

**Final Report to
AIREF**

**THE IMPACT OF HOME BURGLAR ALARM SYSTEMS
ON RESIDENTIAL BURGLARIES**



**SEUNGMUG (A.K.A. ZECH) LEE
Ph. D.**

THE SCHOOL OF CRIMINAL JUSTICE

**RUTGERS,
THE STATE UNIVERSITY OF NEW JERSEY**

2008
Seungmug Lee
ALL RIGHTS RESERVED

THE IMPACT OF HOME BURGLAR ALARM SYSTEMS ON RESIDENTIAL BURGLARIES

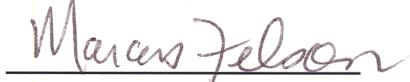
By Seungmug Lee

A dissertation submitted to the
Graduate School-Newark
Rutgers, The State University of New Jersey
in partial fulfillment of requirements
for the degree of
Doctor of Philosophy
Graduate Program in Criminal Justice
Written under the direction of
Professor Ronald V. Clarke

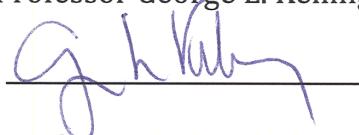


and Approved by

Professor Marcus Felson



Professor George L. Kelling



Professor Robert D. McCrie, Outside Reader



Newark, New Jersey

May, 2008

TABLE OF CONTENTS

Executive Summary.....	ii
Acknowledgements	vi
Table of Contents.....	ix
List of Tables	xiv
List of Figures	xvi
List of Equations	xvii
Chapter 1. Introduction	1
I. Importance of the Study	1
II. Burglar Alarm Systems Defined.....	6
III. Chapter Organization.....	9
Chapter 2. The Development of the Alarm Security Industry in the United States.....	13
I. Private Security Industries in the United States.....	13
1. American Society for Industrial Security (ASIS).....	20
2. Pinkerton and "Pinkertonism".....	21
II. Alarm Industries	25
1. The 18 th - 19 th Century	26
2. The Early Twentieth Century.....	29
3. The Mid-Twentieth Century	30
4. After the 1990s	33
III. Other Security Developments.....	36
IV. Chapter Conclusion.....	37
Chapter 3. Theoretical Framework and Prior Studies.....	39
I. Theoretical Framework for the Study.....	39
1. Routine Activities Theory	41
2. Rational Choice Theory.....	48
3. Situational Crime Prevention.....	52
II. Situational Crime Prevention and Residential Burglar Alarms	58
1. The Conklin-Bittner Study (1973)	59
2. The Repetto Study (1974).....	60
3. The Bennett-Wright Study (1984).....	62
4. The Rengert-Wasilchick Study (1985; 2000)	64
5. The Hakim-Buck Study (1991).....	65
6. The Cromwell-Olson-Avary Study (1991).....	67
7. The Wright-Decker Study (1994).....	69
8. The LeBeau-Vincent Study (1998).....	70
9. The Budd Study (1999).....	72
10. The O'Shea Study (2000).....	73
III. Chapter Conclusion.....	74
Chapter 4. Limitations of Prior Research and Research Questions.....	78
I. Limitations of Prior Research	78
1. Data Source.....	78

2.	Research Design	80
3.	Research Method	83
4.	Statistical Analysis	86
II.	Solutions to Methodological Issues	88
III.	Research Questions and Null Hypotheses	90
IV.	Chapter Conclusion.....	95
Chapter 5.	Data Sources and Research Design.....	98
I.	Overview of the Research Design.....	98
II.	Data Sources	102
1.	The CFS Database	102
2.	The Police Incident Reports (PIR) Database	104
3.	The Alarm-Installed (AI) Residential Burglary Database.....	105
4.	The Alarm Permit Records Database.....	106
5.	The U.S. Census Database.....	107
6.	Data Transformation.....	108
7.	Unit of Analysis.....	110
III.	Research Designs.....	111
1.	Research Design and Statistical Power Analysis	111
2.	Descriptive Analyses of Burglar Alarms and Residential Burglaries.....	117
3.	Relationship between Burglar Alarms and Residential Burglaries.....	119
4.	Descriptive Spatial Analyses of Burglar Alarms and Residential Burglaries	120
5.	Spatial Analyses of the Impact of Burglar Alarms on Residential Burglaries	121
6.	Measurement of Displacement and Diffusion of Benefits of Burglar Alarms on Residential Burglaries.....	124
IV.	Chapter Conclusion.....	125
Chapter 6.	Patterns and Characteristics of Burglar Alarms and Residential Burglaries.....	127
I.	Introduction.....	127
II.	Trends of Residential Burglar Alarms.....	127
1.	Residential Burglar Alarm Permits Records	127
2.	Non-Registered Residential Burglar Alarms	130
III.	Trends of Residential Burglaries.....	131
1.	Trends in NAI Residential Burglary	131
2.	AI Residential Burglaries.....	132
IV.	Temporal Patterns of Residential Burglaries	133
1.	Burglaries by Season	133
2.	Burglaries by Month.....	134
3.	Burglaries by Week.....	135
4.	Burglaries by Time of Day	136
5.	Burglary by Hour of Day.....	137
V.	Chapter Conclusion.....	139

Chapter 7. Quantitative Analyses of the Impact of Burglar Alarms on Residential Burglaries.....	141
I. Introduction.....	141
II. Overall Relationship between Burglar Alarms and Residential Burglaries.....	142
1. Chi-Square Analyses.....	142
2. The Relationship between Burglar Alarms and NAI Burglary according to the Changed Proportions	145
III. Correlated Relationship of Burglar Alarms and Residential Burglaries.....	148
1. Multiple Correlation Analyses with Variables.....	148
2. Binary Correlation Analyses for Burglar Alarms and Burglaries in the Census Tract.....	150
IV. Bivariate Regressions of Burglar Alarms and Residential Burglaries	153
V. Multiple Regression Analyses of Burglar Alarms and Residential Burglaries.....	155
1. Forward Selection Multiple Regression Analyses of Burglar Alarms.....	157
2. Hierarchical Multiple Regression Analyses of NAI Burglary....	167
VI. Chapter Conclusion.....	177
Chapter 8. Descriptive Spatial Analyses of Burglar Alarms and Residential Burglaries.....	182
I. Introduction.....	182
II. Macro-Level Spatial Patterns of Burglar Alarms and Residential Burglaries.....	184
1. Point Maps of Burglar Alarms and NAI and AI Residential Burglaries.....	184
2. Density Maps of Burglar Alarms and NAI and AI Residential Burglaries.....	188
III. Spatial Characteristics of Burglar Alarms and Residential Burglaries Based on Census Tracts	194
1. Spatial Characteristics of Residential Burglar Alarms	196
2. Spatial Characteristics of NAI Residential Burglary.....	210
IV. Chapter Conclusion.....	221
Chapter 9. Spatial Analyses of the Impact of Burglar Alarms on Residential Burglaries.....	225
I. Introduction.....	225
II. Spatial Centrographic Analyses for Burglar Alarms and Residential Burglaries.....	226
1. Measures of Spatial Centrality for Burglar Alarms and Residential Burglaries	226
2. Measures of Spatial Dispersion for Burglar Alarms and Residential Burglaries	229
III. Spatial Autocorrelation Analyses for Burglar Alarms and Residential Burglary at the Macro-Level	235

1.	Measure of the Nearest Neighbor Index (NNI) for Burglar Alarms and Residential Burglaries	238
2.	Measure of the Global Moran's <i>I</i> for Burglar Alarms and Residential Burglaries	243
IV.	Spatial Clustering Analyses for Burglar Alarms and Residential Burglaries at the Micro-Level.....	247
1.	Geographic Clustering Analyses.....	249
2.	Local Moran's <i>I</i> Analyses for Burglar Alarms and Residential Burglaries.....	252
3.	Local Hotspots (Gi^*) Analysis for Burglar Alarms and Residential Burglaries	257
V.	Chapter Conclusion.....	260
Chapter 10. Displacement/Diffusion of Benefits of Burglar Alarms on Residential Burglaries.....		264
I.	Introduction.....	264
II.	Nonequivalent-Groups Research Design for the Measurement of Displacement and Diffusion of Benefits	265
1.	Measurement Issues.....	265
2.	Measurement at the Individual and Household Levels	266
3.	Nonequivalent-Groups Quasi-Experimental Research Design	268
4.	Weighted Displacement Quotient (WDQ)	273
5.	Application of the Nonequivalent-Groups Design and WDQ	275
6.	Measuring Process of Applied Nonequivalent-Groups Design and WDQ Analysis.....	278
III.	Applied WDQ Analysis of Burglar Alarms on Residential Burglaries	281
1.	A Land Parcel Map.....	281
2.	The Selection Process of Buffer and Control Zones	282
3.	The Values of Applied WDQ Analysis	285
4.	The Diffusion of Benefits of Burglar Alarms on Residential Burglaries.....	289
IV.	Chapter Conclusion.....	291
Chapter 11. Discussion and Conclusion		294
I.	Introduction.....	294
II.	Finding Explanations and Policy Implications	294
1.	Results Summary	294
2.	Policy Implications.....	298
III.	Limitations of the Present Study	305
1.	Nonequivalent-Groups Quasi-Experimental Design.....	305
2.	The Potential Drawbacks of Recorded Crime Data	306
3.	Some Proportion of In-Use, but Non-Registered, Burglar Alarms Exists	307
4.	A Sudden Increase in Residential Alarm Permit Records	308
5.	Some Proportion of Unmatched Geocoding Addresses.....	310
6.	Lack of a Multiple Factor Approach in Examining the Impact of Alarm Systems on Crime.....	310
7.	The Generalization of the Study Is in Issue.....	311
IV.	Further Research Agenda	312

