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STUDYING EFFECT OF SPATIAL AUTOCORRLEATION ON THE SOCIAL DISORGANIZATION THEORY: REPLACING THE STUDY OF BALLER AND HIS COLLEAGUES

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STUDYING EFFECT OF THE SPATIAL AUTOCORRELATION ON THE SOCIAL DISORGANIZATION THEORY: REPLICATING THE STUDY OF BALLER AND HIS COLLEAGUES

By

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ABSTRACT

STUDYING EFFECT OF THE SPATIAL AUTOCORRELATION ON THE SOCIAL DISORGANIZATION THEORY: REPLICATING THE STUDY OF BALLER AND HIS COLLEAGUES

By

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Guided by social disorganization theory and the concept of spatial autocorrelation, this thesis examined if there is the presence of spatial autocorrelation in crimes, such as robbery, auto theft, and drug crime. Much of this thesis builds on Baller et al.'s study, but the addition of two independent variables, immigrant concentration and residential stability, was tried to apply social disorganization theory effectively. Census data from ICPSR and three kinds of crimes from the Uniform Crime Report (UCR) was used from the 1980s to 1990s. This thesis did not find diffusion procedure of three crimes at the U.S. level but found the clustering of crimes. To improve separated OLS models, two models of spatial autocorrelation were used (e.g., spatial lag model and spatial error model). This study suggests that the relationship between ecological characteristics and crime are more effectively explained, when controlling for spatial autocorrelation.

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Chapter I: Introduction

This thesis examined whether spatial autocorrelation exists in three kinds of crimes (e.g., robbery, auto theft, and drug crime) and how it is applied to social disorganization theory. According to Baller et al. (2001), a spatial autocorrelation is defined as "a situation in which values on a variable of interest are systematically related to geographic location." First, in order to understand the relationship between spatial autocorrelation and social disorganization theory, readers need to know the theoretical development of social disorganization theory. Social disorganization theory has varied and especially has been changed since Shaw and McKay (1969). They argued that destroyed zones near the Chicago's central business district and industrial areas, showing low socioeconomic status, had the highest delinquency rates and nearby zones in commercial and industrial areas experienced the most population loss. In addition, the efforts of Sampson and Groves (1989) to explain informal control, such as local friendship networks, unsupervised peer groups, and organizational participation, affected the social disorganization theory further, and since then social disorganization theory has been studied increasingly by many scholars. But it seems that various problems lie in the future of social disorganization theory (Kubrin and Weitzer, 2003). In fact, the causality of crime has been debated by sociologists and criminologists over five decades. As a result, there are a lot of

theories in relation to the various kinds of crimes. There have been many valuable findings, but some authors noticed the inconsistency of results even though researchers examined the same theories with similar variables.

One of the problems presented by many authors (e.g., Messner et al., 1999; Rice and Smith, 2002; Kubrin and Weitzer, 2003) is spatial autocorrelation. However, issues of spatial autocorrelation have recently been debated by several authors. Moreover, some authors defined various variables as spatial autocorrelation (e.g., Loftin, 1986; Rice and Smith, 2002), whereas others used statistical methods (e.g., Cohen and Tina, 1999; Baller, et al., 2001). No matter what they used, study on spatial autocorrelation remains incomplete.

In addition, it is useful to understand how, why, and when geographical aspects, from variables of the social disorganization theory, appeared. In combining social disorganization and routine activity theories, Smith et al. (2000) and Rice and Smith (2002) argued that spatial aspects of variables should be considered. Actually, it makes sense that regimes, such as the criminal justice system as well as the economic system, affected homicide rates as time passed, and consequently homicide was not distributed randomly in space. For example, some counties have an aggressive policy on policing, but others have concentrated on community policing. The evidence showed these differences affected crime rates. However, many researchers have tried

to explain just the causality between independent variables, affecting crime, and crime as a dependent variable without considering spatial autocorrelation. For example, it was hard for readers to find articles in relation to spatial autocorrelation and crime until 1997. Since Morenoff and Sampson (1997) used spatial autocorrelation, studying violent transition in Chicago, the research of automobile theft by Rice and Smith (2000), the study of street robbery by Smith et al. (2000), the study of homicide by Messenr et al. (1999), and the study of drug misuse by Frischer et al. (2000) used the spatial autocorrelation. In addition, in "New Direction in Social Disorganization Theory," Kubrin and Weitzer (2003) said that spatial autocorrelation should be considered together with the explanation of how variables connect to each other in social disorganization theory. Probably, the failure of the application of spatial autocorrelation is because it seems that it was not easy to find how to adapt spatial autocorrelation in former statistical techniques.

Recently, responding to this difficulty, some scholars, such as Anselin (1995), have introduced a new analysis technique, called "Exploratory Spatial Data Analysis (ESDA)," which may be an effective answer to solve the problems of spatial autocorrelation. With this technique, showing that homicide rates were not distributed at random, Baller et al. (2001) argued that there is a spatial autocorrelation not explained by measured and unmeasured variables. They asserted that if researchers do

not solve this problem, they will not have consistent results. Several researchers have already stressed the importance of autocorrelation on violent crime. For example, Smith and Davison (2000) said that street robbery has the feature of diffusion, which "can be understood as having been poured out and permitted or caused to spread out freely" (Paulsen & Robinson, 2004), and Rice and Smith (2002) concluded that researchers should consider spatial autocorrelation when studying automotive theft. Frischer et al. (2000), in their study of diffusion of drug misuse in Scotland, said that spatial autocorrelation should be considered in the study of drug use because drug crime could not be explained by demographic factors and housing environments. Hunt and Chambers (1976) also found that diffusion of drugs occurred from Boston to Washington along the coast and in Southern California, and heroin use appeared to diffuse to the interior from areas of large population to those with a small population.

This thesis follows the study of Baller et al. (2001), in which they argued that there was a spatial autocorrelation in homicide. One of the new ideas presented by Baller et al. (2001) is the spatial lag model and the spatial error model to estimate spatial autocorrelation more accurately, concluding that statistically significant diffusion of homicide existed in the South from 1960s to 1990s and the combination of structural components could not perfectly explain the spatial autocorrelation. However, some questions remain unsolved.

First, Baller et al. (2001) only investigated spatial autocorrelation of homicide, but it is possible that spatial autocorrelation exists in other crimes. As seen above, some authors argued that auto theft, robbery, and drug crimes had aspects of spatial autocorrelation, although there were not many studies in relation to these crimes. Second, as stated by Baller et al. (2001), the Baseline Model of Land et al. for independent variables suffered inconsistent results. Land et al. aggregated the correlated independent variables into one variable to avoid multicollinearity, by using Principle Components Analysis (PCA) based on literature reviews. However, two important variables were not used by Baller et al. (2001), i.e. the residential stability and the immigrant concentration used by Sampson et al. (1997). As will be seen in Chapter II, residential stability and immigrant concentration have been used and have been proved important by most authors. This thesis expects that better specification of variables will present more consistent and correct results.

Much of this thesis builds on the Baller et al.'s study, but a few developmental components were added, and the several arguments differ from Baller et al. (2001). First, Baller et al. (2001) only concentrated on spatial autocorrelation. They tried to find the existence and division of spatial autocorrelation, but were not interested in issues of social disorganization theory, such as the relationship between independent and dependent variables. In contrast, the objective of this thesis is to find

a better model to explain the relation between ecological characteristics and crime, controlling a spatial autocorrelation. Therefore, this thesis includes new independent variables, such as residential stability and immigrant concentration. Second, this thesis also examines whether or not there are spatial autocorrelations between robbery, drug crime, and auto theft. The reason that this thesis focuses on the three kinds of crimes is based on the argument, in which these crimes already had the peculiarity of spatial autocorrelation.

This thesis divides all counties into two distinct regions: the Clustered regions and Non-clustered regions of crime through Exploratory Spatial Data Analysis (ESDA). After that, the stability of coefficients across regimes is examined by a spatial regime regression (Baller et al., 2001). This method allows the research to choose which model, between the spatial lag and the spatial error models, fits each area. Finally, the reliability and validity of new models will be tested through comparison between OLS models and the spatial models, such as a spatial lag model or a spatial error model. This study expects that the relationship between ecological characteristics and crime will be more significant and consistent when controlling spatial autocorrelation.

Chapter II: Review of Literature

Spatial Autocorrelation

In his report, Doreian (1981) said that if researchers use spatial units as units of analysis, such as census tracts or counties, the interactions between an origin area and adjacent areas will make findings inconsistent, because of spatial autocorrelation. Among a few of the definitions of spatial autocorrelation, Baller et al. (2001) claimed "a situation in which values on a variable of interest are systematically related to geographic location (p. 563)." In terms of the cause of spatial autocorrelation, Doreian (1981) said that "regression analysis of social data across geographical space often violates regression's assumption of independent errors." In addition to this, Rice and Smith (2000) argued that researchers could not all find indispensable variables in studies using spatial units as units of analysis, and accordingly, examiners did not know how many unmeasured variables affected others, especially adjacent spatial units.

Speaking of the importance of spatial autocorrelation, Baller et al. (2001) argued as follows:

> Statistically, if spatial processes operate and are not accounted for, inference will be inaccurate and estimates of the effects of independent variables may be biased. Explicit modeling of spatial effects is thus important in any effort

> to assess 'invariance' in the structural covariates of homicides. In addition, causal processes do not necessarily operate identically in all places, and spatial analysis can reveal sub-areas of geography in which the effects of predictor variables differ. Spatial effects can be suggestive of diffusion associated with the phenomenon under investigation (p. 562).

In Baller et al. (2001), diffusion of crime is described as an element of spatial autocorrelation.

Diffusion of Crime

Generally, diffusion is synonymous with scattering or becoming transmitted, especially by contact (Merriam-Webster's Collegiate Dictionary, 2002). But, viewed from a criminological standpoint, diffusion "can be understood as having been poured out and permitted or caused to spread out freely" (Paulsen & Robinson, 2004). More importantly, Baller et al. (2001) referred to similarity between diffusion and the spatial lag model of spatial autocorrelation in their study. Therefore, reviews of the diffusion of crime will help give an understanding of deeper spatial autocorrelation.

According to Cohen et al. (1999), there are various kinds of diffusion. They started by dividing diffusion into two types. First is contagious diffusion, which means it is spread by direct contact like a disease. In other words, the homicide rate of

an origin place affects other homicide rates. Contagious diffusion is divided into two kinds of diffusions: relocation diffusion and expansion diffusion. Relocation diffusion spreads outward from an origin place but the homicide rate of the origin goes close to zero automatically, whereas in expansion diffusion, the origin place maintains homicides continuously.

The second is hierarchical diffusion, which means that it is not necessary to have direct contact, but it needs a medium for diffusion. For example, when Chinese see Hollywood movies, they imitate the lifestyle of Hollywood, even though they do not live in U.S. and cannot speak English. They just learn what they like and did not know before and follow the actor's style voluntarily via the medium called "movie."

In terms of the cause of diffusion, Cohen et al. (1999) said that the cause of homicide diffusion is ascribed to crack markets and violent youth gang organizations. In detail, many youth gangs involve themselves in the crack business because high-level skill is not necessary for selling crack, and they can easily make a great deal of money compared to other jobs. So, youth gangs fight with one another to protect their benefits, and many homicides occur because youth gangs rely on violent and lethal tools like guns. That is why Cohen et al. saw the area of gang activity and the racial residential pattern, mainly Black youth, as factors affecting homicide rates.

