

Chapter VIII

Space–Time Measures of Crime Diffusion

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ABSTRACT

This study proposes methods for space-time diffusion measures and a simulation on crime analyses. A spatial pattern of crimes is a constantly changing and ongoing process. However, prior research on spatial crime analysis has focused primarily on identifying fixed spatial patterns, and has neglected temporal aspects. As a result, the literature has difficulty in explaining the formation and development of such spatial crime patterns. This study investigates both spatial and temporal aspects of crime occurrences, particularly on the space-time diffusion process by using the temporal extensions of local spatial autocorrelation measures. In addition, space-time diffusion simulation is applied based on Hagerstrand's diffusion modeling. Consequently, diffusion modeling and the simulation (1) enables further understanding of the mechanism of how crime patterns are formed, (2) provides an in depth resource for policy makers and police to reduce crimes by considering a temporal dimension of crime, (3) and is readily applicable to other fields such as the epidemiology of disease.

INTRODUCTION

The importance of space has recently been recognized in social science as a key dimension in crime analyses (Brantingham & Brantingham, 1981). Research on the spatial aspect of crime, such as crime hotspot analyses, has been of great interest and has been applied to crime mapping. The major

goals of crime hotspot analyses are summarized as follows. First, crime concentrations provide a starting point for understanding the underlying sociological processes, which contribute to the formation of such concentrations (Vigne & Groff, 2001). Second, the identification of more vulnerable areas enables effective allocation of police resources by enforcing more efficient surveillance

strategies (Craglia, Haining, & Signoretta, 2001; Reiss & Roth, 1993). Third, the identified hot spots and corresponding sociological explanations are applicable to generating new policies or law enforcement strategies to prevent crime during the planning stages (Sampson, & Groves, 1989; Skogan, 1986).

Spatial crime patterns are formed over time through continuous changes. As Abler, Adams, and Gould (1971) denote, space and time are fundamental dimensions of human existence and enable us to understand people's use of place over time. Therefore, investigating both spatial and temporal aspects of crimes is crucial in understanding spatial crime patterns. However, despite the developments in spatial crime analysis, many crime studies have problems in explaining the formation and development of spatial crime patterns. Instead, the studies merely find spatial patterns of crime without considering temporal aspects. As a result, the studies lack proper explanations, particularly regarding the causes and underlying mechanisms of crime patterns. Uncovering these causes and underlying mechanisms is the most crucial factor in ultimately controlling crime.

While there are various types of space-time patterns in crime occurrences, this study focuses on . is a result of complex adaptive processes that are human reactions to phenomena, representing space-time interaction among human beings (Hagerstrand, 1967). Additionally, the diffusion enables us to understand space as a condition, which determines the level of speed in the diffusion process when analyzed through time (Nijkamp & Reggiani, 1996). Therefore, the crime diffusion process can be analyzed by carefully studying interactions between space and time and enables us to understand the formation and development of spatial crime patterns.

There are several types of depending on how physical or mental objects spread through population over space and time (Morrill, Gaile, & Thrall, 1988). Contagious diffusion, a form of expansion diffusion, indicates a spread from nearby distance

to further distance. Hierarchical diffusion, another form of expansion diffusion, denotes spreads by "trickling down" from larger to smaller adopting units. In hierarchical diffusion, distance is not important. Inclusive of contagious and hierarchical diffusion, more agents characterize expansion diffusion after the diffusion process. Relocation diffusion refers to change of agent location. Thus, the agent of diffusion is lost in the source location after the relocation diffusion process. In addition, the number of agents is constant after relocation diffusion. Usually, diffusion occurs in a mixed form of several types. In crime analyses, expansion diffusion, particularly contagious diffusion, has been great interest to the field because spatial proximity is considered as a crucial factor in a crime diffusion process (Messner, Anselin, Baller, Hawkins, Deane, & Tolnay, 1999; Sampson & Morenoff, 2004).

Based on conceptual backgrounds of crime diffusion process (Hollinger, Offer, & Ostrov, 1987; Kellerman, 1966), there has been a recent growth in literature on the crime diffusion process and its identification (Baller, Anselin, Messner, Deane, & Hawkins, 2001; Cohen, & Tita, 1999a, 1999b; Cork, 1999; Craglia, Haining, & Signoretta, 2001; Messner et al., 1999; Sampson, & Morenoff, 2004; Smith, Frazee, & Davison, 2000; Tita & Cohen, 2004). Despite the growing interest, many crime diffusion studies exhibit critical limitations because the studies isolate the underlying mechanism of the diffusion process by using only cross-sectional data without temporal information in the diffusion analyses (Cohen & Tita, 1999a). Therefore, the analyses only consider spatial crime patterns and infer diffusion process from the pattern. However, the diffusion process is presented by changes in spatial patterns over time, which can only be accounted by analyzing both spatial and temporal information simultaneously.

This study overcomes the limitations of spatial crime analysis by measuring changes of spatial crime pattern over time. To achieve this goal, the

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