V.	Conclusion	314
	Appendices.....	317
Appendix 1.	Chi-Square statistics between burglar alarms and residential burglaries annually in Newark, NJ	317
Appendix 2.	The rates of alarm installation and NAI/AI residential burglaries annually for 90 census tracts in Newark, NJ	318
Appendix 3.	Lists of the variables for correlation and regression analyses.	320
Appendix 4.	Multiple correlation coefficients (Person's <i>r</i>) for the rates of burglar alarm installations for 90 census tracts annually, in Newark, NJ	321
Appendix 5.	Multiple correction coefficients (Pearson's <i>r</i>) of the rates of NAI burglary for 90 census tracts annually in Newark, NJ	322
Appendix 6.	A series of forward selection multiple regressions for burglar alarm annually in Newark, NJ (<i>N</i> =90 census tracts).....	323
Appendix 7.	A series of hierarchical multivariable regressions for NAI residential burglary annually in Newark, NJ (<i>N</i> =90 census tracts).....	326
Appendix 8.	Points maps of residential burglar alarms annually.....	329
Appendix 9.	Points maps of the NAI residential burglary annually	330
Appendix 10.	Density maps of residential burglar alarms Annually	331
Appendix 11.	Density maps of the NAI residential burglary annually	332
Appendix 12.	Superimposed density maps between burglar alarms and the NAI residential burglary annually in Newark, NJ.....	333
Appendix 13.	Census tract maps of Local Moran's <i>I</i> for residential burglar alarms annually in Newark, NJ	334
Appendix 14.	Census tract maps of Local Moran's <i>I</i> for NAI residential burglary annually in Newark, NJ	335
	Bibliography	336
	VITA	347

LIST OF TABLES

[Table 3.1] Summary of Prior Studies.....	77
[Table 5.1] Total numbers of population, household, household w/o burglar alarm, residential burglary w/o alarm, residential burglar alarm in use, and residential burglary w/ burglar alarm annually in Newark, NJ.....	108
[Table 5.2] Overall minimum number of cases for a variable for the 2X2 table chi-square test (df=1) with different degrees of effect size (ES) with the 0.80 statistical power (SP) and the 0.05 significance level.....	115
[Table 5.3] The 2X2 dummy table (4 cells) with minimum number of cases for a variable with the 0.80 SP and 10% ES	115
[Table 5.4] The chi-square test between residential burglar alarms used in house and victimization of residential burglary with the 0.80 SP and 10% ES in Newark, NJ, 2001*	115
[Table 6.1] Number of residential burglar alarm permits annually in Newark, NJ.....	128
[Table 6.2] Number and proportion of the renewed and non-renewed residential alarm permits annually in Newark, NJ (%)	129
[Table 6.3] Number of the expired and unlicensed burglar alarms in use annually in Newark, NJ	130
[Table 6.4] Number of residential burglaries at NAI homes annually in Newark, NJ.....	132
[Table 6.5] Number of residential burglaries at the AI homes annually in Newark, NJ	133
[Table 6.6] Proportion of NAI and AI residential burglaries seasonally in Newark, NJ	134
[Table 6.7] Proportion of the NAI and AI residential burglaries monthly in Newark, NJ.....	135
[Table 6.8] Proportion of the NAI and AI residential burglaries weekly in Newark, NJ.....	136
[Table 6.9] Proportion of the NAI and AI residential burglaries by time of day in Newark, NJ	137
[Table 6.10] Proportion of NAI/AI residential burglaries hourly in Newark, NJ	138
[Table 7.1] The chi-square test between residential burglar alarms and residential burglaries in Newark, NJ, 2001 ^a	143
[Table 7.2] Values of chi-square tests between burglar alarms and residential burglaries annually in Newark, NJ (df=1) ^a	143
[Table 7.3] The chi-square test by year and NAI/AI residential burglaries in Newark, NJ...	145
[Table 7.4] Changed percentages and proportions of AI and NAI residential burglaries annually in Newark, NJ.....	147
[Table 7.5] Multiple correlation statistics between year and burglar alarms and NAI/AI residential burglaries in Newark, NJ.....	149
[Table 7.6] Rates of alarm installation ¹ and NAI/AI residential burglaries ² for 90 census tracts in Newark, NJ, 2001	151
[Table 7.7] Binary correlation coefficients (Pearson's <i>r</i>) for burglar alarms with NAI/AI burglaries for 90 census tracts annually in Newark, NJ.....	152
[Table 7.8] Bi-variate regression coefficients of burglar alarms on NAI residential burglary annually in Newark, NJ ¹ (N=90 census tracts)	154

[Table 7.9] Forward selection multiple regression of burglar alarms for overall (2001-2005) in Newark, NJ ($N=90$ census tracts)	159
[Table 7.10] Hierarchical multiple regression of NAI residential burglary for overall period (2001-2005) in Newark, NJ ($N=90$ census tracts)	170
[Table 9.1] Nearest Neighbor Index (NNI) ratios and results.....	239
[Table 9.2] NNI ratios and z-scores for burglar alarms and NAI/AI burglaries annually in Newark, NJ	240
[Table 9.3] Global Moran's <i>I</i> Index values and results.....	244
[Table 9.4] Global Moran's <i>I</i> values for burglar alarms and NAI/AI burglaries annually in Newark, NJ	244
[Table 10.1] Three examples of nonequivalent-groups quasi-experimental designs.....	270
[Table 10.2] Nonequivalent-groups quasi-experimental design for the current study	272
[Table 10.3] Interpretation guide for WDQ ratios.....	281
[Table 10.4] Number of parcel-mapped residential alarm records annually, Newark, NJ....	285
[Table 10.5] Values of applied WDQ analysis in Newark, NJ	286
[Table 11.1] Numbers of three different residential alarm system usages annually in Newark, NJ	307
[Table 11.2] Number of residential burglar-alarm permits annually in Newark, NJ, 2001-2005	309

LIST OF FIGURES

[Figure 3.1] A concept map of the effectiveness of crime prevention for residential burglaries	76
[Figure 5.1] A density map of NAI residential burglary over burglar alarms in Newark, NJ, 2005.....	123
[Figure 8.1] Point maps for burglar alarms and NAI/AI residential burglaries in Newark, NJ, 2004 and 2005	185
[Figure 8.2] Overlaid point maps of burglar alarms and NAI residential burglary in Newark, NJ, 2004 and 2005	187
[Figure 8.3] Density maps for burglar alarms and NAI residential burglary in Newark, NJ, 2004 and 2005.....	190
[Figure 8.4] Overlaid density maps between burglar alarms and NAI residential burglary in Newark, NJ, 2004 and 2005	192
[Figure 8.5] Census-tract maps of the general population by race with density maps of burglar alarms in Newark, NJ, 2005	198
[Figure 8.6] Census-tract maps for the population age groups with density maps of burglar alarms in Newark, NJ, 2005	201
[Figure 8.7] Census tract maps of socio-economic characteristics with density maps of burglar alarms in Newark, NJ, 2005	204
[Figure 8.8] Census-tract maps of householders by race and age with density maps of burglar alarms in Newark, NJ, 2005	207
[Figure 8.9] Census-tract maps of housing characteristics with density maps of burglar alarms in Newark, NJ, 2005.....	209
[Figure 8.10] Census-tract maps of the general population by race with density maps of NAI burglary in Newark, NJ, 2005.....	211
[Figure 8.11] Census-tract maps of population age groups with density maps of NAI burglary in Newark, NJ, 2005	213
[Figure 8.12] Census-tract maps of socio-economic conditions with density maps of NAI burglary in Newark, NJ, 2005	216
[Figure 8.13] Census-tract maps of householders by race and age with density maps of NAI burglary in Newark, NJ, 2005	218
[Figure 8.14] Census-tract maps of housing characteristics composition with density maps of NAI burglary in Newark, NJ, 2005	220
[Figure 9.1] Mean centers of burglar alarms and residential burglaries annually in Newark, NJ	228
[Figure 9.2] Standard distance deviation, standard deviational ellipse, and mean center of burglar alarms and NAI/AI burglaries in Newark, NJ, 2005	233
[Figure 9.3] The results of NNI analyses.....	240
[Figure 9.4] The results of Global Moran's <i>I</i> analysis for burglar alarms and NAI/AI burglaries	244
[Figure 9.5] Overlaid density map of burglar alarms and NAI burglary in Newark, NJ, 2005.....	251

[Figure 9.6] Local Moran's I for burglar alarms and NAI/AI burglaries in Newark, NJ, 2005 and overall	254
[Figure 9.7] Gi^* for burglar alarms and NAI burglary in Newark, NJ, 2005 and overall	258
[Figure 10.1] Nested buffer and control zones	274
[Figure 10.2] Four-ring buffering maps of burglar alarms and NAI burglary in the western and northeastern parts of Newark, NJ, 2005	275
[Figure 10.3] Application of the nested buffer and control zones in a typical housing layout.....	276
[Figure 10.4] Application of the nested buffer and control zones	278
[Figure 10.5] Example of the land parcel map of the western part in Newark, NJ	282
[Figure 10.6] Land parcel maps of 9-meter control zone (C_1) and 18-meter control zone (C_2) with 9-meter buffer zone (B)	285

LIST OF EQUATIONS

[Equation 10.1].....	279
[Equation 10.2].....	279

CHAPTER 1. INTRODUCTION

I. Importance of the Study

Private security in the United States has a long and rich history. Since 1851 when Alan Pinkerton founded what would become the Pinkerton Detective Agency, private security has grown to become a \$104 billion industry, with recent expenditures for police protection at all levels of governmental spending being about \$50 billion annually. The ratio of private security employees to local law enforcement is reported to be 3:1 (Fischer and Green, 2004; Collins, Ricks, and Van Meter, 2000). Private security professionals are now employed to protect both public and private places, providing services such as physical security, loss prevention, information security, and the protection of personnel. Now more than ever, the people of the United States, as well as many other places in the world, are given surveillance and protection by the private security industry.

Since the late 1960s, the public police have been subject to a “research revolution” that has enormously expanded their body of knowledge (National Research Council, 2004; Button, 1998). Police forces have been the focus of numerous studies and a major topic of consideration when studying the drop in crime rates, partly because the police are the first line of response to violent activity. The steady reduction of violence in the 1990s is especially unprecedented in contemporary crime statistics, and its causes have become a major research topic (Blumstein and Wallman, 2000). For example, New York City experienced a dramatic reduction in all forms of crime and disorder. Among the competing explanations for crime reduction in this city, policing strategies and the New York

City Police Department's impact have generated considerable discussion in academic, political, and media circles. Several studies have examined the contributions of the public police to the effectiveness of crime control and prevention (Sousa, 2003; Eck and Maguire, 2000). Kelling and Sousa (2001) concluded that the policing variable had a direct effect on crime reduction in New York City.