Frischer et al. (2000), in their study of diffusion of drug misuse in Scotland,

said that drug use could not be explained only by demographic factors and the environment of housing, and argued that there clearly remains diffusion of drug misuse in Scotland. Hunt and Chambers (1976) also stressed that there is drug diffusion in the study of U.S. heroin use. In addition to drug misuse, Messner et al. (1999) said that aggressive violence was very similar to an infectious disease, and violent behavior could be conveyed from origin place to another place via social communication systems like mass media. Moreover, the distribution pattern was not random because mass media could not be transported from the origin place to another randomly.

Interestingly, from time to time, physical and socioeconomic features of a region play a role as a barrier preventing violent behavior from being transmitted. For example, Messner et al. (1999) found that there were obstacles that prevented diffusion of crime from spreading. In their study of the diffusion of homicides in St. Louis, Missouri, they argued that agricultural activity affected the homicide rates of rural areas, and aspects of agriculture and rural-ness would be barriers blocking the diffusion of violence. The barrier against diffusion would be a typical example to explain why the distribution of homicides was not random.

In conclusion, spatial clustering is statistically significant, and the diffusion phenomenon was attributed to spatial autocorrelation (Messner et al., 1999). As seen

above, there are various kinds of diffusion, and therefore, it is possible that types of spatial processes are diverse like spatial lag effect and spatial error effect. However, according to Baller et al., diffusion of crime clearly differs from clustering of crime. A Cluster is a place with high crime rate that also has adjacent neighborhoods with high crime rate, while diffusion is related to a complicated mechanism, called spatial lag model.

Application of Spatial Autocorrelation and Diffusion in Former Studies

There are not many studies of spatial autocorrelation and diffusion of crime because they recently appeared. But it is said that studying social disorganization theory without considering spatial autocorrelation led to a contradictory consequence. (Baller et al., 2001) Roncek and Montgomery (1993) suggested a new variable, the so-called "population potential," [1] to control spatial autocorrelation in examining relationships between migration and other spatial processes. Morenoff and Sampson also created "population change potential" [2] to eliminate spatial dependence of the dependent variables, in investigating the relationship between violent crime and neighborhood transition. To avoid the shortcoming of Roncek and Montgomery's approach, in which the error term was correlated, Morenoff and Sampson (1997) followed Land and Deane's (1992) "two-stage least squares" (2SLS) technique "to

derive consistent estimators in spatial- effects models with potential variables." Morenoff and Sampson (1997) assumed that the homicide rate of a census tract affects residents of adjacent tracts because a census tract is an arbitrary boundary, and finally, adjacent areas experience depopulation. Also, they hypothesized that although two cities have the same violent crime rates, a city surrounded by an area having high crime rates will lose more population than another city because fear of crime affects residents' motivation to move. Morenoff and Sampson (1997) concluded that homicide diffusion, as well as homicide itself, affected population loss.

In recent attempts to integrate social disorganization and routine activity theories, some authors have argued that spatial characteristics must be considered carefully (e.g., Smith et al., 2000; Rice & Smith, 2000). Rice and Smith (2000) created a new variable, a so-called "automobile theft potential variable," [3] to handle the spatial autocorrelation. Rice and Smith concluded that auto theft was affected by variables of adjacent face blocks, as well as independent variables of face blocks, after comparing models, including automobile theft potential variables, with others not including potential variables. In their report of street robbery, Smith et al. (2000) found street robbery in a place was affected by street robbery of adjacent places. Accordingly, to control the diffusion process, Smith et al. created a new independent variable, which is called "street robbery potential." [4] After comparing models,

including the street robbery potential, with the others not included, they found more improved results, which showed R squared of results increased from 0.149 to 0.165, and a unit increment in street robbery potential led to 32 percent growth of the number of street robberies. In summary, even though primary concern of the authors varied, the consistent argument was that the value in adjacent places could have an influence on the value of dependent variables in a place (Smith et al., 2000). Accordingly, if authors do not consider spatial autocorrelation when they use spatial units as the unit of analysis, they will find inconsistent and unfruitful results.

Exploratory Spatial Data Analysis (ESDA)

Recent authors used a statistical means to find spatial autocorrelation, stressing the importance of the location where the crime occurred, because the distribution of crime is not random. For example, Dennis Roncek said that just knowing to whom and by whom a crime are committed, does not explain the crime perfectly without the knowing place where it occurs (Messner et al., 1999). Also, Loftin (1986) said that violent behavior is almost the same as epidemic disease spread by contagion. However, as seen above, most scholars have tried to solve the problems by adding new variables as a regressor in a conventional linear model. In contrast to previous researchers, in their examination of spatial clustering of homicide in St. Louis,

Missouri, Messner et al. used the newly advanced ESDA method. Messner et al. (1999) defined ESDA as follows:

> ESDA is a collection of techniques for the statistical analysis of geographic information to describe and visualize spatial distribution, identify atypical locations or spatial outliers, and discover patterns of spatial association, clusters or hot spots. By combing descriptive and traditional graphs in an interactive computing environment, it augments visualization through maps with hypothesis tests for spatial patterns and finally suggests spatial regimes or other forms of spatial heterogeneity (p. 424).

In addition, Messner et al. (1999) argued that because conventional ways, such as visual maps and multivariate regression analysis, are not sufficient enough to detect spatial covariates, researchers often found doubtful results and that is why they need to consider spatial autocorrelation. Besides, Baller et al. (2001) argued that conducting an Exploratory Spatial Data Analysis (ESDA) is very important, because it identifies "spatial clusters and spatial outliers and diagnos[es] possible misspecification in analyses, wherein we assess the effects of structural variables and formally model spatial processes." ESDA will be explained in detail later.

The Study of Baller et al. (2001) on Spatial Autocorrelation

Although multivariate statistical techniques enable researches to analyze more variables in detail, sometimes readers are confused. This is because many studies showed inconsistent results with one another when using similar measurements and data (Land et al, 1990). There are several explanations of the inconsistent results. Land et al. said multicollinearity was a key element, which hinders researchers from having reliable results. In other words, investigators did not consider a correlation even though the independent variables used were very interrelated to each other. Note that an examination of the study by Land et al. (1990) is important because independent variables of Baller et al. (2001) used the Baseline Model of Land et al. Based on multicollinearity, Land et al. said that most findings on Southern subculture of violence with various kinds of covariates were disappointing. In detail, it happened very often that one study having significant results easily turned into a non-significant or negative effect at a different time or different unit of analysis. Land et al. (1990) thought inconsistency of the findings resulted from difference, which was generated when researchers used different units of analysis and statistical inference. Accordingly, to find a consistent outcome on homicide rates, Land et al. extracted 11 independent variables, which had a significant influence on homicide rates from 21 former studies: population size, population density, percentage of the

population that is Black, percentage of the population age 15-29, percentage divorced, percentage of children 18 years old or younger not living with both parents, median family income, percentage of families living below the official poverty line, the Gini index of family income inequality, and the unemployment rate.

After analyzing problems of former results, Land et al. concluded that disparity between time periods, units of analysis, samples, model of specification and problems of statistical inference led to inconsistent findings, and those problems could be controlled by adjusting the model (e.g., conformity of time periods, unit of analysis, sample size, model specification, data transformation, and so on). Using the Principle Components Analysis (PCA), Land et al. combined 11 independent variables into five categories in considering aspects of spatial clustering to overcome the problem on structural covariate of space. For example, population size and population density were compounded into a population structure component; and a resource-deprivation/affluence component was made of three variables related to money, such as median family income, the percentage of families living below the official poverty line, and the Gini index of family income inequality as well as two social variables, such as the percentage of the unit population that is Black and the percentage of children age 18 or under not living with both parents.

Finally, Land et al. (1990) created six independent variables affecting

homicide rates, called the Baseline Model: population structure, resource deprivation/affluence, percentage of the population age 15-29, unemployment rate, percentage divorced, and South/non-South. In addition, Land et al. found that the positive effect of homicide in the South was different from the size of unit of analysis, such as city, metropolitan area, and states. However, Land et al. (1990) only conjectured inconsistent results were ascribed to a southern subculture of violence.

Baller et al. (2001) attributed inconsistent results of Land et al. to spatial autocorrelation. Accordingly, Baller et al. (2001) made the null hypothesis, in which all variables are randomized in space, and an alternative hypothesis that has a spatial autocorrelation in order to test spatial autocorrelation of variables.

According to Baller et al. (2001), y_i is defined as homicide rates on structural factors at location i and ε_i is a stochastic error term.

$y_i = \sum_k X_{ki} \beta_k + \varepsilon_i$, where each X_{ki} is an element in a $1 \times K$ matrix row vector of covariates and β_k is the corresponding element in a $K \times 1$ vector of regression coefficients. If homicide rates are determined solely by the structural factors included in the model, there should be no spatial patterning of homicide beyond that created by sociodemographic similarities of geographically proximate counties. In other words, no remaining spatial dependence should be found once the structural similarity of neighboring

counties has been explicitly controlled for, or, $E[\varepsilon_i \varepsilon_j] = 0$ for neighboring i, j. (p. 565)

Baller et al. (2001) assumed a spatial pattern could not be explained by only a structural model and introduced two ways to specify new approaches. One is a "spatial effect model, in which spatial dependence is illustrated as an additional covariate in the model, as it were, spatial lag, or a weighted average of values for the dependent variable in neighboring locations, and the other is a spatial disturbance model, in which the spatial dependence is incorporated in the regression error term" (Baller et al., 2001). The former means that a spatial dependence shows a possibility of diffusion process, but the latter spatial dependence implies the existence of omitted covariates being spatially correlated somewhere in the model. In addition to spatial autocorrelation, Baller et al. (2001) stressed that researchers have to consider spatial heterogeneity, in which "coefficients or error patterns vary systematically across geographic areas." Actually, because it is not easy to differentiate spatial dependence from spatial heterogeneity based on regression residuals, Baller et al. (2001) assumed an evident coefficient for the South. That is because the South showed potential structural difference in the regression relationship between geographic regions based on Land et al.'s model. Therefore, if there is spatial dependence controlling for spatial heterogeneity, researchers need to compare a spatial error model with a spatial lag

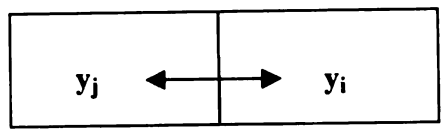
model.

Baller et al. (2001) explain a spatial error model and a spatial lag model as follows:

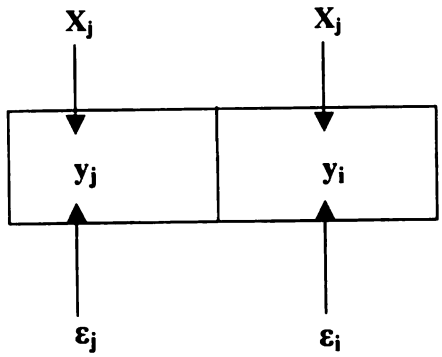
> The spatial error model evaluates the extent to which the clustering of homicide rates not explained by measured independent variables can [be] accounted for with reference to the clustering of error terms. In this sense, it captures the spatial influence of unmeasured independent variables. ... The observed spatial clustering in homicide rates is accounted for simply by the geographic patterning of measured and unmeasured independent variables. The spatial lag model, in contrast, incorporates the spatial influence of unmeasured independent variables but also stipulates an additional effect of neighbors' homicide rates, i.e., the lagged dependent variable. This is the model most compatible with common notions of diffusion processes because it implies an influence of neighbors' homicide rates that is not simply an artifact of measured or unmeasured independent variables. Figure 1 shows [the] difference between spatial error effects and spatial lag effects geometrically and a dashed arrow is indicative of the influence of homicide in neighboring counties (p. 566-577).

