence measure

Variable	Minimum	Maximum	Mean	Std. Deviation
Con. poverty	-1.24	4.70	0.00	0.80
ICE	-0.54	1.00	0.38	0.25
Residential stability	5.84	79.34	46.17	13.17
Heterogeneity index	0.06	0.74	0.34	0.16
Single households	8.33	91.66	31.97	14.11
Married families	26.53	100.00	74.16	14.99
Population density	0.03	11.13	2.71	1.38
Multiple land use	0.00	86.00	12.57	15.57
N	448			

TABLE C.2. OLS Regression model, violent crime rate

Variables	Parameter Estimates		<i>t</i>	VIF
	Unstand.	Stand.		
Intercept	6.47		10.49	
Con. poverty	0.44	0.21	3.92	2.41
ICE	1.72	0.26	4.84	2.39
Residential stability	-0.02	-0.13	-2.45	2.24
Heterogeneity index	2.74	0.26	5.14	2.07
Single households	0.02	0.13	2.43	2.33
Married families	-0.02	-0.14	-2.97	1.83
Population density	-0.14	-0.12	-2.94	1.30
Multiple land use	0.02	0.21	4.46	1.83
Light rail stop	0.50	0.08	2.07	1.28
West of Willamette R.	-1.52	-0.35	-8.27	1.46
Adj. R^2 : 0.462, Std. Error of Estimate: 1.2231				

TABLE C.3. Components of violence and descriptive statistics for GWR clusters, Portland

Variable	Group 1		Group 2		Group 3		Group 4	
	Mean	Std. Dev.						
Violence rate*	80.00	58.93	255.20	250.96	345.30	298.26	362.22	378.15
Homicide	0.00	0.00	0.54	2.31	1.92	5.70	0.00	0.00
Sexual assault	1.33	2.97	13.94	18.65	22.09	29.10	23.33	23.40
Robbery	6.87	9.80	71.10	111.32	52.74	49.62	62.68	97.62
Aggravated Assault	71.81	58.95	169.62	157.80	268.55	247.69	276.22	270.58
Con. poverty	-0.56	0.20	-0.61	0.37	-0.48	0.55	-0.48	0.38
ICE	0.50	0.27	0.62	0.18	0.53	0.25	0.40	0.22
Residential stability	53.65	11.31	53.30	15.10	49.25	11.26	43.50	9.87
Heterogeneity Index	0.17	0.06	0.18	0.08	0.18	0.09	0.27	0.06
Single households	30.27	8.76	30.26	8.60	27.46	13.50	24.73	10.85
Married families	90.95	8.54	79.42	14.36	87.69	11.70	92.97	11.26
Population density	1.94	0.67	1.59	0.54	1.69	0.96	1.53	1.21
Multiple land use	1.59	1.60	6.69	9.91	9.33	9.85	2.64	2.74

Variable	Group 5		Group 6		Group 7	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Violence rate*	370.32	511.66	1160.01	1287.94	1435.62	2874.90
Homicide	0.00	0.00	6.46	16.07	5.72	13.01
Sexual assault	15.85	16.89	57.25	81.04	68.03	95.74
Robbery	72.44	95.61	292.64	461.84	422.43	1248.77
Aggravated Assault	282.03	428.18	803.66	873.27	939.44	1569.79
Con. poverty	-0.58	0.21	0.06	0.77	0.24	0.90
ICE	0.37	0.28	0.37	0.25	0.33	0.24
Residential stability	49.57	12.64	45.75	12.80	44.66	14.29
Heterogeneity Index	0.25	0.13	0.36	0.16	0.38	0.11
Single households	28.62	8.10	32.39	13.14	33.53	18.02
Married families	90.90	13.12	70.79	14.65	75.55	12.14
Population density	2.13	1.17	2.91	1.35	2.80	1.43
Multiple land use	15.96	19.99	11.63	13.84	18.90	20.79

*Violence measures are per 100,000 persons.

TABLE C.4. Average parameter estimates within GWR clusters, Portland

Variables	Cluster groups						
	1	2	3	4	5	6	7
Intercept	-1.13	9.22	8.67	2.33	-10.27	7.05	4.89
Con. poverty	11.86	6.12	1.33	10.26	16.15	-0.86	-0.61
ICE	16.76	3.58	-0.64	0.48	5.59	1.97	2.73
Residential stability	-0.55	-0.53	-0.25	0.32	0.63	-0.19	-0.07
Heterogeneity Index	-0.09	-0.11	-0.02	-0.05	-0.08	-0.01	0.01
Single households	-0.04	-0.06	0.02	0.04	0.11	0.00	0.02
Married families	0.09	0.05	0.03	0.05	0.08	0.02	0.02
Population density	0.02	0.00	-0.04	0.00	0.05	0.00	0.00
Multiple land use	0.24	1.51	0.27	1.15	0.85	0.04	0.22
Rail stop	1.29	1.54	0.55	-0.06	-3.98	0.26	0.11
N	5	18	26	9	7	289	94