However, in the public sector of the crime control and prevention industry, costs are high and rising. Both the quality and the quantity of the effectiveness of the criminal justice system clearly have room for improvement. Developments in crime prevention have gradually and systematically driven down costs while increasing both the quantity and the quality of crime prevention efforts (Kirzner, 1997). During the last three decades, government officials, scholars, politicians, and a vast array of other professionals have responded with programs and projects all designed to reduce crime. Although many of these initiatives have made improvements, the cost of crime and the damages caused by crime continue to rise. Since the mid-1990s, the actual number of crimes has dropped, yet the fear of crime has increased.

The private security industry has offered alternatives for coping with crime unlike any other and the development of the private security sector regarding crime prevention may have advantages (Benson, 1998). It has undertaken a significant range of functions and is larger in numerical terms than the public police. The goods and services the industry supplies to facilitate all types of crime-control activities are quite substantial. In 2002, security guards alone held more than 1.1

million jobs (BLS, 2004). The security alarm industry has been developed with sales of more than \$20 billion annually (Security Sales & Integration, 2004). A 1976 National Advisory Commission on Criminal Justice Standards and Goals report noted that:

One massive resource... has not been tapped by governments in the fight against criminality. The private security industry... offers a potential for coping with crime that cannot be equaled by any other remedy... The private security professional may be the only person in this society who has the knowledge to effectively prevent crime.

This conclusion had no noticeable impact on public policy toward crime. A 1985 National Institute of Justice report by Cunningham and Taylor (1985) explained that despite continual increases in taxpayer dollars spent on the criminal justice system, “neither local, State, nor Federal resources had seriously affected the problem of crime” and that yet still “conspicuously absent from ... crime prevention programs ... is the input of the private security industry.”

In the United States over the last 30 years, there have been a number of significant government funded reports. For instance, the 1971 five volume Rand report is probably the most extensive study of private security that has ever been undertaken (Kakalik and Wildhorn, 1972). It was followed by another significant government funded research project conducted by the National Advisory Committee on Criminal Justice Standards and Goals (1976). These have been succeeded by the Hallcrest Reports I and II (Cunningham and Taylor, 1985; Cunningham, Strauchs and van Meter, 1990). The substantial contributions made by these reports were: (1) to profile trends in allocation of resources to private security; (2) to describe the

current structure and functioning of the various types of private forces; (3) to describe the problems and issues in the private security sector.

The growth of private security raises new challenges for researchers and policy-makers, but these studies mainly focused on the general description and overview of the private security industry in the United States. Scientifically driven investigations have seldom been conducted to examine the effectiveness of crime control and prevention by private security entrepreneurs in general (O'Shea, 2000).

As Button (1998) argued, the field of private security has been under-utilized, under-researched, and underestimated. When policing and crime prevention are considered, the private security industry's usefulness is often overlooked. The standards of the industry could be improved by statutory regulation, which could impact crime. The private security industry could also be given a greater role in the crime prevention infrastructure that exists at a national, regional, and local level, and more effective partnerships could be established with the police. But the police often neglect the potential benefits of working with the private security industry.

Garland (2001) argued that despite the substantial size of private security, the effects of these private adaptations have not been carefully evaluated. Button (1998) argued that 'policing' has become increasingly synonymous with the public police service. As a consequence, the private security industry has received very little attention. The attention of researchers and policy-makers interested in policing has been firmly fixed on the public police service. When the activities undertaken by the private security industry and the estimated size of the industry in relation to the police are considered, the amount of research that has been

conducted on the private security industry seems highly disproportionate. The public police have been the subject of numerous studies, but there have been relatively few on the private security sector. As Jones and Newburn (1998) observed in their study on the private security industry:

Over the past two decades, criminologists have become increasingly preoccupied with policing. However, their gaze has been almost exclusively fixed upon that body of state officials which forms what is known as the police service.

In particular, the deterrent effect of burglar alarm systems and their impact on crime in residential areas has not been adequately researched (O'Shea, 2000; Bennett and Wright, 1984), though alarm systems have potential to prevent residential burglary as argued in the National Advisory Committee on Criminal Justice Standards and Goals (1976):

... In many instances, the presence of an alarm system can serve as a psychological deterrent to crime—most would-be offenders stay away from premises they suspect are protected by alarm systems... In short, alarms provide a valuable, viable means of achieving overall security.

It is, thus, imperative to have more research in the impact of alarm systems on burglary. For example, Sorensen (2005) noted that despite its widespread implementation, there is still little concrete evidence that one popular crime prevention approach, the situational crime prevention which is the core theoretical foundation of this study, to residential burglary have any marked effect on burglary reduction. While numerous evaluations are available in connection with some

situational crime prevention approaches,¹ others have received very little attention. He concluded that given its intuitive appeal and widespread use, it is surprising how few studies have examined the effectiveness of burglar alarms. This dearth of evidence may stem from the fact that very few of the programs enacted to date have been evaluated under controlled, experimental conditions. With these considerations in mind, this study will carefully examine in depth the impact of home burglar alarm systems on residential burglary.

II. Burglar Alarm Systems Defined

Fischer and Green (2004) describe that three basic types of alarm systems are in use to provide protection for a security system: (1) burglar (intrusion) alarms; (2) fire alarms; and (3) special-use alarms. The fire alarms operate to warn of fire dangers in various stages of development of a fire or respond protectively by announcing the flow of water in a sprinkler system. The special-use alarms use to warn of a process reaching a dangerous temperature, or of the presence of toxic fumes. The burglar alarms signal the entry of persons into a facility or a protected area while the system is in operation. Of the three types of alarm systems, the fire and special-use alarms are excluded in the present study. Only the burglar alarm system is included (Fischer and Green, 2004; Central Station Alarm Association, 1994; Cunningham and Taylor, 1985; National Advisory Committee on Criminal Justice Standards and Goals, 1976; Moolman, 1970).

¹⁾ See Clarke, Ronald V. (1997). "Situational crime prevention; Successful case studies" (2nd ed.) and "Crime Prevention Studies" (volumes 1 ~ 20) edited by Ronald V. Clarke.

The primary purpose of a burglar alarm system is to detect the entry or attempted entry of intruders into a protected facility and signal their presence to others either locally or at a remote location. The burglar alarm system has three common components: detection devices, control unit, and reporting device. The detection devices are installed at the protected premises to detect the burglar. They are usually connected by an electrical circuit to the control unit. The control unit provides power for the sensors, and receives and evaluates signals from them. Upon receipt of an alarm signal, the control unit communicates with the reporting device, also called the alarm indicating device, to annunciate an alarm. This alarm can be either a sounding/visual device installed at the protected premises and/or a signal to an alarm receiving unit at a remote location (Central Station Alarm Association, 1994; Moolman, 1970).

Each of these devices are integrated and developed into a variety of application devices and systems, depending on security needs and cost considerations. For example, Underwriters Laboratories Inc. (UL) classifies burglar alarm systems into five types of systems according to the method of annunciating an alarm: central station, proprietary, police station connected, local, and residential (Central Station Alarm Association, 1994). First, in a central station burglar alarm system, an intrusion is automatically transmitted to a commercial agency called a central station. There, trained operators and alarm investigators are present at all times to supervise, record, and respond to the signal. The operator can immediately dispatch alarm investigators and telephones the police. Second, in a proprietary burglar alarm system, the detection devices and circuits are connected to constantly

monitored receiving equipment at a central supervising station, which is located at the protected property and is operated by personnel responsible to the owner of the property. Third, a police station connected burglar alarm system consists of protective devices and circuits connected through a control unit to a constantly-manned police department. An intrusion causes the sounding/visual device to be actuated and a signal to be transmitted to the police department. So the police can respond to a silent alarm. But its operation is solely under the control of the property owner. There is no outside agency to assure that the alarm system has been turned on. But this system generally is not available. Fourth, a local burglar alarm system operates a sounding/visual device at the protected property in the event of an unauthorized or attempted intrusion, assuming that the device would scare off the intruders before a loss occurs by attracting the attention of a neighbor or passerby who would notify the police. But the operation of this system is under the control of the owner of the property. As a result, there is no guarantee that the system can be turned on when the protection is needed. Finally, a residential burglar alarm system consists of devices and circuits connected through a control unit to a sounding/visual device, which may have a remote connection to a central station, police station, proprietary station, or residential monitoring station. A residential monitoring station is a facility that has personnel on duty trained to handle signals received from burglar alarm systems.

A burglar alarm system for the present study is a combined system with sensors, sending devices, and sounding devices with the primary purpose of

detecting the entry or attempted entry and signaling an intrusion to others either locally or at a remote location, including several types of burglar alarm systems.

III. Chapter Organization

A historical context of several distinctive developments of private security industries in the United States since the middle of 1850s is discussed in Chapter 2. As one of the major developments of security industries, together with armored car services and security guard services, the alarm industry has expanded robustly for decades, driven by technological efficiencies and the expansion of the residential security market. Those security developments have a long tradition of filling perceived gaps in government-initiated policing services by playing a critical role to provide crime prevention and security services in the society.

Chapter 3 discusses, firstly, the relevant theories (e.g., routine activities theory, rational choice theory, and situational crime prevention approach) for the present study. A burglar alarm in residential area is an example of target-hardening technique by substituting for the absence of capable guardians against residential burglaries and/or the existence of inadequate surveillance in order to prevent residential burglaries from a rationally calculated and motivated burglar. Then, several prior studies of residential burglary conducted since the 1970s are presented according to the data source, research design, and study finding. In spite of a substantial body of research projects to study the problem of burglary, few studies have examined the effectiveness of home burglar alarms or their impact on residential burglary.

Chapter 4 presents the research limitations drawn from the discussion of prior burglary studies according to data source, research design, research method, and statistical analysis. Though this one study does not overcome all methodological limitations, several solutions are sought and presented to remedy some of them. Then, given the review of relevant theories and prior studies on the effectiveness of burglar alarms on residential burglaries, six research questions and null hypotheses are proposed.

Chapter 5 discusses the data sources and research design for the present study. The three primary databases (e.g., residential burglar alarms permits, residential burglaries, and U.S. Census information) are prepared by retrieving from the Newark Police Department, City Hall, and U.S. Census. The issue of research design and statistical power analysis is discussed. In addition, a non-equivalent quasi-experimental research design to measure spatial displacement and diffusion of benefits is discussed briefly.