Figure 1. Spatial Processes

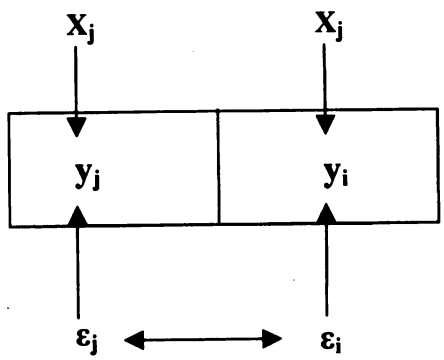
Univariate Spatial Autocorrelation



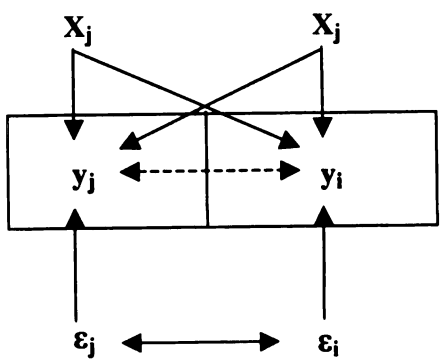
Structural Similarity



Spatial Error Effects



Spatial Lag Effects



Source by Baller et al. (2001)

Based on Messner et al.'s argument (1999), in which there is significant evidence that is indicative of spatial autocorrelation of homicide rates in counties, Baller et al. (2001) examined global autocorrelation and local spatial autocorrelation. Baller et al. (2001) used the SpaceStat software package to carry out all computations. If the value of Moran's I statistic of global autocorrelation is positive and significant, it means clustering in space (Baller et al., 2001). Local spatial autocorrelation, which is a relationship between the pattern of specific locations and the values at neighboring locations in the homicide rates by Moran's I statistic, shows whether or not there is spatial randomness of a given place on crime. In other words, "rejection of this null hypothesis indicates local clustering of high (high surrounded by high) or low (low surrounded by low) values, or local spatial outliers in the form of high values surrounded by low neighbors or low values surrounded by high neighbors" (Baller et al., 2001). Baller et al. (2001) concluded there was an obvious spatial pattern in homicide rates between southern and non-Southern regions and much of homicide was clustered in the South.

Besides, stability of spatial heterogeneity was tested by "Spatial Chow test,[5]" which can estimate stability of coefficients across regimes. Based on finding instability of regime, Baller et al. (2001) confirmed the existence of spatial autocorrelation and at the same time, they divided the original model into the South

and non-South. From examining spatial dependence through investigation of the residuals of OLS estimation, the authors finally decided that the spatial lag model is fit for the South and the spatial error model (except for the 1960s) is fit for the non-South. Technically, use of the spatial lag model differs from the spatial error model. In the spatial error model, stochastic errors had an influence on the value of dependent variables whereas in the spatial lag model, dependent variables of adjacent counties as well as stochastic errors affected origin dependent variable (Baller et al., 2001).

After analyzing results, Baller et al. (2001) argued that the distribution of homicide is not random in space and spatial clustering remains even after controlling for ecological characteristics of homicide. Also, the baseline regression model did not explain homicide rates completely and regional differences were generated significantly by regimes. Finally, diffusion was not applied in non-South regions because unmeasured variables fully explained residual autocorrelation in non-South regions whereas a spatial lag model described homicide rates in southern regions as well.

Social Disorganization Theory

Theoretical Development of Social Disorganization Theory

Generally speaking, it seems that social disorganization theory seeks a

relationship between structural characteristics, informal and formal controls derived from community members and public agencies, and crime. The essence of this theory is that if a community suffered from environmental and structural characteristics, such as poverty, ethnic heterogeneity, and residential stability, this community would lack informal and formal control, and finally, crime would increase (Rose & Clear, 1998).

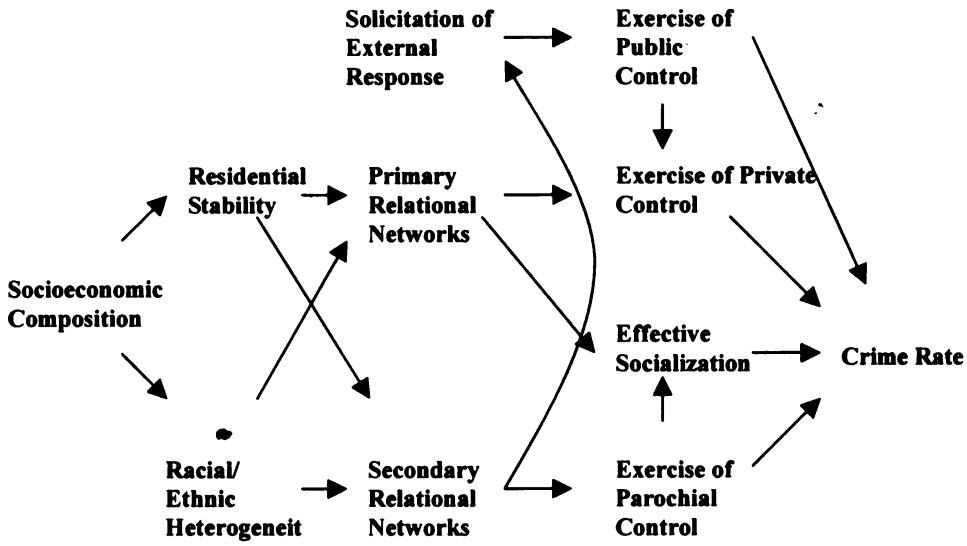
In the beginning, however, social disorganization theorists tried to find which ecological characteristics of society affected crime. As most researchers state, Shaw and McKay had a tremendous influence on sociologists and criminologists. In 1942, Shaw and McKay found traditional components of the social disorganization theory, and in their report, *Juvenile Delinquency and Urban Areas* (1969), Shaw and McKay said that low economic status, ethnic heterogeneity, and residential mobility had an influence on the stability of social structure, and then a collapse of social organization increased crime and delinquency.

Based on Shaw and McKay's study, in 1989, Sampson and Groves showed the improved mechanism of how social disorganization theory works. Socioeconomic status, ethnic heterogeneity, residential stability, family disruption, and urbanization, as independent variables, were used in their report. In addition to these, they created local friendship networks, unsupervised peer groups, and organizational participation, as intervening variables, from national surveys of England and Wales. Sampson and

Groves (1989) argued that local friendship networks, unsupervised peer groups, and organizational participation had an influence on crime by affecting traditional components. Since Sampson and Groves' (1989) argument, many authors have examined the relationship of informal and formal control. In other words, the attention of authors moved social characteristics, such as socioeconomic composition, residential stability, and racial/ethnic heterogeneity, into relationships among community members, local institutions, and governmental agencies. Likewise, Bellair (1997) also said that the quantity and frequency of a neighborhood's network affected traditional characteristics. A shared common norm or value is another expression of community network. For example, Kornhauser (1978) said that in a community, in which residents did not have common goals and norms on community, ordinary crimes increased, and Bursik and Grasmick (1993) argued that one of the goals of residents sharing common values is to hope they live safely in their residence.

Rose and Clear (1998) said that Bursik and Grasmick added public control to the result of Sampson and Groves, in highlighting that service provided by outside agencies varied, and quality and quantity of the service affected crime in the community, whereas Sampson and Groves focused on just private and parochial control.

Figure 2. Bursik and Grasmick's Basic System Model of Crime



Source by Rose and Clear (1998)

Figure 2 presented by Bursik and Grasmick (1993) shows their argument on basic procedure clearly. According to Bursik and Grasmick (1993), private control is defined as close observation and opinion derived from the relationship between family and close friends; parochial control is intervention and supervision within community, including residents and local institution such as schools, churches, and stores; public control is relationship between community and government agencies. However, Rose and Clear (1998) argued that the distinction of three kinds of control by Bursik and Grasmick is not obvious, and they are correlated with one another. For

example, the greater the private control the greater the parochial control, and vice versa. Besides, a relationship between public control and other controls could not be explained explicitly. In other words, policing can be carried out regardless of private and parochial control, but attenuated informal control could increase public control (Rose and Clear, 1998). Moreover, Black (1976) said that formal control rose when informal control became worse because informal control caused lots of crime, and then the police tried to reduce crime rates.

In contrast to most studies that were carried out in urban areas, Osgood and Chambers (2000) studied whether social disorganization theory would be generalized in non-metropolitan counties or not, by using per capita rates of juvenile arrest for violent offenses as dependent variables. They found residential instability, family disruption, and ethnic heterogeneity were strongly associated with violent crime except unemployment. In addition, they hypothesized, that increased population size would increase crime because the anonymity of juveniles increased, but results showed crime rates varied regardless of population size. Recently, Markowitz et al. (2001) examined the relationship between disorder, cohesion, fear of crime and burglary in a non-recursive model. According to Markowitz et al (2001), the biggest problem of social disorganization studies is investigators could not discover the role of neighborhood's cohesion in social disorganization theory although a

neighborhoods' cohesion affected traditional characteristics of social disorganization.

However, the suggestion that close and friendly relationships between residents reduced crime was not welcomed by all researchers. Warner and Rountree (1997) said that assault rates, as well as ecological characteristics, were not affected by neighboring activities. Also, Patillo (1998) argued that close social networks could not reduce crime rates effectively. In his report, Patillo explained not all social networks were good things because gang members and criminals also had their relationships and values. Additionally, Markowitz (2001) concluded there was a significant relationship between ecological characteristics, disorder, cohesion, and burglary as noted by former researchers. But, Markowitz argued that there is another element, such as the cultural influence of the region, which could not be explained before. Another concern of Markowitz et al. (2001) was the feedback effect of crime. Markowitz argued that unless effects of feedback are considered, results would be biased. In other words, because disorder, fear, and cohesion were correlated in the non-recursive model, feedback processes should be considered.

Veysey and Messner (1999) admitted accomplishment of Sampson and Groves (1989) on social disorganization, but argued that Sampson and Groves did not more exactly explain the relationship between independent, intervening variables and crime. Veysey and Messner (1999) concluded that the mediating effect of variables by

Sampson and Groves is somewhat right, but there are several mechanisms in social disorganization theory not explained by the argument of Sampson and Groves.

In summary, in the beginning, authors tried to find a relationship between social and economic characteristics and crime, but since the findings of Sampson and Groves, informal and formal control were the matter of common interest. However, these days many researchers have tried to figure out how the mechanism of social disorganization works. As such, many authors argued various mechanisms, but it is too early to tell which one is right. Accordingly, because spatial autocorrelation will be another answer, it is worth a try.

Measure of Independent Variables

As the social disorganization theory has developed, new independent variables have been added continuously. In studying the relationship between social and organizational characteristics of neighborhood and crime rates, Sampson et al. (1997) argued that a collection of informal controls not enforced by police or courts, what is called Collective efficacy or neighborhood efficacy, had an influence on interpersonal violence behaviors in urban areas, regardless of demographic components. In other words, Collective efficacy is neighborhood ability to prevent crime in their community. Collective efficacy is comprised of ten variables, derived from census

data. After conducting factor analysis to get a smaller number of variables and avoid multicollinearity, Sampson et al. (1997) aggregated ten variables into three: Concentrated Disadvantage (below poverty line, on public assistance, female-headed families, unemployed, less than age 18, and Black), Immigrant Concentration (Latino and foreign-born), and Residential Stability (same house as in 1985 and owner-occupied house).