Chapters 6 and 7 focus on descriptive and numerical analyses. Chapter 6 presents descriptive analyses (e.g., general and temporal trends) of both burglar alarms and residential burglaries over the multiple years. Chapter 7 discusses the overall and correction relationships between burglar alarms and residential burglaries. Various numerical statistics, such as chi-square and bi- and multivariate correlation tests are employed. In addition, the regression statistics are used to examine the relationships between burglar alarms and residential burglaries with other independent variables. The primary purpose is to identify the indicators to show significant relationships to the increase of burglar alarms in use and the

decrease of residential burglary incidents. Bi- and multivariate regression and advanced multiple regression statistics (e.g., forward selection multiple regression and hierarchical multiple regression) are used.

Chapters 8, 9, and 10 focus on spatial analyses of burglar alarms and residential burglary and their spatial relationships with other variables. Chapter 8 discusses the descriptive spatial analyses of burglar alarms and residential burglaries, using point and density mapping methods. Chief aims are to examine the spatial distributions and patterns of both burglar alarms and residential burglaries and to verify quantitative analyses analyzed in Chapter 7 in a spatial dimension, using the geographic information system (GIS) computer program.

Chapter 9 discusses spatial impact analyses of both burglar alarms and residential burglaries. Some simple spatial statistics (e.g., spatial centrality and spatial dispersion analyses) and advanced spatial statistics (e.g., spatial autocorrelation analyses and spatial clustering analyses) for burglar alarms and residential burglaries are employed.

Chapter 10 discusses the spatial displacement and diffusion of benefit to examine the impact of burglar alarms on residential burglaries. Acknowledging the absence of a standardized study design for the measurement of this issue, nonequivalent-group quasi-experimental research design and the theoretical approach of the weighted displacement quotient (WDQ) are discussed and utilized to devise the research design to measure spatial displacement and diffusion of benefits with nested buffer and control zones approach at the individual household level.

The research questions and hypotheses proposed in Chapter 4 are revisited in Chapter 11. In addition to summarizing the findings of the present study, Chapter 11 discusses implication for policy, limitations of the current study, and proposals for future research focusing on the impact of alarm systems on crimes.

CHAPTER 2. THE DEVELOPMENT OF THE ALARM SECURITY INDUSTRY IN THE UNITED STATES

I. Private Security Industries in the United States

Private security organizations have a long tradition of filling perceived gaps in government-provided policing services. In America, colonial settlement of newly discovered lands gave rise to different security needs than those of Europe. Frontier life, with its many dangers, promoted the ideas of self-help and mutual aid. As early as 1699 the colony of Massachusetts instituted a formal night watch. Other measures and precautions followed suit (Lipson, 1988).

Early American law enforcement, for the most part, resembled that of England. Colonial towns, like their English counterparts, relied on the medieval institutions of the constable, the night watch, and “hue and cry” – institutions that drew no clear lines between public and private sectors. As in England, although the constables were legally and traditionally agents of the courts, they not only served warrants and took responsibility for any daytime patrolling, but also looked after the condition of streets, sidewalks, privies, slaughterhouses, and oversaw the miscellaneous activities which affected the health, safety, and well-being of the urban population. Serving as constable or watchman was generally an unpaid civic obligation, but in practice everyone who could afford to hire a substitute did so. In the decades following independence, there existed a constant chorus of complaints about the constables and watchmen. Those with sufficient resources hired additional protection, though the boundary between private guards and public watchmen often remained indistinct (Sklansky, 1999).

As the United States became an independent nation, the founding fathers made a conscious decision not to follow the French type of national police. Thus, common law, which was already established during the colonial period, continued after the declaration of independence. The first quarter of the nineteenth century saw the growth of cities in the United States. Each had its own version of a night watch, and some had a newly organized day force called a ward. These were later consolidated and organized into formal local police organizations after 1844, when the New York legislature created day and night police for the city. The next decade witnessed the creation of similar departments in cities across the nation (Lipson, 1988).

At the same time, the nineteenth century was the period westward expansion. The movement followed natural routes, such as rivers and lakes, and was furthered by the building of canals. Along newly opened routes, people and both local and foreign goods moved in increasing volume. The goods needed protection, and watchmen manned docks, barges, and other installations vital to this traffic. Soon thereafter, the developing railroads followed suit with private security of their own (Lipson, 1988).

But, in many respects, the security needs of the railroads and other companies coincided. Little security assistance was available from the new local police departments, which lacked jurisdiction apart from their own limited areas as well as the necessary financial support for efforts beyond their own taxpayers' borders. At the same time, no federal service existed to which they could turn for

help. These companies could not wait for legislation to be instituted to fill these voids. Pulled into the gap were the newly emerging private security firms.

The response to the need for private security during and after the Civil War included the creation of express companies engaged in handling and transporting valuables. For example, the American Express Company was formally started in 1850 by Henry Wells and Walter Fargo. In addition, with the opening of the railroads, the express companies began to send valuables in safes accompanied by messengers in their cars. By the late 1850s, both Adams Express and American Express were designing and using their own express cars on the railroads (Lipson, 1988).

Other companies also became involved in supplying security services. The railroads soon had their own in-house police as did steamship lines, freight carriers, forwarders, banks, factories, mines, and retail establishments. Major competition on a national scale emerged in 1909 with the William J. Burns International Detective Agency. Burns had received a great deal of publicity in connection with his work as an operative of the United States Secret Service in cases involving municipal corruption in San Francisco, Homestead scandals in the West, and criminal manipulation of timberlands in Oregon. His successful career in arresting notorious criminals, following painstaking fact-finding measures, earned Burns a reputation of reliability, persistence and eventual success in pursuing cases that were becoming more complex in the early twentieth century. When Burns opened a private office for "detective services," he was by no means pioneering a field and promoted a rigor and organization in the investigative-services business. Burns agreed to provide

protective services for the American Bankers Association, winning the contract from the Pinkerton firm and the American Hotel Association (Lipson, 1988; McCrie, 1997).

The entry of the United States into World War I marked the federal takeover of railroads and express companies, with all in-house security staffs becoming government employees. Before and during World War I, concern for security intensified throughout American industries because of the fear of sabotage and espionage. Private security forces were used to protect war industries and the docks against destruction by saboteurs. The end of the conflict, though, saw these properties and employees returned to private ownership and control (Hess and Wroblewski, 1996).

World War II gave significant impetus to the development of the private security industry. By the end of World War II, American commerce and industry were served by scores of well-established investigative agencies and by hundreds of companies that provided watch, guard, and patrol services. For industrial clients, detectives primarily undertook specific-loss investigations. When solved, the client could pursue criminal charges and/or initiate a civil suit for recovery of losses. Generally, the larger and better established investigative firms shunned matrimonial assignments and refused to conduct industrial spying for a client against competitors. However, freelance detectives operated without such a code, sometimes providing services of ambivalent legality (McCrie, 1997).

In the four decades following World War II, the use of private security services expanded to encompass all segments of the private sector. In fact, people employed in private security far outnumbered those employed in all phases of law

enforcement (Hess and Wroblewski, 1996; Lipson, 1988). According to Shearing and Stenning (1987, 9), "since World War II the phenomenon of private security has been growing exponentially, and continues to do so."

By the 1950s, large-scale personnel protection had become the main source for many traditionally investigative-oriented services. While most manufacturing corporations maintained their own security departments, increasingly these services were being contracted out to existing security guard and patrol companies. Although never as profitable as investigations on an hourly basis, guard and patrol services nevertheless provided larger gross revenues. These services could create substantial business; and they did (McCrie, 1997).

In 1955, the private security field took a major leap forward with the formation of the American Society for Industrial Security (ASIS). For most people in the industry, 1955 signifies the beginning of the modern epoch of security. Before 1955, there were no professional organizations of note, no certifications, no college programs, and no cohesive body to advance the interests of the field (Fisher and Green, 2004).

By the end of the 1960s, the government-financed Rand Report (Kakalik and Wildhorn, 1972) made it clear that the industry was growing rapidly without there being any understanding of how its practices might impinge upon public concerns. The report documented a chasm between private security and public law enforcement. The two sectors cooperated only when they had to and were conceptually and administratively quite different, drawing from separate labor pools and following substantially different vetting (pre-employment screening) and

training practices. While security directors often had law enforcement experience, there still seemed to be no constructive basis of interaction with public law enforcement (McCrie, 1997).

By the mid-1970s, there were no substantial changes in federal, state, or local policies relating to guards, watchmen, and private investigators. However, the Rand Report was not forgotten. The U.S. Law Enforcement Assistance Administration (LEAA)-sponsored initiative sought to take action on some of the concerns identified in the Rand Report; the National Advisory Committee on Criminal Justice Standards and Goals convened a Task Force on Private Security (1976) to study the industry, to offer public and private sector guidance, and to report their findings to the public (McCrie, 1997).

By the mid-1990s, much of the direction provided by the Rand Report and the Task Force on Private Security resulted in measurable changes within the industry. According to *The Hallcrest Report II*, around 10,000 operating private security guard and patrol companies existed, and about 67,000 private investigators had registered with state regulators in 37. Total industry revenues for guard services were estimated at \$9.8 billion in 1990 and projected to grow to \$21 billion by 2000, at an annual growth rate of 8 percent. Additionally, revenues for private investigations were estimated to be \$2.4 billion in 1990, growing to about \$4.6 billion by the year 2000 (Cunningham et al., 1990). By 1996, two companies had achieved annual revenues of more than \$1 billion dollars from security guard, patrol, and investigative services alone—a growth achieved through internal and external acquisitions. The dour picture of the “aging white male...poorly educated and

poorly paid" painted by the Rand Report no longer was wholly accurate (McCrie, 1997).

McCrie (1997; 1988) noted that the modern U.S. security services industry has developed three distinct forms: alarm monitoring and servicing; armored car services; and security guard services, which include private investigative services. Among them, the guard and investigation businesses remain the largest, as measured by revenues, and the most visible. Companies in this sector are characterized generally as having ease-of-entry to the marketplace; thus, they tend to be highly competitive, low profit and flexible at meeting changing market needs.

The alarm industry has expanded robustly for three decades, driven by technological efficiencies and the expansion of the residential security market. The future entry of at least some Regional Bell Operating Companies (RBOCs) as security-alarm services providers to the market will assure the continued shuffling of alarm accounts among consolidating service operators (McCrie, 1997).

The armored-carrier and security-hardware businesses have been marked by steady and modest growth in recent decades. Both require access to capital to finance their activities (purchasing and maintaining trucks, and manufacturing and distributing products) and have experienced variable profitability. The electronic access-control industry is highly dynamic and substantially affects other segments of the industry during this period of growth, innovation, and consolidation (McCrie, 1997).

These figures, however, are not necessarily precise. Sklansky (1999) argued along two separate lines concerning this matter. The first is empirical: Reliable

information on the size and composition of the private security industry is notoriously sparse. The second reason is definitional: One of the hallmarks of private security is its non-specialized character, i.e., its tendency to be implemented in part by employees—such as store clerks, insurance adjusters, and amusement park attendants—whose principal duties at least ostensibly lie elsewhere.

But still, there can be no doubt that specialized private security personnel play a large and growing role in policing America. On any given day, many Americans are already far more likely to encounter a security guard than a police officer. Nor is private policing limited to uniformed security guards. America has more than 70,000 private investigators and over 26,000 store detectives; together these individuals outnumber FBI agents by almost ten to one. In addition, an estimated 15,000 police officers moonlight as private security guards, often in police uniform. This practice, too, appears to have escalated sharply; more than half of the officers in many metropolitan police departments now supplement their income with private security work (Sklansky, 1999).

1. American Society for Industrial Security (ASIS)

One of the most significant developments in private security in the United States is the establishment of the ASIS. In 1955, private security professional groups founded the ASIS when the chill of the Cold War brought together industrial security practitioners who largely were charged to manage government-mandated protective measures for federally financed research and development, as well as military and technical armaments and materials providers.

Soon, membership broadened to include security directors in non-military-oriented industrial categories and eventually protection managers from other manufacturing and service institutions. ASIS became a meeting place where the tensions and mistrust among local police, federal security authorities, and local private protection executives could be discussed and reduced. Representatives of the security industry itself, including guard company and alarm business operators and sales personnel, were accepted as associate members but were not permitted to hold national offices in the society (McCrie, 1997).

McCrie (1997), however, noted that by the mid-1990s, many ASIS chapters were chaired by security-industry members. Following a decline in security director ASIS members due to corporate downsizing from the late 1980s through the mid-1990s, the society sought aggressively to expand membership to new managers whose corporate duties might include security oversight, among other responsibilities.

2. Pinkerton and “Pinkertonism”

Allan Pinkerton was a key figure in the development of the private security industry in the United States. Born in Scotland, he joined the radical Chartist group as a young man and was forced to flee from Scotland or face imprisonment. In 1844, he and his young wife came to America, where Pinkerton set up his coopering (making barrels) business in Chicago (Lipson, 1988).

In 1849, he was appointed as Chicago's first detective, but he resigned his position from the Chicago Police Department in 1850 and became an agent of the United States Post Office with a mandate to solve a series of postal thefts and

robberies in the area. He arranged to be hired as a postal clerk, a position in which he worked for several weeks. Later, he was able to arrest a mail clerk and recovered almost \$4,000 from the mail clerk's room. This arrest made Pinkerton gain much public attention. He decided to form a business, the North-Western Police Agency in 1855, and in 1858, he formed Pinkerton's Protective Patrol, a smaller operation that, along with several other competitors, offered uniformed night watch service to Chicago businesses (McCrie, 1997; Sklansky, 1999).

Pinkerton's agency was a success. By 1853, he had a staff of five full-time detectives, including a woman (Lipson, 1988). In 1855, one of his clients, the Illinois Central Railroad, was on a retainer of \$10,000 a year. Other railroads that used his services at that time included: the Michigan Central; Michigan Southern and Northern Indiana; Chicago and Rock Island; and the Chicago, Burlington, and Quincy. Another client was the United States Post Office, and Eastern railroads, including the Pennsylvania Railroad, joined the group later. Work for railroads and express companies had become the main source of income for the North-Western Police Agency, which had broadened its geographical scope and become Pinkerton's National Detective Agency (Sklansky, 1999).

Pinkerton's services were important to his clients mainly because public enforcement agencies either were inadequate or lacked jurisdiction. When the Civil War broke out in 1861, President Lincoln called Pinkerton to Washington to discuss establishing a secret service department and later appointed Pinkerton as his chief of intelligence. During the Civil War, Pinkerton organized a counter-surveillance network behind Confederate battle lines and briefly provided personal security

services to Lincoln. He did intelligence work for the Union army, work which today would be performed by a governmental agency (Lipson, 1988; McCrie, 1997).

With the end of the Civil War, industrial growth in the north surged and with it grew the fortunes and prominence of the Pinkerton agency. Relying on its reputation as a creative and tireless investigative group—the “eye” that never sleeps—Pinkerton coined the term “private eye” (Lipson, 1988; McCrie, 1997). His agency concentrated on catching train robbers and setting up security systems for the railroads.

During the 1870s, the agency’s work began to shift toward protecting clients against growing labor unrest, and this shift accelerated after Pinkerton’s death in 1884. By the late 1880s and early 1890s, the Pinkerton agency specialized in infiltrating labor unions, guarding industrial property, and, to a lesser extent, supplying substitute workers during strikes. A turning point occurred in 1892 when the agency was involved into breaking a strike of the Carnegie, Phipps Steel Company at Homestead, Pennsylvania, near Pittsburgh. Although this was not all it did, anti-union assignments came to be the company’s mainstay and the work for which it was best known. The guard services it provided were completed by an expanded, militarized version of Pinkerton’s Private Patrol, and it chiefly protected industrial facilities during labor disturbances (McCrie, 1997).

The public generally did not distinguish between the plant guards and the industrial spies; both were referred to as “Pinkertons.” Often the same name was used for the growing number of operatives employed by agencies formed to compete with Pinkerton, and by the end of the century, the term “Pinkertonism” had

become synonymous with the practice of employing large numbers of private security personnel in the service of industrial capitalism, as well as with the underlying laissez-faire ideology this practice grew to symbolize. Due to the negative image of “Pinkertons,” hostility toward private policing mounted during the second half of the ninth century. By the 1890s, a growing number of Americans thought private police were at best a necessary evil, and at worst an inexcusable one (Hess and Wroblewski, 1996; McCrie, 1997; Sklansky, 1999).

In the aftermath of the labor-capital conflict, Congress passed an “Anti-Pinkerton Act” (1893) prohibiting the federal government from employing the services of private investigative firms. The Pinkerton agency subsequently vowed never again to accept strike-related assignments (McCrie, 1997). Since then, the Pinkerton company itself had found new roles protecting banks, jewelry stores, and other commercial operations against professional robbers and thieves—work that was more in line with the crime-fighting public image the agency had always tried to craft for itself (Sklansky, 1999).

With the backing of its commercial clients, Pinkerton introduced a system of substantial rewards for arrests and information, resulting in a network of reward-seeking sheriffs and informants. They maintained good records and were willing to share their information with others in their own field as well as with law enforcement. The records were the closest thing to a national crime information service that existed at the time and were regarded as such even by official law enforcement (Lipson, 1988).

The company became a public corporation in 1965, and changed its name to Pinkerton's Inc. Currently it employs between 36,000 to 40,000 people and concentrates on security in industry and institutions, security for sporting facilities, investigations of industrial theft, and investigations for insurance claims (Hess and Wroblewski, 1996).

II. Alarm Industries

McCrie (1997) noted that alarm systems have several purposes: (1) a means to decrease dependence on hourly employees who are, nonetheless, a substantial aggregate cost over time and sometimes are less reliable than a systems approach to security; (2) a way of alerting guards, property owners, or the public at large to investigate and respond to the signal; and (3) a method of deterring burglars from attacking premises fitted with alarms.

When reduced to its basic form of a signal or call for help, alarm security is thousands of years old. Long before recorded history, people acted as their own alarm system. The five senses acted as sensors, and vocal cords as the means for sounding an alarm (Greer, 1991). Animals, on the other hand, provided the earliest non-human alarms. Over the centuries, offensive and defensive armies used animals, runners, smoke, noise, mirrored surfaces, and other means to warn against invaders. The private sector relied mostly on animals and watchmen (McCrie, 1997). Landowners in eighteenth century England employed armed gamekeepers to protect their property. As society grew and became more complex, public protection with paid police began replacing private protection. In England, the early

efforts of tythingmen, watchmen, constables, sheriffs and special police units were directed primarily toward maintaining order in a growing society. In the mid-1800's, watchmen, beltmen, and door "rattlers" were replaced by organized police departments in the United States. In 1829, during the beginning of organized police protection, the founder of the famous London "Bobbies," Sir Robert Peel, explained to the people, "We're forming a body of men who will be paid to do what every citizen has a moral and legal obligation to do for themselves" (Kaye, 1987).

1. The 18th - 19th Century

The first modern alarm was invented in the early eighteenth century by an English promoter named Tildesley. A set of chimes was mechanically linked to the door lock. Tildesley's chime contraption was one of several variants found in the American colonies in the early 1700s. For example, a bank in Plymouth, Mass., had an alarm that carried a signal by wire from the safe door to the cashier's house next door; it was the nation's first bank alarm (McCrie, 1988).

In October 1852, an inventor in Somerville, Mass., a Boston suburb, filed a patent for an "improvement in elector-mechanic alarms." August Pope patented one of the first electric burglar alarm systems. The system had electromagnetic contacts mounted on doors and windows that were then wired to a battery and bell. He used electricity to sound a continuous alarm when a door or window was opened without authorization. His system had another innovation: magnetic contacts on the doors and windows were wired in a series circuit. However, it is not known if Pope ever marketed his system. In 1857, he sold his alarm patent to Edwin Holmes who took it to New York City and sold alarms to wealthy homeowners. In 1858, Holmes

established the first central burglar alarm service in the country and his operation evolved into Holmes Protection, Inc. Pope also used electrified metal foil and screens still widely used by many alarm companies. In addition, he built the first central communications center wired to bank and jewelry vaults. He apparently purchased the alarm patent as a speculative investment. As crime was low in Boston, and Boston businessmen did not trust electricity, he sought more fertile ground for his enterprise in New York City. Once in New York, Holmes concentrated on providing alarm signals for the wealthy. Over time, a number of ingenious features were developed. The first multiplexed alarm system was introduced. Thus, when electric lights were introduced in 1880, Holmes added a device that illuminated parts of the house when an alarm signal was activated. Thus, well over a century ago, many of the elements in today's automated alarm system were already in place such as magnetic contacts, timing mechanisms, multiplexed signals, bells, and lights (Greer, 1991; Hess and Wroblewski, 1996; Kaye, 1987; McCrie, 1988).