Similarly, Fagan and Schwartz (1986) said that delinquency and criminality of individuals could not be explained completely by only individual-level effects without community contextual effects created by six independent variables of census data. In their report, Fagan and Schwartz created six area dimensions with census data and information reported in the survey: Social Rank, Family Disorganization, Family Life Cycle-Child Density, Urban Center versus Ring, Population Mobility, and Unemployed-Unenrolled Youth. Of six dimensions, Family Disorganization and Social Rank were based on census data through factor analysis. Family Disorganization is comprised of: the percentage of married, male separation rate, divorce rate, percent bad units, and percent children in two-parent families. Social Rank is comprised of: family income less than $ 3,000 per year, median income, families income more than $ 15,000, percent over-crowded units, percent vacant units, females in labor force, males in labor force, professional and managerial, percent

service workers and laborers, percent with some college, percent high school graduates, and median education.

In addition, Ross and Mirowsky (1999) used age, African American population, education, house income, and place where respondents lived, as main independent variables to explain the relationship between disorder and decay in arguing disorder and order are two ends of a single line.

Skogan (1990) also used similar variables in his famous book, *Disorder and Decline*. He argued that neighborhood conditions, such as poverty, instability, and racial composition, together with random shock, affected incivilities, and then incivilities affected more victimization and increased the number of people moving to other places.

In a study about population change in a tract's population over prior census data and homicide in each census tract, Morenoff and Sampson (1997) carried out Principal Components Analysis (PCA) like Land et al. (1990) to reduce multicollinearity between variables. Then, Morenoff and Sampson (1997) divided ecological characteristics into four categories: socioeconomic disadvantage, ethnicity/immigration, age composition, and residential stability.

In summary, the concept of variables in most studies is very similar to each other, even though measurement was somewhat different. More importantly, when

compared former studies, the study of Land et al. did not use two independent variables, such as immigrant concentration and residential stability. This thesis expects that the addition of immigrant concentration and residential stability will improve the R squared value of Baller et al.'s study. Accordingly, this thesis uses the Baseline Model and the two additional variables mentioned above.

Residential Stability

Residential stability differs from economic features, but is a very important element affecting urban social community (Kasarda and Janowitz, 1974). Sampson and Raudenbush (1999) said that the higher the home ownership and length of residence, the stronger the community attachment, which had an influence on social ties and cohesion. Also, frequent turnover of residents led to disorganization of the local community and weakened residents' willingness to curb disorder behaviors (Bursik, 1988).

Taylor (1996) said in his study, *Neighborhood Response to Disorder and Local Attachment*, stability, as well as education, was the best predictor to know local attachment. Taylor's neighborhood stability was combined with percentage of owner-occupied housing units (from census), percentage of respondents who are homeowners (from survey), average length of residence in the neighborhood (from

survey), and percentage of married couple households (from survey). Markowitz et al (2001) also found that residential stability was related to disorder. Markowitz et al.'s residential stability is defined as the percentage of the population raised within a 15-minute walk of their current residence.

In 1997, the residential stability of the collective efficacy by Sampson et al. was measured as the percentage of the population that has lived in the same house for more than five years and the percentage of owner-occupied homes. The study by Morenoff and Sampson (1997) also found that residential stability is associated with population loss following the collective efficacy.

In contrast to stability, residential instability was described by both Sampson (1985) and Osgood and Chambers (2000) as proportion of households moved from another place in former five years. Osgood and Chambers (2000) argued that residential instability was significantly related with all violent crime, such as homicide, rape, robbery, aggregated assault, violence to weapons, and simple assault.

In contrast, Hackler et al. (1974) argued that there was no relationship between neighborhood stability and informal control. Besides, to estimate an indicator of guardianship or parochial control, the number of owner-occupied places was used by Rice and Smith (2002). The objective of the variable by Rice and Smith was somewhat different from others, but it still holds the same concept. In the study by

Rice and Smith, this variable was always statistically significant in the OLS model and the model controlling for autocorrelation. As seen above, residential stability was a very important element for most investigators, and the omission of this would lead to inconsistent results.

Ethnic heterogeneity/immigration

It is essential to know the tribal and linguistic heterogeneity of society because both of them affect the residents' shared value, which can reduce crime rates because community members know each other (Sampson et al., 1997). Most ethnic heterogeneity was defined as the proportion of white and nonwhite in community. With the above definition, Sampson and Grove (1989) said that ethnic heterogeneity caused trouble in unsupervised teen groups, which led to victimization and offense. Osgood and Chambers (2000) created the formula for ethnic heterogeneity: "$1 - \sum p_i^2$, where p_i is equal to the proportion of those in the neighborhood in each of the four groups (white, black, Indian, and other)." Osgood and Chambers (2000) found a strong relationship between ethnic heterogeneity and most violent crime. In the study by Markowitz et al. (2001), ethnic heterogeneity was related with disorder, as well as burglary, after controlling for cohesion. Heterogeneity is measured as the number of Blacks because Markowitz et al. believed that African Americans were short of

economic, political, and social resources. Racial heterogeneity was also defined as the ratio of racial formation of a face block (Rice and Smith, 2002). In the study by Rice and Smith, the number of African Americans was significant in OLS model, but was not in the model controlling for spatial autocorrelation. In the study by Smith and Davison (2000), the heterogeneity was measured as the number of African Americans, and racial heterogeneity was defined as multiplying the proportion of African Americans by the proportion of whites. Racial heterogeneity was significant statistically. Ethnicity/immigration is composed of the population that is Hispanic and foreign-born and the percentage of African Americans (Morenoff and Sampson, 1997). This variable was associated with population loss.

In summary, although ethnic heterogeneity/immigration was an essential element in social disorganization, Baller et al. (2001) did not use it. First of all, the immigrant concentration of collective efficacy by Sampson et al. (1997) is very important in this thesis. This is because the resource deprivation/affluence of the Baseline Model already included African Americans like the concentrated disadvantage of collective efficacy by Sampson et al. (1997), whereas in other studies African Americans are included in the dimension of heterogeneity as seen above. The immigrant concentration of collective efficacy contained only the percentage of foreign-born persons and the percentage of Latinos from census data. Accordingly,

this thesis will use the immigrant concentration of the collective efficacy to avoid the duplication of African Americans.

Chapter III: Methodology

Hypotheses

H1: Additional independent variables, such as residential stability and immigrant concentration would improve the Baseline Model of Land et al. (1990)

H2: There is spatial autocorrelation in robbery, auto theft, and drug crime like homicide.

H3: Relationship between ecological characteristics and crime would be explained more significantly if spatial autocorrelation were controlled.

The most important point of this study is to find whether or not there is the presence of a spatial autocorrelation in other crimes. For example, with the better model, if this thesis finds spatial autocorrelation of specific crime in the U.S., this paper can suggest that unknown characteristics of some regions affect the specific crime, as most researchers said that the cultural element of the southern areas is the cause of homicide diffusion. In addition, the relationship between ecological characteristics and crimes will be more obvious and significant when controlling for spatial autocorrelation.

Data

Basically, this thesis uses Baller et al.'s data to compare their model with

model of this thesis. In other words, new independent variables and other crimes were added into the model of Baller et al. to maintain consistency. Additional independent variables came from census data, and the data of three kinds of crimes from the Uniform Crime Report (UCR). In contrast, Baller et al. used the homicide rates of the National Center for Health Statistics (NCHS) mortality files and the Centers for Disease Control and Prevention (CDC) WONDER system. So, this thesis expects there are some disparities from using different data.

In terms of the combination of county groups, Baller et al. had to merge some counties into one because the county boundary had been changed during the period of study. In detail, 53 counties were merged into 20 counties. In addition to this, three counties, such as Dukes County, Massachusetts, Nantucket County, Massachusetts, and San Juan County, Washington, as well as counties in the states of Alaska and Hawaii, were excluded from study because they were islands. This thesis follows the same method. However, due to the limitation of data, this thesis will examine only data in the 1980s and the 1990s. In addition, drug crime will be examined in only the 1990s, because there is no data in 1980s in the UCR. Finally, all computation will be carried out by the SpaceStat and Geoda Software programs.

Variables

As explained above, the measure of ecological characteristics for social

disorganization theory changed over many decades. Especially, the discovery and the application of informal control and formal control were obvious advances, and those were indispensable constituents when studying social disorganization theory. But, this study will not use informal and formal controls because Baller et al. (2001) did not use them.

Basically, the independent variables used by Baller et al. are completely the same as those of Land et al. (1990). In addition, based on analysis of former research, this study finds additional factors, such as residential stability and immigrant concentration. Among various measures used by researchers, this study will use residential stability and immigrant concentration of the collective efficacy by Sampson et al. (1997). Residential stability was measured by the percentage of the population that has lived in the same house for more than five years, and the percentage of houses in tracts that are owner occupied. The immigrant concentration of the collective efficacy was composed of the percentage of foreign-born persons and the percentage of Latinos from census data, not including African Americans. One of the reasons why this thesis uses the collective efficacy of Sampson et al. (1997) is because the concentrated disadvantage of the collective efficacy already included African Americans as a resource deprivation/affluence of the Baseline Model. Besides, this study had to consider whether or not the variable could be extracted from census

data. For example, this study could not use the measure of Fagan and Schwartz (1986) used by both census and survey data.

In terms of a dependent variable, in contrast to the study of Baller et al. (2001) this thesis adds other crimes: robbery, drug crime, and auto theft. Like Baller et al. (2001), each crime rate is rate per 100,000 people and the numerator is a 3 year average centered on the decennial census year (e.g., 1979, 1980, and 1981) to avoid heterogeneity. The average value is divided by census population (e.g., 1980).

Analytic Strategy

Generally, this thesis follows the analytic procedure of Baller et al. Based on several studies on why the homicide of the South and non-South differed, Baller et al. could have logical reasons for their study. In terms of three kinds of crimes of this thesis, recent authors argued that violent crime (robbery), property crime (auto theft), and drug crime have characteristics of diffusion and the study of those crimes should consider spatial autocorrelation. Therefore, this thesis assumes that the above three crimes had peculiarity of diffusion like homicide. However, robbery and auto theft was only studied at the specific area level, different from drug crime which was studied at the U.S. level. This thesis begins by adding new variables into Baller et al.'s model and assumes that results will be improved (e.g., the increase of R squared). The

second step is to find spatial autocorrelation of other crimes. To do so, Global Moran's I statistics and Local Moran's I statistics will be carried out to find significant spatial patterns and Clustered regions, and then a dummy variable will be created by aggregating Clustered regions of each crime. Through the Spatial Chow test the next step is to find which model between a spatial lag model and a spatial error model is better fitted to disaggregated regions. Finally, this study verified validity and reliability of each model through spatial lag and spatial error analysis.

Limitations of This Study

Although the analytic strategy of this thesis is better than that of Baller et al.'s study, this study has three limitations like Baller et al.'s study. For example, Messner et al. (1999) argued that using spatial covariates by ESDA solves spuriousness of the former result, but they could not prove the theoretical mechanism of how the spatial pattern of diffusion precisely works. As Baller et al. stated, authors could not explain a clear mechanism of diffusion, although they assumed vectors of transmission exist somewhere in the model. Also, they said that structural difference just inferred from the regression relationship between South and non-South regions, but this mechanism was not explained. Simply, Baller et al. conjectured that diffusion processes were associated with spatial autocorrelation. Further study is needed to concentrate on how

spatial autocorrelation occurs.