The Holmes organization was not the only firm providing installation of alarm equipment, monitoring of alarms, and responses to alarms. By 1890, several competing companies existed in New York City alone. Some of them developed as fire signaling services in conjunction with Holmes' concentration on burglary signals. The district telegraph companies soon produced a signal box that would accept three different messages: fire, police, and messenger. But eventually the distinction between fire-signal-only and burglary-signal-only companies largely disappeared. The development of public fire signal services by municipalities further decreased the market drive for these separate types of signal companies (McCrie, 1988).

While still in Boston, Holmes met the inventor of the telephone, Alexander Graham Bell, who used the services of the same electrical technician, Thomas A. Watson. Holmes watched the development of the telephone every day in Watson's shop and evidently was impressed. Eventually, Holmes offered his alarm stations to become the first telephone exchanges, first in Boston and later in New York City (McCrie, 1988).

Holmes became an investor and officer in the Bell Telephone Company of New York, an interest he sold in 1880. In 1900, Holmes maintained contact with the companies that formed American Telephone & Telegraph (AT&T), and in 1905, AT&T bought Holmes' company. The combination of the leading phone company with Holmes' company aided enormously in the national expansion of the alarm system. Edwin Holmes' son, Edwin T. Holmes, who was in charge of the company after his father's death, had turned down previous acquisition offers, including one from R. C. Clowry, president of Western Union, the nation's largest telegraph service (McCrie, 1988).

While the two major burglar alarm companies were carving up the market, the two major fire protection firms, Automatic Fire Alarm of New York and Automatic Fire Protection, were doing the same thing. The former agreed to operate in the Northeast and exclusively in Boston, New York City, and Philadelphia. The latter was to receive the remaining territory. By the 1870s and 1880s, mansions and businesses were being protected against fire with heat sensors. William Watkins established a company called AFA Protection and was the first to use such sensors in a central monitoring station. Other companies followed suit,

adding burglar alarms to the fire protection systems. The use of alarms and detection devices grew to provide protective services through the use of messengers and telegraph lines. By 1889, the use of such alarms and detection devices in industrial and commercial enterprises was well established. In 1901, Western Union consolidated several of these local alarm companies into American District Telegraph Company (ADT) (Kaye, 1987).

Within a few years, the burglar and fire alarm business had become a closed industry, with only a few companies controlling the major industrial and commercial accounts, and these major national companies would remain dominant for the next half century.

2. The Early Twentieth Century

By the twentieth century, a “Holmes” was synonymous with an alarm installed and centrally monitored by the Holmes Burglar Alarm Company. While the initial application of telegraphy was for fire protection, defense against burglary soon became an important reason for installing alarm systems. Part of the success of the Holmes organization was the early personal association established in Boston between Holmes and Alexander Graham Bell. With the growth of both businesses—burglary alarm and telephones, which both needed the costly laying of wire—Bell’s company agreed to lay subvoice-grade lines at the same time they laid voice grade wires for their own growing service requirements. Holmes held an equity position in the telephone business for years, but eventually divested it to concentrate capital on his own business. Nonetheless, the two businesses continued to cooperate (McCrie, 1997).

The early twentieth century was a time of rapid growth of telegraphic-based burglary alarm services among businesses and of the consolidation of many such operations into a single holding company. In addition to the Western Union consolidation, an agent of American Telephone and Telegraph (AT&T), Charles F. Cutler, who headed the New York Telephone Company, succeeded in purchasing the Holmes entity in 1905. Then just four years later, AT&T bought a controlling interest in Western Union; thus, the leading alarm businesses were owned by the same consolidating company or trust. The monopolization of the communications industry resulted in a Justice Department investigation, and in 1914, a federal court ordered AT&T to divest itself of Western Union (McCrie, 1997).

3. The Mid-Twentieth Century

By the mid-twentieth century, the alarm business continued to expand, but another monopoly emerged. The most dominant personality in the alarm industry to emerge during these years was James Douglas Fleming. Starting at a Grinnell subsidiary in 1919 as a sprinkler fitter's helper, Fleming steadily rose in Grinnell, which was then the dominant manufacturer of sprinkler equipment. He became president of the company in 1948, and began a period of heated acquisition for Grinnell.

Within a few years, he purchased the assets of Holmes, ADT, and AFA (Automatic Fire Alarm of New York). Many hundreds of alarm companies also competed in the marketplace, but Fleming's assemblage dominated the most profitable, regulated service response category of alarm businesses: those which

provided certificated services listed by the standard group, Underwriters Laboratories (UL) (McCrie, 1997; Greer, 1991).

But in 1958, the Antitrust Division of the Department of Justice began an investigation of the Grinnell holdings. The division concluded that Grinnell controlled 90 percent of the accredited central station market. Grinnell countered that it was not a monopoly when the entire market, including all businesses and residences, was considered, but the courts did not accept his argument. In 1964, Federal Judge J. Wyzanski ruled against Grinnell on every legal issue raised by the Department of Justice and invoked the Sherman Anti-trust Act in his 1964 opinion ordering the break up of this alarm business. He further ordered the company to divest itself of all its holdings. After an appeal to the Supreme Court, the terms against Grinnell were modified somewhat, but the company was substantially liquidated. As a result, new companies—including Honeywell Protection, Wells Fargo, Westinghouse, and 3M Corporation—were able to enter the industry (McCrie, 1988).

Since then, the industry has been more competitive than ever, helped by new low-cost technology that has produced easy-to-install sensors and modular central alarm equipment. Competition and innovation in the alarm industry have made protection more available to middle-income families — the harsh reality that crime exists everywhere, in the inner city, the suburbs, and everywhere in-between had taken hold. The new options for line signal systems as a result of the breakup of AT&T have also aided in market opportunity for independent companies.

Kaye (1987) described Westec Security, Inc., as a perfect indication of the rising fear of crime across the country in the late 1960s. This company had its origins as Westinghouse Security Systems, Inc., a subsidiary of Westinghouse Electric, and was formed in 1968 to design and market security systems for the home. Westinghouse had purchased a small Minneapolis, Minn., company which had developed some innovative concepts for residential security, including: the first alarm activation talk-in device; the first prestigious sophisticated home demonstrator; and the novel sales concept (for the alarm industry) of out-right sale of the product and the system. In 1979, Westinghouse decided to concentrate on other areas and discontinue marketing consumer products. As the largest and most successful dealer of Westinghouse security systems, Westec purchased the security division from Westinghouse. This was a period of rapid growth throughout the industry. By November 1982, Westec was acquired by Secom Ltd., the largest security company in Japan. Westec's manufacturing operations were moved to Orange County, Calif., and it became not only the largest manufacturer of home security systems, but also one of the largest companies to have direct sales and installation experience.

Total North American security industry revenues from the commercial, industrial, and integrated systems market segments were approximately \$4 billion in 1986. In 1988, about \$500 million was spent on residential security services; the major revenues derived from commercial, industrial, and institutional services. Over 13,000 companies provide electronic security services. Only 11 percent of these have annual revenues of more than \$1 million, while 49 percent have

revenues under \$100,000. The trend strongly favors a pattern of consolidation by larger companies, but where well-managed regional organizations would be able to thrive by emphasizing superior service (McCrie, 1988). The proportion of homes with alarm systems increased from 1 percent in 1975 to 10 percent in 1985 (Gest, 1995), with no signs that the trend has abated in the years since.

4. After the 1990s

By the mid-1990s, the burglar alarm industry remained a dynamic component of the security industry. For most of the past century, reliable alarm systems necessitated a costly installation of sensors for the perimeter (doors and windows) and the space inside (volumetric detectors), often requiring the supervision of a licensed electrician. These requirements limited alarm services to industrial and large commercial and retail applications, and it excluded most residential installations. However, since the advent of radio frequency-communicating sensors, cheaper telephonic communications and modular central monitoring stations, residential, smaller commercial and retail alarm installations have proliferated (McCrie, 1997).

According to *The Hallcrest Report II*, the industry generated about \$4.5 billion in revenues in 1990 and was predicted to grow at a 12 percent compound rate to \$14 billion by 2000. About 100 alarm companies provide UL-certificated services, while an additional 12,600 companies in 1990 provided uncertified and less costly alarm services (Cunningham et al., 1990).

As pointed out previously, competition and innovation in the industry have made residential security more affordable. There used to be the notion that residential security was available only for the very rich, but in recent decades,

technological innovations have increased the availability of home security systems.

Although the basic concept remains the same—a sensor of some type detects an emergency and signals for assistance—today's equipment is more reliable because of the new electronic technology. Computers, printed circuits, digital communicators, and microprocessors have refined monitoring and signaling technology, and modern electronic sensors now include ultrasonic, infrared and microwave devices which were formerly available only in more sophisticated commercial and industrial applications. Indeed, the systems available today can be personalized to offer maximum protection wherever they are installed. In addition, such variables as the size, construction and accessibility of the home; lifestyle patterns; presence of children and pets; domestic duties; and contents value are all weighted in the tailoring of a workable residential system. Today's systems come complete with many devices to provide protection in the home. They offer multiple levels of home security, depending upon the needs of the client. Systems can even be provided for everything from a single condominium with only two entrances to an entire gated community where thousands of sensors are independently supervised by an on-site computerized central station (Kaye, 1987).

According to the report prepared by the Security Sales & Integration (2004), 25 percent of the U.S. households in 2003 installed electronic home security systems. Although the penetration rate of security systems in homes has slowed from the boom of the 1990s, it continues to move upward. One in four homeowners had a security system, while about one in five of those were monitored by a central station.

The revenue of the electronic security market² in 2003 was \$20.3 billion and was estimated to be \$21.9 billion in 2004. These revenues have increased nearly 44 percent in the past 10 years. The entire electronic security industry, along with fencing, lighting, guard services, armored transport, and patrol generates an estimated \$100 billion annually. In 2004, residential installation accounted for 32 percent of new alarm systems, while commercial installation accounted for 50 percent and large industrial installation (e.g., government, utilities, airports, stadiums) for 18 percent. Among different types of business for electronic security revenues in 2004, burglar alarm systems were industry's No. 1 source of revenue (24 percent), followed by CCTV (22 percent), access control (14 percent), fire alarm system (12 percent), and others³ (28 percent).

Those figures are more promising according the Security Annual 2006 by the report of Lehman Brothers (2006). Its projected market for the alarm security industry was about a \$30 billion annually, growing at a compound annual rate of 7-8 percent. Several factors contribute industry growth, such as heightened security awareness due to terrorist activities and threats, new technologies driven consumer adoption and product innovation, increase in dual-income households or two-career families, improvement in capital spending dynamics for business, and requirements by insurance underwriters that many commercial enterprise have monitored alarm systems.

²⁾ Security items included are access control, burglary, CCTV, fire, and systems integration.

³⁾ Others include monitoring services, structured wiring, intercoms/telephones, home controls, and outdoor detection.

III. Other Security Developments

McCrie (1997) explained that the security industry also includes separate categories of companies that design, manufacture, distribute, and sell a wide variety of products, components, and systems. Examples of such categories are locks, safes and vaults, access control, communication and identification, and other services.

Safety locks invented in the eighteenth century were enhanced through the ninth century in Europe, but the American lock industry, centered initially in Connecticut, made numerous other advances in mechanical locking. Electronic locks were only integrated into access-control systems in recent decades. The locking industry and locksmiths are often classified in the hardware industry; however, they may also be considered part of the security industry. According to *The Hallcrest Report II*, almost 70,000 people were employed as locksmiths in 1990, with industry reaching revenues about \$2.9 billion (Cunningham et al., 1990).

The creation of locked chests, safes (four-sided secured containers), and vaults (secured chambers capable of being walked into) is centuries old. In the United States, the industry traces its origins to businesses like Diebold (founded in 1858), the Mosler Company (begun in 1867), and Lefebure (started in 1892). In 1995, 23 companies based in the United States possessed Underwriters Laboratories' (UL) certification for burglary-resistive safes and another 12 based abroad sought UL certification and marketing opportunities in the United States (McCrie, 1997).

The security industry in the United States has been energized by rapid increases in a wide variety of electronic products and systems, and aided by the

advent of the personal computer, innovative software, semi-conductor technology, and advances in radio frequency and microwave communication. The newest technology – access control with its ramifications – is the one that is reshaping the security industry in the United States. For 1990, *The Hallcrest Report II* identified annual revenues among equipment sales providers of \$11.7 billion with an average anticipated growth rate for the decade 1980 to 1990 of 15 percent (Cunningham et al., 1990).

In addition, a broad variety of specialist security consulting services have evolved over the years. *The Hallcrest Report II* estimated that 800 security consultants and engineers were active in 1990, operating in a myriad of specialties. The consultants are available for private, public and institutional clientele to help resolve a wide variety of problems (Cunningham et al., 1990). In some of these categories, security is one market segment among many, particularly in newer technological industries. All have earlier historical antecedents.

IV. Chapter Conclusion

A brief history of the development of private security industries, including the alarm security industry in the United States was discussed. Private security organizations have a long tradition of filling perceived gaps in government-initiated policing services. Inherited from English tradition, the public police have played a critical role to provide crime prevention and security services in the society. At the same time, the private security industry has undertaken a significant range of functions and services and become large in numerical terms than the public police.

The alarm industry among several distinctive security developments (e.g., armored-carrier, security-hardware businesses, and security guard services) has grown steadily at compound rates for the last several decades. Competition and innovation in the alarm industry and low-cost technology that have produced easy-to-install sensors and alarm equipment have made residential burglar alarms more available and affordable since the nation's first bank alarm was used in Plymouth, Mass., in the middle of eighteenth century.

In the following chapter, relevant theories (e.g., routine activities theory, rational choice theory, and situational crime prevention approach) for this study will be discussed. A burglar alarm in residential area is an example of target-hardening technique by substituting for the absence of capable guardians against residential burglaries and/or the existence of inadequate surveillance in order to prevent residential burglaries from a rationally calculated and motivated burglar.

Then, several prior studies of residential burglary conducted since the 1970s will be presented according to the data source, research design, and study finding. In spite of a substantial body of research projects to study the problem of burglary, few studies have examined the effectiveness of home burglar alarms or their impact on residential burglary.

CHAPTER 3. THEORETICAL FRAMEWORK AND PRIOR STUDIES

I. Theoretical Framework for the Study

In order to discuss and evaluate any crime prevention programs, it is critical to consider the theoretical background through which crime manifests itself. One shortcoming of previous empirical studies on the effectiveness of the home burglar system on residential burglary is a lack of theoretical discussion. Burglary does not occur randomly across space and time; both burglary opportunities and offenders availability interact. In the chapter that follows, the generic theoretical framework for this project, including the factors believed to influence the occurrences of crimes and the effective preventive approach against residential burglary will be discussed.

Garland (2001) argues that one of the most significant developments of the last two decades in criminology has been the emergence of a new style of criminological thinking. He terms this as the new criminologies of everyday life. He contrasts new criminological approaches with the earlier criminologies:

- ① The new criminological approaches begin from the premise that crime is a *normal, commonplace* aspect of modern society and that it is regarded as a routinely produced form of behavior by the normal patterns of social and economic life in contemporary society, while the earlier criminologies begin from the premise that crime is a deviation from normal civilized conduct and is explicable in terms of individual pathology or faulty socialization.
- ② The new approaches see crime as *continuous* with normal social interaction and explicable by reference to *standard* motivational patterns. Crime

comes to be viewed as a routine risk to be calculated or an accident to be avoided, rather than a moral aberration that needs to be explained.

- ③ While the old approach has viewed crime *retrospectively* and *individually* for the purpose of itemizing individual wrongdoing and allocating punishment or treatment, the new approaches tend to view crime *prospectively* and *aggregatively* in order to calculate risks and shape preventative measures.
- ④ The old criminologies view the problem of crime from the perspective of the criminal justice system, insisting on seeing crime as a problem of individual offenders, but the new criminologies reject this institutional point of view, approaching crime in a social and economic perspective that owes nothing to the process of law enforcement.
- ⑤ Many of the practical prescriptions for the old criminologies are addressed to state agencies such as the police, the courts, and the prisons, but for the new approaches addressed beyond the state apparatus, to the organizations, institutions, and individuals of society.
- ⑥ Where the older criminology concerns itself with disciplining delinquent individuals or punishing legal subjects, the new approach identifies recurring criminal opportunities and seeks to govern them by developing situational controls. Criminogenic situations, hot products, and hotspots are the new objects of control.

Thus, these new criminological approaches have succeeded in attracting the interest of government officials and have functioned as a crucial support for much

recent crime prevention policies. It has become one of the key strands of official criminology, shaping government policies and organizational practices in many areas around the world, including the U.S., U.K., Canada, Australia, New Zealand, Scandinavia, Western Europe, and Asia.

These new criminologies of everyday life are a set of kindred theoretical frameworks that include routine activities theory (Cohen and Felson, 1979), rational choice theory (Cornish and Clarke, 1986), crime as opportunity (Felson and Clarke, 1998), and situational crime prevention (Clarke, 1997). In particular, the theoretical background for studying burglary and the offender's perspective has been built upon well-established theories: *Routine activities theory* and *rational choice theory*. These theories have become the basis of the development of prevention approach known as situational crime prevention, which is employed in examining the impact of the home burglar alarm system on residential burglary. Situational crime prevention is the action-oriented outgrowth of rational choice and routine activities theories. Rational choice theory (Cornish and Clarke, 1986) takes the neo-classical position that the decision to commit a specific crime results from a rational calculation of the perceived costs and benefits of doing so in a specific context. Routine activity theory (Cohen and Felson, 1979) complements rational choice theory by specifying the factors necessary for crime to occur.

1. Routine Activities Theory

Crawford (1998) argues that crime prevention strategies need to be based on wide-ranging theories. These theories need to address the causes of crime as well as the

interactions between key actors in certain situations over time. "Routine Activities" theory offers one such model.

In an influential paper, Cohen and Feslon (1979) suggest that changes in Americans' routine activities were responsible for increases in crime rates in the U.S. from 1947 to 1974. They note that the number of Americans who routinely left their homes on a daily basis to go to the workplace increased significantly during these years. As a consequence, guardianship over homes decreased, leaving opportunities for offenders to commit crimes. For example, they explain the escalating residential burglary rate in the U.S. after the 1960s by referring to the increasing proportion of empty homes in the day and the increasing availability of valuable, lightweight portable electronic goods. The proliferation of empty homes was caused in part by the greater number of single-person households and the expanded participation of women in the workplace. In addition, more people in the workplace increased the number of potential victims and targets, and the opportunities for robbery, rape, and vehicular crime.

In order to explain such an escalation of crime rates, they present their *routine activities theory*, which states that for crimes to occur, the following must converge in space and time:

- ① The presence of a motivated offender;
- ② The absence of capable guardians against crime or the existence of inadequate surveillance; and
- ③ The presence of suitable targets (the opportunity to commit crime).

In short, this theory identifies elements and audiences in specific strategies which can be adapted to specific types of crime in different places. Capable guardians are not restricted to police officers or security guards, but rather anybody whose presence or proximity would discourage a crime from happening. They may include housewives, neighbors, and employees who by being present at a given place and time serve as guardians against crime. Guardianship is often inadvertent, yet still has a powerful impact against crime. Most importantly, when guardians are absent, a target is especially subject to the risk of criminal attack (Felson and Clarke, 1998).

Later, Felson (1995) updated the notions of “guardians,” who can discourage crime from occurring at specific times and places even by their simple presence. Originally the routine activity approach took offender as given, but later work took into account informal social control of offenders. This was accomplished by linking the routine activity approach to Hirschi’s (1969) control theory. Thus, Felson (1995) identifies three types of guardians or supervisors which include:

- ① A guardian who keeps watch over potential crime targets;
- ② A handler who supervises potential offenders; and
- ③ A place manager who monitors or controls places.