The unit of analysis will be another limitation. It is said that counties as units of analysis are poor because of ecological fallacy (King, 1997). Although counties as units of analysis have a few advantages (for example, easy to access), possible diffusion processes occur at the boundary of counties like spatial heterogeneity. In other words, some counties may have large areas consisting of various races and many ethnic groups, and the diffusion processes perhaps happen within the counties, but authors could not find it. Moreover, an additional problem to be considered is if the population of a county is very small, homicide rates are unstable (Messner et al., 1999).

Third, as stressed by many critics, reliability and validity of the official record were suspect because many crimes were not reported to the police (Loeber & Blanc, 1990). For example, even if the offenders were arrested it would not be recorded officially. In contrast, Osgood and Chambers (2000) said that late studies showed the official record's usefulness through additional methods, such as calls for police assistance (Warner and Pierce, 1993), self-reports of victims (Sampson and Groves, 1989), and self-reports of offenders (Simcha-Fagan and Schwartz, 1986). However, this thesis, using only official data, could not free itself from that limitation. Also, it is obvious that the omission of informal and formal control will lead to another

limitation. In addition, this thesis used data for other crime derived from the Uniform Crime Report (UCR), whereas Baller et al. used data for the homicide rates of the National Center for Health Statistics (NCHS) mortality files and the Centers for Disease Control and Prevention (CDC) WONDER system. This thesis expects some disparities because generally, the number of homicides of NCHS is greater than that of UCR.

Finally, note that this thesis could not apply "the K nearest neighbors (KNN)" weight that was used in Baller et al.'s study to know the value of LML and LME. That is because the Geoda program did not work with KNN weight. The solution of this problem is very important because the analysis of a spatial model is dependent on which weight would be chosen. Therefore, this thesis consulted Dr. Luc Anselin, who created the Spacestat and the Geoda programs, and Dr. Robert Baller about the matter. According to the staff of Dr. Luc Anselin, other weights, such as a queen or a rook, could be used instead of the KNN weight, only if the result by other weight was similar to one by the KNN weight. Moreover, Dr. Robert Baller also agreed with the opinion of the staff. As such, after comparing the result by the KNN weight with results by other weight, this thesis found the queen contiguity of 3 order was the most proper weight. In brief, while Baller et al. found the difference of spatial regimes between the South and the Non-south, using the Spacestat program with the KNN

weight, this thesis similarly, but not exactly, replicated Baller et al.'s study through the Geoda program with the queen weight. Therefore, this thesis used the queen weight instead of the KNN weight for three crime rates to examine spatial autocorrelation.

Chapter IV: Results

In this chapter, results are presented in three sections. Each section relates to each hypothesis. Section I details the findings that relate to the improvement of the Baseline Model by adding residential stability and immigrant concentration. Section II shows whether or not there is clustering pattern in three kinds of crimes. Additionally, if the clustering exists in the model, the stability of a model will be examined by the Spatial Chow test. Section III explains how social disorganization theory is advanced by using the spatial lag and the spatial error models.

Section I

The first hypothesis of this thesis is that additional independent variables, such as residential stability and immigrant concentration would improve the Baseline Model of Land et al. (1990). Overall, adding new variables into the Baseline Model gave this thesis somewhat satisfaction as expected. In other words, the two variables did not greatly affect the homicide rates, but the effect was statistically significant. In detail, table 1 shows that in the 1980s, the value of R squared of the thesis model increased 0.431 into 0.433, even though it was small. Differently from what other studies expected, residential stability positively affected homicide, but was not significant. The value of immigrant

Table 1. Ordinary Least-Square Regression of County Homicide Rates 1980-1990[a]

Independent Variables	1980		1990	
	Baseline Model	Thesis Model	Baseline Model	Thesis Model
Resource Dep.	3.412**	3.337**	3.872**	3.892**
Pop. Comp.	0.747**	0.724**	1.353**	1.324**
Median Age	-0.242**	-0.234**	-0.101**	-0.066*
Divorce	1.250**	1.249**	0.583**	0.519**
Unemployment	-0.122**	-0.109**	-0.306**	-0.303**
South	2.113**	2.199**	2.194**	2.242**
Res-Stability	—	0.014	—	-0.333**
Imm-Con.	—	0.342**	—	0.288**
Intercept	8.541**	8.186**	6.517**	5.749**
Adj. R-Squared	0.431	0.433	0.435	0.438
N	3085	3085	3085	3085

[a] Unstandardized regression coefficients.
[b] Thesis model of UCR data for homicide
* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

concentration negatively affected homicide and is significant like expectation. Moreover, the coefficient of immigrant concentration is greater than that of median age and unemployment. The other coefficients are similar to those of the Baseline model. Baller et al. said the negative effect of median age explained that counties having younger people have higher homicide rate because younger people commit more homicides. In the 1990s, the R squared increased from 0.435 into 0.438 by .003 like the 1980s. The value of immigrant concentration and residential stability was significant; immigrant concentration was positive and residential stability was negative as expected by the literature review. In particular, the coefficient of residential stability was larger than that

Table 2. Comparison of Spatial Regression Models of South Homicide rates, 1980-1990[a]

	1980		1990	
	Baseline[b]	Thesis[c]	Baseline	Thesis
Resource Dep.	3.026**	2.941**	4.028**	4.232**
Pop. Struct. Comp.	1.551**	1.707**	1.747**	1.789**
Median Age	-.150**	-.175**	-.018	.000
Divorce	.775**	.892**	.482**	.469**
Unemployment	-.244**	-.270**	-0.438**	-.447**
Res-Stability	-	.597**	-	-.246
Imm-Con.	-	-.004	-	.246
Spatial Lag (ρ)	.182*	.557**	.230**	.198**
Intercept	9.101**	8.716**	5.249*	5.001*
N	1412	1412	1412	1412

[a] Unstandardized regression coefficients

* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

[b]Baseline Model of Baller et al.'s data

[c]Thesis Model with Baller et al.'s data

of median age and that of unemployment. Additionally, immigrant concentration presents a more important element than median age in the 1990s. This study examined just two decades (the 1980s, the 1990s) due to the limitation of data. To know clearly whether or not residential stability and immigrant concentration affect dependent variable, researchers need to investigate more decades, such as the 2000s.

In summary, in view of the values of R squared, two additional variables slightly affected the dependent variable in both decades, but their coefficients are greater than median age in thesis model. Accordingly, new variables did not largely affect homicide rates, but the above results provided sufficient evidence, in which the addition of two variables improved the Baseline model somewhat. Longer terms will give a clear answer.

Table 3. Comparison of Spatial error Models of Non-South Homicide rates, 1980-1990[a]

	1980		1990	
	Baseline[b]	Thesis[c]	Baseline	Thesis
Resource Dep.	4.143**	3.642**	2.875**	2.581**
Pop. Struct. Comp.	.290*	.211**	.962**	.858**
Median Age	-.304**	-.299**	-.066*	.058
Divorce	1.318**	1.307**	.572**	.494**
Unemployment	.008	-.003	-.045**	-0.051
Res-Stability	-	.062	-	-.276**
Imm-Con.	-	1.072**	-	.715**
Spatial Error (λ)	.329	.275**	.268	.154*
Intercept	9.622**	9.317**	3.261**	3.431**
N	1673	1673	1673	1673

[a] Unstandardized regression coefficients

* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

[b]Baseline Model of Baller et al.'s data

[c]Thesis Model with Baller et al.'s data

Table 2 shows the comparison of spatial lag models of South homicide rates in the 1980s and the 1990s. Generally, the coefficients of the thesis model are similar to those of the Baseline model. For example, all spatial lag coefficients are significant, and five coefficients of the Baseline model increased and decreased within small scope. However, differently from what other studies expected, in the 1980s residential stability had a positive influence on homicide and is even significant. Additionally, immigrant concentration negatively affected homicide and is not significant. In contrast to the 1980s, in the 1990s residential stability negatively affected homicide and immigrant concentration positively affected homicide. But, neither of them is

significant. With the above results, this study cannot say that the thesis model improved the Baseline model because residential stability and immigrant concentration are not significant and even affected homicide in the 1980s, differently from what the literature review expected.

In table 3, the comparison of the spatial error models of Non-South homicide rates show more positive results compared to the spatial lag models of South homicide rates. Basically, five coefficients of the thesis model except immigrant concentration and residential stability are similar to those of the Baseline model. In the 1980s, immigrant concentration positively affected homicide and is significant similarly to what the literature review expected. In contrast to literature review, residential stability positively affected homicide, but is not significant. In the 1990s, the coefficients of two variables are desirable. Residential stability and immigrant concentration significantly affected homicide; the former was negative and the latter was positive.

In conclusion, the addition of residential stability and immigrant concentration is useful. Small amount of R-squared increased and most coefficients of two variables are significant. The result of the 1990s is more desirable than that of the 1980s. As Baller et al. said that the Baseline model was overstated, the Baseline model is not sufficient to explain the mechanism between crime and variables. As

shown above, residential stability and immigrant concentration must be indispensable factors. But, one of the concerns is multicollinearity among variables. Even though Land et al. severely examined the Baseline model and this thesis used new factors that differed from the Baseline model, the addition of two variables would cause multicollinearity. Next section will examine multicollinearity among independent variables.

Figure 3. Moran Scatterplot Map Auto Theft 1980 Rate (W=10 nearest Neighbors)

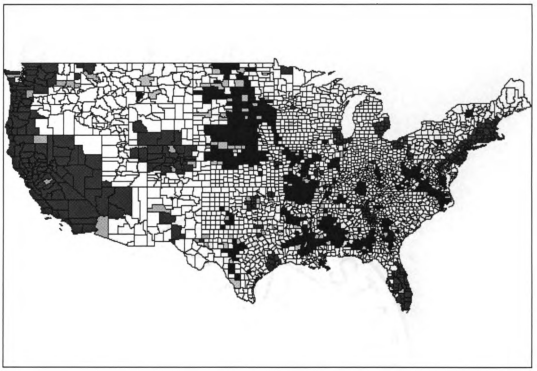
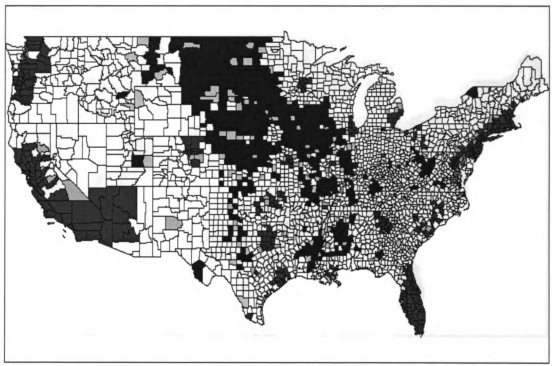


Figure 4. Moran Scatterplot Map Auto Theft 1990 Rate (W=10 nearest Neighbors)



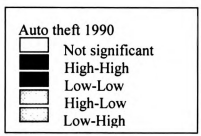
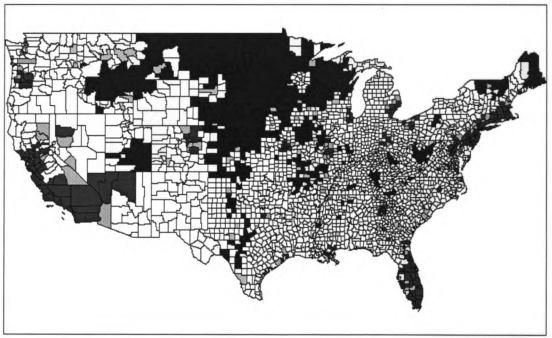


Figure 5. Moran Scatterplot Map Robbery 1980 Rate (W=10 nearest Neighbors)



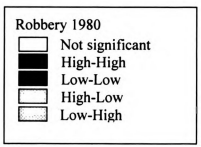


Figure 6. Moran Scatterplot Map Robbery 1990 Rate (W=10 nearest Neighbors)

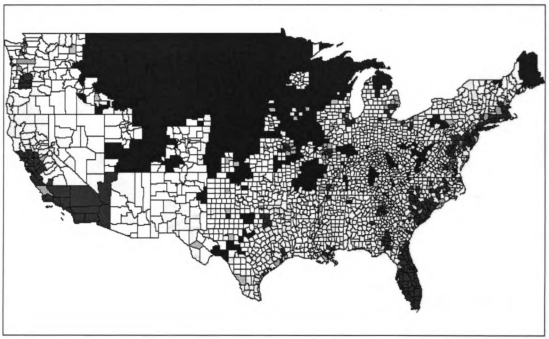
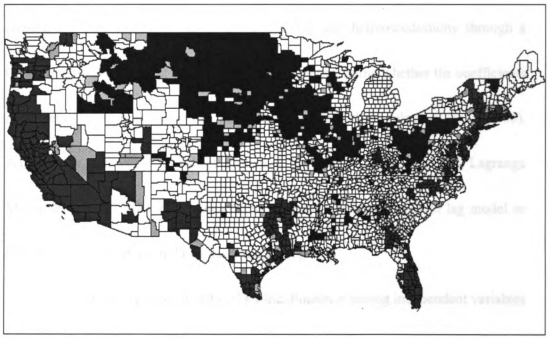
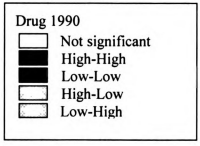


Figure 7. Moran Scatterplot Map Drug 1990 Rate (W=10 nearest Neighbors)





Section II

Section II presents whether or not the clustering exists in three kinds of crimes, and also examines the structural stability and heteroscedasticity through a Chow test, which is "a test for structural change to determine whether the coefficients in a regression model are the same in separate sub-samples" (Chow, 1960). Additionally, the value of robust Lagrange Multiplier Lag (LML) and Lagrange Multiplier Error (LME) will be examined to know whether the spatial lag model or the spatial error model should be used in each region.

However, this thesis examined multicollinearity among independent variables before moving to next stage to know whether or not adding two new variables causes multicollinearity. Unfortunately, this thesis found some multicollinearity. In Table 2, in the 1980s, Collinearity Statistics of divorce and residential stability are less than 0.7, and in the 1990s, those of resource deprivation/affluence component and unemployment are less than 0.7. Based on the above results, this thesis can suggest that the Baseline model of Land et al. should have fixed the problem of multicollinearity between resource deprivation/affluence component and unemployment in the 1990s. Moreover, the addition of residential stability causes multicollinearity with divorce in the 1980s. To fix the multicollinearity, this thesis has to remove related variables, but if so, this thesis can not replicate Baller et al.'s study.

Table 4. Collinearity Statistics (Tolerance) among independent variables

Independent	Robbery		Auto Theft		Drug
Variables	1980	1990	1980	1990	1990
Resource Dep.	.872	.563	.836	.547	.562
Pop. Struct. Comp.	.777	.755	.850	.823	.812
Median Age	.823	.743	.842	.759	.759
Divorce	.678	.728	.673	.728	.730
Unemployment	.853	.543	.855	.541	.542
Clustered Regions	.823	.815	.811	.805	.832
Res-Stability	.664	.735	.639	.710	.731
Imm-Con.	.915	.888	.922	.896	.845

Accordingly, all variables will be used continuously even though this thesis knows that multicollinearity causes several problems.

Like Baller et al.'s study, in the first stage, this thesis investigated Global Moran's I statistics for other crime rates. The coefficients of robbery rate of the 1980s and the 1990s, respectively, are .255 and .274; those of auto theft rate of the 1980s and the 1990s are .370 and .365; those of drug crime of the 1990 are .351. On the basis of a permutation approach with 999 random, all coefficients are statistically significant at the .001 level. That means that spatial randomness is rejected for all crimes and decades, and there is an obvious spatial pattern. Figure 3 to 7 are Moran scatterplot maps of all crimes rates. "High-High" in the map shows the clustering of three kinds of crime rates. For auto theft rate, the clustering of crime rates is concentrated on Western and Florida regions, New York City and Washington D.C. areas, and Colorado State and Wyoming

Table 5. Comparison of Ordinary Least-Square of County Robbery Rates 1980-1990[a]

Independent Variables	1980			1990		
	M1	M2	M3	M1	M2	M3
Resource Dep.	.017**	.017**	.017**	.029**	.032**	.032**
Pop. Struct. Comp.	.043**	.042**	.040**	.051**	.049**	.046**
Median Age	.000	.002**	.001**	.000	.002**	.002**
Divorce	.014**	.008**	.008**	.006**	.002**	.002**
Unemployment	-.003**	-.002**	-.002**	-.006**	-.006**	-.006**
Clustered Regions	-	-	.030**	-	-	.044**
Res-Stability	-	-.015**	-.014**	-	-.020**	-.019**
Imm-Con.	-	.013**	.011**	-	.014**	.012**
Intercept	-.011	-.030**	-.023**	.023	-.017	-.008
Adj. R-Squared	.489	0.551	0.557	.454	.538	.548
N	3085	3085	3085	3085	3085	3085

[a] Unstandardized regression coefficients

* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

M1: OLS regression of County Robbery Rates of Baseline Model without Immigrant Concentration, Residential Stability, and Clustered Regions

M2: OLS regression of County Robbery Rates of Thesis Model without Clustered Regions

M3: OLS regression of County Robbery Rates with all variables

State areas. The clustering of robbery rates is located in California, New York, and Washington D.C. areas. In terms of the drug crime rates, as expected by the literature review, the clustering of drug crime rates went around the coastline of the U.S. Based on the Global Moran's I statistics and these maps, this study concludes that there are differences of spatial regimes in three crimes.

Table 5 shows the Comparison of Ordinary Least-Squared of County robbery Rates from the 1980s to the 1990s in adding two new variables and Clustered regions

into the Baseline model. In general, most results of this thesis are similar to Baller et al.'s study of homicide. For example, the four variables of the Baseline model except unemployment positively affected robbery and most variables of the Baseline model are significant. However, the direction of median age of robbery is different from that of median age of homicide rates. Median age positively affected robbery rates. This thesis conjectures that older people engage in more robberies based on Baller et al.'s explanation, in which younger people committed homicide more than older people.

Immigrant concentration and residential stability significantly affected robbery; the former was positive and the latter was negative as expected by the literature review. According to Baller et al., the negative effect of unemployment could be explained by the decrease of chances for potential criminals to commit crime. As expected by the literature review, residential stability, showing stronger community attachment, had a negative influence on crime. Also, the coefficients of residential stability and immigrant concentration are the greatest after population structure component. Interestingly, after controlling the residential stability and the immigrant concentration, the population structure component was more important part than the resource-deprivation/affluence component.

The change of Adjusted R squared is very desirable. In the 1980s, adding immigrant concentration and residential stability increased Adjusted R squared by .062, and the addition of Clustered regions increased Adjusted R squared by .006.

Table 6. Comparison of Ordinary Least-Square of County Auto theft Rates 1980-1990[a]

Independent	1980			1990		
Variables	M1	M2	M3	M1	M2	M3
Resource Dep.	-.008**	-.008**	-.007**	.021**	.025**	0.027**
Pop. Struct. Comp.	.057**	.055**	.053**	.094**	.091**	0.090**
Median Age	-.003**	.000	-.001	-.001	.003**	0.003**
Divorce	.029**	.018**	.017**	.016**	.008**	0.008**
Unemployment	-.004**	-.002**	-.002**	-.006**	-.006**	-0.006**
Clustered Regions	-	-	.051**	-	-	0.031**
Res-Stability	-	-.032**	-.029**	-	-.041**	-0.040**
Imm-Con.	-	.028**	.025**	-	.039**	0.037**
Intercept	.129**	.089**	.101**	.111**	.015	0.022
Adj. R-Squared	.448	.545	.554	.453	.579	0.581
N	3085	3085	3085	3085	3085	3085

[a] Unstandardized regression coefficients

* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

M1: OLS regression of County Auto theft Rates of Baseline Model without Immigrant Concentration, Residential Stability, and Clustered Regions

M2: OLS regression of County Auto theft Rates of Thesis Model without Clustered Regions

M3: OLS regression of County Auto theft Rates with all variables

Similarly, in the 1990s, Adjusted R squared increased .84 by the addition of two variables and increased .01 by the addition of Clustered regions.

Table 6 shows the Comparison of Ordinary Least-Square of County auto theft Rates from the 1980s to the 1990s, adding two new variables and Clustered regions into the Baseline model. As shown by the above results for robbery, results of auto theft are similar to Baller et al.'s study of homicide. However, the resource

deprivation/affluence component is different. Different from homicide and robbery, the resource deprivation/affluence component negatively affected auto theft in the 1980s but positively affected auto theft in the 1990s. In fact, it was not easy to find the factor like resource deprivation/affluence component in the studies of auto theft. In the study of auto theft by Rice and Smith (2002), there was also no variable related to resource deprivation/affluence component. Rice and Smith just conjectured that the percentage of population of African American is likely to be associated with auto theft because they assumed African American have low socioeconomic status. In their study, the African American positively affected auto theft. Likewise, immigrant concentration of this study including African American positively affected auto theft like Rice and Smith (2002).

Immigrant concentration and residential stability significantly affected robbery; the former was positive and the latter was negative as expected by the literature review. Median age negatively affected robbery rates but most coefficients of median age are not significant. The change of Adjusted R squared is satisfactory. In the 1980s, adding immigrant concentration and residential stability increased Adjusted R squared by .097, and the addition of Clustered regions increased Adjusted R squared by .009. Similarly, in the 1990s, Adjusted R squared increased .126 and .002 respectively.

Table 7. Comparison of Ordinary Least-Square of County Drug Crime Rates 1990[a]

	M1	M2	M3
Resource Dep.	.034**	.039**	0.027**
Pop. Struct. Comp.	.052**	.049**	0.038**
Median Age	-.003**	.002*	0.001
Divorce	.018**	.010**	0.008**
Unemployment	-.006**	-.007**	-0.005**
Clustered Regions	-	-	0.087**
Res-Stability	-	-.043**	-0.038**
Imm-Con.	-	.042**	0.034**
Intercept	.195**	.091**	0.080**
Adj. R-Squared	.179	.306	0.360
N	3085	3085	3085

[a] Unstandardized regression coefficients

* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

M1: OLS regression of County Drug Rates of Baseline Model without Immigrant Concentration, Residential Stability, and Clustered Regions

M2: OLS regression of County Drug Rates of Thesis Model without Clustered Regions

M3: OLS regression of County Drug Rates with all variables

Table 7 shows the Comparison of Ordinary Least-Square of County drug crime Rates in the 1990s, adding two new variables and Clustered regions into the Baseline model. As shown above, results of drug crime are similar to those of robbery, but the difference is that median age is insignificant and inconsistent. Other variables except unemployment and residential stability positively affected drug like robbery and auto theft. Immigrant concentration and residential stability are significant and important

factors. The change of Adjusted R squared is very desirable. Adding immigrant concentration and residential stability increased Adjusted R squared by 1.127, and the addition of Clustered regions increased R squared by .054.

In sum, the above results did not deviate from the former studies, and it appears to have worth to add two variables into the Baseline Model. Accordingly, this thesis suggests that the addition of residential stability and immigrant concentration improve the Baseline model. However, as said before, this thesis could not know how badly multicollinearity affected the results. Additional examination is needed to solve the problems.

Structural stability and Heteroscedasticity

In the next stage, like Baller et al.'s study, this study found that there were heteroscedasticity and spatial instability in crime rates by analyzing the stability of the regression coefficients of a spatial regime. As said above, the Spatial Chow test examines whether the same model is proper for two dissimilar sub-samples. Table 8 shows the results of the Spatial Chow test, the stability of individual coefficients (Clustered regions versus Non-clustered), the heteroscedastic coefficients, and the test on heteroscedasticity.

Table 8. Stability of Regression Coefficients by Spatial Regime- County Other Crimes 1980-1990

	Robbery		Auto Theft		Drug
	1980	1990	1980	1990	1990
I. Spatial Chow Test on Overall Stability [a]:					
	303.556**	296.774**	245.086**	72.227**	210.503**
II. Stability of Individual Coefficients (Non-Clustered versus Clustered Regions)					
Resource Dep.	102.006**	108.452**	7.489**	15.830**	4.715
Pop. Struct. Comp.	152.521**	92.588**	.594	10.161**	.774
Median Age	3.617	.612	5.099*	2.310	.061
Divorce	.404	3.087	.107	.004	.073
Unemployment	.243	2.261	10.569**	1.149	.261
Res-Stability	9.495**	.004	27.678**	.957	.092
Imm-Con.	8.720**	1.238	69.102**	.821	.695
III. Heteroscedastic Coefficients					
Non-Clustered	.002	.002	.006	.008	.011
Clustered	.005	.005	.009	.017	.025
IV. Test on Heteroscedasticity [b]:					
	27.349**	18.929**	8.312**	30.676**	123.605**
N	3085	3085	3085	3085	3085
(N of Clustered regions)	(131)	(131)	(222)	(222)	(904)

[a] distributed as $\chi 2$ with 8 degrees of freedom.

[b] distributed as $\chi 2$ with 1 degree of freedom.

* $p \leq .05$; ** $p \leq .01$ (two tailed tests)

Table 8 says that the Spatial Chow test rejects the coefficient stability. Moreover, the stability of Individual Coefficients (Non-Clustered versus Clustered Regions) shows that several variables, such as resource deprivation/affluence component, population structure component, and residential stability, exert significantly different effects across crimes and regions. In addition, heteroscedastic coefficients of Clustered regions compared to Non-clustered ones are bigger, even though the difference is small. Finally, the test of heteroscedasticity said that all cases do not have equal error

variance. Therefore, this thesis assumes that addition of Clustered regions only could not reduce spatial heterogeneity.

In summary, similar to at Baller et al. found separated spatial regimes, there is also an obvious difference of spatial regimes between Clustered and Non-clustered regions in three crime rates. Therefore, like the Baseline model which was not sufficient, thesis model developed from the Baseline model is not also enough to detect the heterogeneity of regions, and each region is needed to be analyzed separately, because dividing the U.S. into Clustered and Non-clustered regions did not explain spatial dependence and heterogeneity sufficiently. Accordingly, like Baller et al.'s study, this thesis will carry out disaggregated modeling method.

Following Baller et al.'s study, this thesis examined the value of robust Lagrange Multiplier Lag (LML) and Lagrange Multiplier Error (LME) to know whether the spatial lag model and the spatial error model should be used in each region. In other words, if the value of LML is greater than that of LME, the spatial lag model should be used in that model. Table 9 presents each decade's LML and LME of three kind crime rates. The value of LME of all regions, except the Clustered regions of auto theft in the 1980s, is greater than the value of the LML, which means only Clustered regions of auto theft in the 1980s are fit for a spatial lag model, and the rest of them are fit for a spatial error model.

Table 9. Robust Lagrange Multiplier Lag and Lagrange Multiplier Error of County Other Crimes 1980-1990

		Clustered Regions		Non-clustered Regions	
		Robust LML	Robust LME	Robust LML	Robust LME
Robbery	1980	0.374	1.900	143.875**	297.139**
	1990	1.972	5.660*	63.171**	173.517**
Auto Theft	1980	2.216	2.202	99.897**	385.136**
	1990	0.131	0.250	75.247**	271.848**
Drug	1990	2.174*	9.329**	2.641*	17.668**

In general, this result is quite different from Baller et al.'s homicide study. Whereas the spatial lag model was used for studying the homicide rate in the South of all years and the Non-south of the 1960s, only auto theft of Clustered regions in the 1980s among three kinds of crime rates fits for the spatial lag model. Moreover, because the auto theft's LML in the 1980s is not even significant, and the difference between LML and LME is very small, this thesis assumes that there is not big difference between the spatial lag model and the spatial error model.

Unlike Baller et al.'s study, several coefficients are small and not significant. According to Baller, small coefficient and insignificance do not matter if Global Moran's I statistics are significant. Therefore, this thesis can proceed to next stage because all Global Moran's I statistics are significant. However, it is not too much to say that there is little diffusion in three crimes because Baller et al. (2001) said that the spatial lag model has the feature of diffusion of crime. In fact, the all homicide rates of the South in the U.S. found diffusion procedure. But different from

expectation, the spatial autocorrelation of three kinds of crimes could be explained by unmeasured variables.

Section III

This section presents the spatial lag model for the Clustered regions of the auto theft of the 1980s and the spatial error model for the rest of the regions. In addition, this study examines how much the spatial model improved OLS model. To meet the convenience of analysis, this thesis will explain the spatial model of robbery, auto theft, and drug crime.

Robbery

First, table 10 separately shows the comparison of OLS and the spatial error model of county robbery rates in Clustered regions and Non-clustered regions. Basically, the coefficients of two models are similar to former OLS model before separating one into two regions. In detail, the resource deprivation/affluence component, the population structure component, and the immigrant concentration always positively and significantly affected robbery rates over time and regions. The residential stability was significant and negatively affected robbery in two decades. Divorce, immigrant concentration, and unemployment are always significant except Clustered regions of the 1980s in the spatial error model. The difference, compared to the former OLS model before separating, is that median age of Clustered regions in the 1980s negatively affected robbery. But, median age does not matter due to its insignificance.

Table 10. Comparison Between OLS and Spatial model of County Robbery Rates 1980-1990[a]

Independent Variables	1980				1990			
	Clustered		Non-Clustered		Clustered		Non-Clustered	
	OLS [b]	Spatial [c]	OLS	Spatial	OLS	Spatial	OLS	Spatial
Resource Dep.	.088**	.094**	.014**	.017**	.120**	.124**	.028**	.028**
Pop. Comp.	.103**	.095**	.037**	.040**	.120**	.106**	.044**	.047**
Median Age	-.002	-0.002	.001**	.001**	.001	-.001	.002**	.002**
Divorce	.005	.010	.009**	.009**	.012*	.019**	.002**	.002**
Unemployment	-.002	-0.001	-.002**	-.002**	-.013*	-.011*	-.005**	-.005**
Res-Stability	-.038**	-.038**	-.012**	-.011**	-.018*	-.025**	-.018**	-.017**
Imm-Con.	.012*	.010	.009**	.010**	.016**	.021**	.009**	.010**
Spatial Error (λ)	-	.366**	-	.331**	-	.531**	-	.288**
Intercept	.023	.010	-.017*	-.034**	-.014	-.019	-.003	-.023*
R-Squared	.798	.810	.513	.530	.808	.832	.497	.509
N	131	131	2954	2954	131	131	2954	2954

[a] Unstandardized regression coefficients

* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

[b] OLS regression of County Robbery Rates

[c] Spatial error model of County Robbery Rates

More importantly, the coefficients of the spatial error were always significant and affected robbery strongly and positively.

To know how much the spatial error model improved OLS model, this thesis tried to examine the Adjusted R squared between two models. However, the spatial model of Geoda software did not present Adjusted R squared. So, this thesis calculated the value of F test[6] between OLS model and the spatial error model. The value of F distribution's table between two models is consistently 3.84 because all

cases of the spatial models are greater than 120 and the difference between the number of the spatial models (K_f) and the number of OLS models (K_r) is always 1. For robbery of the 1980s, the F test value in Clustered regions is 10.582 and that in Non-clustered regions is 127.515. In the 1990s, the F test value in Clustered regions is 17.429 and that in Non-clustered regions is 71.976. Therefore, all F test values are greater than 3.84, which means that the spatial model improved OLS model.

In summary, a spatial error model accounted for robbery well. In other words, robbery could be explained by the presence of unmeasured variables. Differently from what the former studies expected, it does not seem that there is diffusion in robbery.

Auto theft

Table 11 shows the spatial lag model for Clustered regions in the 1980s and the spatial error model for Non-clustered regions in the 1980s and Clustered and Non-clustered regions in the 1990s. Generally, the result of spatial analysis was similar to that of non-spatial analysis except the resource deprivation/affluence component. The coefficient of resource deprivation/affluence component of OLS of Non-clustered regions in the 1980s negatively affected auto theft. Median age also is inconsistent over times and regions.

Table 11. Comparison Between OLS and Spatial model of County Auto theft Rates 1980-1990[a]

Independent Variables	1980				1990			
	Clustered		Non-Clustered		Clustered		Non-Clustered	
	OLS [b]	Spatial [c]	OLS	Spatial [d]	OLS	Spatial [d]	OLS	Spatial [d]
Resource Dep.	.052**	.052**	-.008**	.002	.108**	.107**	.024**	.028**
Pop. Comp.	.051**	.051**	.051**	.070**	.115**	.115**	.084**	.095**
Median Age	-.005*	-0.005*	-.000	.001	-.001	-.001	.003**	.003**
Divorce	.014**	.014**	.018**	.019**	.009	.010	.009**	.009**
Unemployment	-.012**	-.013**	-.002**	-.001*	-.009	-.008	-.006**	-.005**
Res-Stability	-.022**	-.021**	-.029**	.023**	-.030**	-.031**	-.040**	-.036**
Imm-Con.	.030**	.030**	.023**	.020**	.040**	.041**	.033**	.036**
Spatial Lag (ρ)	-	-.049	-	-	-	-	-	-
Spatial Error (λ)	-	-	-	.685**	-	.069	-	.505**
Intercept	.417**	.437**	.009**	.060**	.260*	.236*	.027	.013
R-Squared	.482	.483	.495	.551	.646	.647	.538	.567
N	222	222	2863	2863	222	222	2863	2863

[a] Unstandardized regression coefficients

* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

[b] OLS regression of County Auto theft Rates

[c] Spatial lag model of County Auto theft Rates

[d] Spatial error model of County Auto theft Rates

Additionally, like non-spatial analysis, the unemployment and the residential stability of the spatial error model consistently and negatively affected auto theft crime rates, and the divorce, the population structure component, and the immigrant concentration positively did. All values are significant except the unemployment of the Clustered regions in the 1980s.

For the spatial lag model, all coefficients of dependent variables, except the value of spatial lag (ρ), were significant. According to Baller, insignificance of the

coefficient of spatial lag does not matter. Baller said that the coefficient of spatial lag is just a coefficient. As shown by table 9, the difference between the value of LML and LME of auto theft in the 1980s is very small. This thesis assumes that the tiny difference explains that the reason why the coefficient of the spatial lag was not significant, which means there is not big difference between the spatial lag model and the spatial error model in Clustered regions of auto theft in the 1980s.

In terms of R squared, for auto theft of the 1980s, the value in Clustered regions is 3.48 and that in Non-clustered regions is 519.478. In the 1990s, the value in Clustered regions is 0.603 and that in Non-clustered regions is 191.145. The F test values of Non-clustered regions are greater than 3.48, but those of Clustered regions less than 3.84. Therefore, this thesis suggests that the spatial lag model and the spatial error model of Clustered regions did not improve OLS model, but the non-spatial models of Non-clustered regions are improved through spatial error models.

In conclusion, a spatial model seems to be better than a non-spatial model in Non-clustered regions. However, Clustered regions could be sufficiently explained by OLS model because F test value is less than 3.48. Therefore, diffusion of auto theft in the U.S. hardly exists. In contrast, Rice and Smith (2002) argued that auto theft's diffusion exists at micro level, after combing social disorganization theory and routine activity theory. But, their data was collected from a southeastern U.S. city with an

approximate population of 250,000. In other words, Rice and Smith did not use data of all the U.S. Accordingly, based on above results, this thesis suggests that auto theft was sufficiently explained by a spatial error model at the U.S. level. But, careful and additional investigations are needed to know whether or not diffusion of auto theft exists at the macro level.

Drug Crime

Like other crimes, the result of the spatial model of drug crime was alike to that of the non-spatial model. For example, the coefficients of spatial error (λ) were always significant over time. Resource deprivation/affluence component, population structure component, and divorce were always positive and significant. Unemployment and residential stability were negative and significant. However, median age positively affected drug crime but was insignificant. Each coefficient of residential stability and immigrant concentration was greater than each coefficient of median age, unemployment, and divorce.

In terms of F test, the value in Clustered regions is 4.469 and that in Non-clustered regions is 65.306, which means the spatial error model improved the OLS model. Accordingly, drug crime was sufficiently explained by unmeasured variables.

Table 12. Comparison Between OLS and Spatial model of County Drug Crime Rates 1990[a]

Independent Variables	1990			
	Clustered		Non-Clustered	
	OLS [b]	Spatial [c]	OLS	Spatial
Resource Dep.	.040**	.042**	.022**	.013**
Pop. Comp.	.043**	.042**	.037**	.035**
Median Age	.002	.002	.001	.001
Divorce	.009**	.009*	.008**	.006**
Unemployment	-.006*	-.006*	-.004**	-.003**
Res-Stability	-.040**	-.040**	-.038**	-.037**
Imm-Con.	.033**	.033**	.037**	.038**
Spatial Error (λ)	-	.134	-	.448**
Intercept	.147*	.141*	.078**	.084**
R-Squared	.195	.199	.240	.271
N	904	904	2181	2181

[a] Unstandardized regression coefficients

* $p \leq .05$ ** $p \leq .01$ (two tailed tests)

[b] OLS regression of County Drug Crime Rates

[c] Spatial error model of County Drug Crime Rates

While there is no study of robbery and auto theft at macro level, several investigators had studied diffusion of drug crime in the U.S. Hunt and Chambers (1976) said that diffusion of drugs occurred from Boston to Washington along the coast and in Southern California, and heroin use appeared to diffuse to the interior from areas of large population to those with a small population. Similarly, Frischer et al. (2000), in their study of diffusion of drug misuse in Scotland, said that spatial autocorrelation should be considered in the study of drug use because drug crime could not be explained by demographic factors and housing environments. But, this

thesis could not find diffusion of drug crime in the U.S. This thesis does not argue that their findings are wrong. But, if it is true that this thesis uses better model than former investigators, the presence of diffusion of drug crime should be examined again. Additionally, like Hunt and Chambers (1976), this study suggests that drug crime appears to relate to coastlines. As shown by Moran scatterplot maps, most of drug crimes and the clustering of drug crime were concentrated on coastline. According to Baller et al., the clustering of crime is different from diffusion. The cluster is a place with high crime rate that also has adjacent neighborhoods with high crime rate, while diffusion is related to a complicated mechanism, called a spatial lag model. More detailed explanations will be presented in summary and discussions.

Chapter IV: Summary and Discussions

This thesis replicated Baller et al.'s study to examine the presence of the spatial autocorrelation of robbery, auto theft, and drug crime. Before the replication, this study added immigrant concentration and residential stability to improve the Baseline Model. Adding two variables was somewhat effective to examine the relationship between independent variables and dependent variables. But, this thesis only examined two decades due to restricted data. The study of extended terms will give a clear answer.

As expected, this thesis found several similar findings to Baller et al.'s study, but there are also several important differences. In terms of common points, first of all, three kinds of crimes were also not randomly distributed like homicide. Most Clustered regions have higher crime rates than Non-clustered ones. This shows that the differences of the spatial regimes obviously affected crime rates. In homicide's study, Baller et al. (2001) argued that "the South and the Non-South constitute two distinct spatial regimes in the geographic clustering of homicide" (p. 582). As such, three crimes also showed the difference of spatial regimes.

Second, regardless of controlling structural factors, the clustering of crimes remained in both decades in this study. According to Baller et al., in addition to independent variables, this means that there is another ingredient somewhere in model,

in generating crime rates.

Third, independent variables differently affected crime rates in Clustered regions and Non-clustered ones. When it comes to homicide, a few scholars attributed it to "a culture of violence" (Baller et al., 2001) For example, Hackney and Gastil argued that different value systems, affecting violent behavior, could explain higher homicide rates of the South. They called it "a subculture of violence" (Land et al, 1990). In terms of three crimes, this thesis suggests the new outline of mechanism about clustering of three crimes. Interestingly, after close examination of Moran Scatterplot Maps, this thesis observed that clustering of robbery, auto theft, and drug crime were consistently concentrated on regions that are famous for the tourist industry. In detail, regardless of the kinds of crime, areas of California Las Vegas, Florida, New York City, and Washington D.C. experienced the most clustering of crime. This trend was quite different from the homicide's clustering focusing on the South. This thesis does not argue that there is a relationship between the tourist industry and clustering of three crimes. It is just a hypothesis based on the findings. In fact, this study could not explain why clustering phenomena happen. As argued by Baller et al., further studies are required to explicate the obscure mechanism.

In contrast to points of sameness, robbery, auto theft, and drug crime hardly have diffusion phenomena. Only auto theft of Clustered regions in the 1980s showed

weak diffusion. This was quite different from the former studies related to robbery, auto theft, and drug crime to examine the presence of diffusion. In fact, former studies are concentrated on restricted areas. In other words, researchers found the diffusion of those crimes at the micro level, such as a city, but this thesis did not find diffusion at the macro level. Only auto theft of Clustered regions showed weak diffusion in the 1980s. Therefore, three crimes rates could be explained by unmeasured variables, not interaction between dependent variables.

Consideration for Future Study

During the study, this thesis found several new points to be considered for future examiners. First, this research, including Baller et al.'s study, missed the true nature of the time variables. For the future study, the time variable should be considered because diffusion itself necessarily needs an intermediary called time. In other words, former situations affect present ones and present resulted from the past. For example, the Butterfly Effect of chaos theory says that tiny variations of the beginning of time caused large difference in the long term. As such, independent and dependent variables of the former month can affect dependent variables and even independent variables of present month. In detail, it is possible that the weak residential stability of the former month, not only affects the present crime rate of

community, but also affects residential stability itself of the present month or other independent variables. But, this study and Baller et al.'s study just used the crime rate and independent variables of the given year. In detail, each of the four kinds of crime rate is the rate per 100,000 people and the numerator is a 3 year average centered on the decennial census year (e.g., 1979, 1980, and 1981) to avoid heterogeneity. The average value is divided by census population. Other independent variables are the same. This thesis and Baller et al.'s study never considered how former variables affected late ones. Even though Baller et al. said that spatial lag model is very similar to diffusion process, they did not consider time. Dividing independent and dependent variables by month would be an example.

Second, compared to the number of the Clustered regions of homicide (1679), the number of those of robbery (131), auto theft (222), and drug crime (904) were very small. But, this thesis does not know how that small number of Clustered regions of three kinds of crime rates affects results. Also, this thesis could not suggest whether or not the diffusion of crime was substantially related with the number of clustered regions. More importantly, the procedure of deciding the number of Clustered regions depends on investigators. Therefore, this thesis suggests that investigators should be careful when they choose the number of Clustered regions (e.g., the homicide study by Baller et al.).

Third, this thesis found that the presence and the magnitude of spatial autocorrelation related to what weight is used. The amount of magnitude and direction of spatial autocorrelation is dependent on a used weight. To replicate Baller et al.'s study, this thesis used the queen weight that is the most similar to the 10 nearest neighbors of Baller et al. During the procedure which found the proper weight, this research realized that the weight greatly affected the result. This means that examiners need to conceptualize carefully the objective of study to decide what weight will be used.

Finally, the multicollinearity of variables should be removed from model. Even though this thesis knew that multicollinearity exists in the Baseline model and the thesis model, this study did not remove it. To remove multicollinearity this thesis would have had to take out several independent variables, but if so, this thesis could not have replicated Baller et al.'s study. If multicollinearity were eliminated from models, better results would be obtained. Even Baller et al. (2001) did not remove multicollinearity. Accordingly, careful investigations are needed to remove multicollinearity.

ENDNOTES

[1] This variable was defined as the total population of all other places in the city. Each adjacent tract is weighted by its geographical proximity to the reference tract. "Formally, the population potential for a given areal unit i, PP_i, is defined by

$PP_i = \sum (P_j / D_{ij}) \, j \neq i$

where P_j is the population of the jth areal unit, D_{ij} is the distance of unit j from unit i, and the summation is taken over all units in the city other than i".

This variable enables Roncek and Montgomery to study in relation to spatial phenomenon, such as the diffusion of crime (Morenoff and Sampson , 1997).

[2] In the first stage, Morenoff and Sampson created predicted values of the potential variables "by regressing the generalized potential on the set of predictors as well as a set of instrumental variables, which in this case are dichotomous variables representing police districts." They assumed that these police district variables described some place which has an influence on the population change in the city, except the reference census tract. Land and Deane in 1992 showed how to use regional dummy variables as instruments. They used the predicted values for the generalized potential variable as another regressor in the next procedure, where population change is the dependent variable. (Morenoff and Sampson , 1997)

[3] This variable is the value of the weighted average of the number of auto thefts for the 10 next adjacent face blocks in either direction from the face block in question (Rice and Smith, 2000).

[4] According to Smith et al., street robbery potential is "the weighted average of the street robberies on these proximate face blocks which are computed weighting those further away less. The street robbery potential of a face block was defined as the weighted average of two directions of 10 face blocks (Smith et al., 2000).

[5] This test is examined for the stability of the regression coefficients over the regimes. To do so, this test was carried out for all coefficients jointly and for each coefficient separately. According to the Baller et al., in the classic regression model, this is the Chow (1960) test on the stability of regression coefficients, and Anselin extended it into the spatial chow test.

[6] F test formula is as follows.

$$F\ (K_f\text{-}K_r, N\text{-}f\text{-}1) = \frac{(R_F^2\text{-}R_R^2)/(K_f\text{-}K_r)}{(1\text{-}R_F^2\text{-})/(N\text{-}K_f\text{-}1)}$$

R_F^2: R-square for the full model

R_R^2: R- square for the restricted model

K_f: number of Independent variables in the full model

K_r : number of Independent variables in the restricted model

N : total number of cases

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