The category of handlers who supervise potential offenders is based on informal social control. This mechanism requires both attaching handlers to youths and organizing community life so that such handles can be grasped. Handlers include parents who develop an emotional attachment with their children. The parents become an intimate handler whose proximity to and knowledge of the

child's behavior becomes instrumental for informal social control. Just as a guardian supervises the suitable target, a handler supervises the likely offender. In both cases, direct physical contact serves to discourage crime from occurring. Thus, social control requires keeping suitable targets near capable guardians and likely offenders near intimate handlers.

The third category of a place manager who monitors or controls places is based on Eck's study (1994) of the spatial structure of illegal drug markets. Important roles in discouraging crime go to those who control or monitor places. The examples of place managers include homeowners, doormen, concierges, building managers, janitors, resident-owners, facility managers, close neighbors, receptionists, private security officers, bus drivers, and restaurant managers – each of these can serve to discourage crime by looking after particular places.

Integrating Eck's work, three objects of supervision can be possible: the suitable target of crime, the likely offender, and the amenable place for the crime to occur. Thus, crime opportunity is least when target are directly supervised by guardians; offenders, by handlers; and places, by managers. These various actors can directly discourage an offender by proximity to targets, places, or the offenders themselves. In addition, such discouragement may depend upon social ties with targets, offenders, or places, respectively (Felson, 1995).

But the guardians are not necessarily individuals, such as the "guardians," "handlers," or "managers" discussed above. The principal responsibility of those guardians is to monitor or control certain territories and areas (e.g., high-rising apartment complexes, commercial areas, business districts, and residential areas).

Electronic devices, such as CCTV and fire and burglar alarm systems can be used effectively as alternatives to guardians.

In addition, it should be noted that in the theory, the term *target* is preferred over victim, who might be completely absent from the scene of the crime. Targets of crime can be a person or an object, whose position in space or time puts it at more or less risk of criminal attack. For example, Felson and Clarke (1998) explain the four main elements which influence a target's risk of criminal attack, summed up by the acronym VIVA: values, inertia, visibility, and access. According to their explanation, all four of these are considered from an offender's viewpoint. Offenders would only be interested in targets which they *value*. For instance, the latest popular CD hit could be stolen more from record stores than a Beethoven CD of roughly equal monetary value because most offenders would like to have the former, not the latter. *Inertia* is simply the weight of the item. For instance, small electronic products are stolen more than weighty items, unless these latter are wheeled or motorized to overcome their weight. *Visibility* refers to the exposure of theft targets to offenders, as when someone flashes money in public or puts valuable goods by the window. *Access* refers to street patterns, placement of products near the door, or other features of everyday life making it easy for offenders to get to targets. Thus, for the usual predatory crime to occur, a likely offender must find a suitable target in the absence of a capable guardian. This theory implies that crime can increase without more offenders if there are more targets, or if offenders can get to target with no guardians present.

In addition, it should be noted that opportunities to commit crimes, in particular, residential burglaries, are neither uniformly nor randomly distributed across the urban environment, but are clustered into hotspots of criminal activity due to situational factors (Ratcliffe, 2002). Three components of routine activities theory are not evenly or randomly distributed over space and time, nor are all targets “suitable,” all offenders “motivated,” and all guardians “capable.” For example, as Ratcliffe (2002) argues, the supply of suitable targets is limited. In more affluent areas, homeowners may be prepared and able to spend money on alarms, locks, and more sophisticated crime prevention devices which are beyond the means of less well-off homeowners and tenants. In lower-income communities, the housing stock may be older and poorly maintained, thus offering easier entry opportunities to the offender, because residents of less affluent areas often lack resources or political influence, leaving low-income housing vulnerable to residential burglary.

The supply of motivated offenders is also limited. Studies have shown that a small number of offenders are responsible for a significant amount of crime in an area. By concentrating on known repeat offenders, crime prevention programs aimed to reduce residential burglary would have had a considerable impact on the number of motivated offenders. This may bring an initial reduction in the number of burglaries and a decrease in offenders able or willing to explore burglary opportunities in the same or other areas (Ratcliffe, 2002).

The availability of capable guardians to inhibit crime has situational and spatial dimensions. In lower-income areas, it may be necessary for every adult in

the home to work full time, leaving a property or group of houses unattended during the day. On the contrary, more affluent areas, or areas with a high proportion of pre-school children may have more people around during the middle of the day. These people can provide surveillance or a guardianship role for nearby houses.

Thus, in dynamic and ever-changing day-to-day routines, opportunities for crime vary over space and time. The presence of offenders will also vary over space and time and be influenced by a myriad of factors. According to routine activity explanation, any policies aimed at preventing and reducing crime generally do so by wielding influence over one or more of the three routine activity theory elements (Johnson and Bowers, 2003; Crawford, 1998). For example, one approach to affect change would be to improve surveillance by helping ensure that sufficient guardians are present at specific times of the day to make it more difficult for a motivated offender to target a suitable victim, perpetrate a crime, and make an escape. Another example is to reduce the vulnerability of potential victims, and hence opportunities for crime, by protecting them from motivated offenders. This can be done through the installation of new door/window locks and other physical security measures, which are effective in reducing the risk of burglary.

Routine activities theory has contributed to the growing theoretical underpinnings of situational crime prevention. The routine activity approach seeks to explain the supply of criminal opportunities. Its focus is on criminal events rather than inclinations. So, routine activities theory is a causal theory in that it links changes in routine activities to changes in crime rates.

2. Rational Choice Theory

The rational choice perspective focuses upon the offender's decision-making process (Felson and Clarke, 1998). As discussed above, the premise of traditional criminological thought is that crime is a deviation from normal civilized conduct and that it is explicable in terms of individual pathology or faulty socialization. But the new everyday criminological approach begins with the premise that crime is regarded as a generalized normal form of behavior in contemporarily modern society, routinely produced by the normal patterns of social and economic life (Garland, 2001).

Based on this rationale, rational choice regards criminal acts as calculated, utility-maximizing conduct, resulting from a straightforward process of individual choice. It sees offenders as rational opportunists or career criminals whose conduct is variously deterred by the manipulation of incentives. Offenders are no different from other individuals. Crime is very human and ordinary people do ordinary crimes. Offenders make choices about committing crimes based on anticipated opportunities and rewards. If given a choice or the right opportunity, any person may commit a crime (Felson and Clarke, 1998). Thus, the majority of criminal events are the result of a conscious decision on the part of the offender. Although these offenders may be plagued with social or psychological problems, and their decision to commit crimes may not be entirely voluntary, most offenders may choose their targets, locations, and times with a certain degree of regularity using rational choice when making their decision to commit a specific criminal act.

In short, the general premise of rational choice perspective on crimes is that offenders are decision makers and that they seek to benefit themselves by their criminal behavior. However, it is important to understand that offenders' decisions and choices might be constrained by time and space, the offender's cognitive abilities, and the availability of relevant information. Cornish and Clarke (1987) made the additional premise that the decision processes and the factors taken into account are likely to vary greatly at the different stages of decision making and among different crimes. For this reason, they further discuss the needs to be crime-specific when analyzing criminal choices and to treat decisions relating to the various stages of criminal involvement in particular crimes (e.g., initial involvement, continuation, and desistance). Decisions to offend are influenced by the characteristics of both offenses and offenders, and are the outcome of interactions between these two. The properties of those offense characteristics are type and amount of payoff, perceived risk, and skills needed. They are perceived by offenders as being salient to their goals, motives, experience, abilities, expertise, and preferences. Such properties provide a basis for selecting among alternative courses of action, and effectively structure the offender's choice. Cornish and Clarke (1987) term these characteristics of offenses which render them differentially attractive to particular individuals or sub-groups as "choice-structuring properties." The concept of choice-structuring properties is "the readiness with which the offender will be prepared to substitute one offense for another will depend upon the extent to which alternative offenses share characteristics which the offender

considers salient to his or her goals and abilities.” In short, the individual choose only from among criminal alternatives when seeking to achieve his goals.

For example, burglars are rational in their choice of a target in that they consider both the revenue generated by the burglary and the possibility and consequences of being apprehended. In their study, Rengert and Wasilchick (2000) argue that the decision to commit burglaries is a purposeful, rational decision in almost every case. After interviewing the burglars, they noted that the primary reason to decide to commit a burglary was simply to obtain money. Without describing family background, demographic characteristics, and socio-economic standing in detail, the need for money did not result from a struggle to feed and clothe a family. Many of these individuals were middle class or lower middle class, and many had employable skills. The need for money rose out of psychologically defined needs, not subsistence needs. These psychologically defined needs are things like a faster lifestyle, drugs, and gambling. These activities demand more money than these people could legitimately earn. Thus, the decision to commit burglaries is a purposeful, rational choice to satisfy their needs.

However, it should be noted that an offender’s rationality is also limited in many ways where crime prevention tactics can be developed effectively. Bennett and Wright (1984) say that the rational approach is based on the view that offenders are rational actors who freely choose to offend; it is less certain to what extent offenders’ decision-making process to offend can be called “rational.” Instead, an emphasis should be placed on the limited nature of rationality because it is assumed that offenders weigh up all the relevant factors every time an offense is

contemplated. Practically they rarely have a full picture of all the various costs and benefits of the crime (Felson and Clarke, 1998; Wright and Decker, 1994). Offenders' rationality may be constrained by the influence of moods, feelings, immediate motives, and intentions; moral judgments regarding the act in question; alcohol or drug intoxication; and the effect of others and their willingness to take risks. It can also be limited by the amount of time and effort that offenders can give to the decision to commit a crime and the quality of the information available to offenders.

Prevention, therefore, is aimed at altering the decision-making process in order to increase the risk or the effort involved in the commission of a crime, and to decrease any reward associated with it. It is also important to note that rational choice theory suggests that individuals will decide *not* to commit crimes when the risks are too high or the rewards are not adequate after an individual's rational calculation. This rationale is quite different from traditional criminological theories, which imply that criminal behavior is inevitable. Thus understanding why individuals "choose" to commit crimes in particular circumstances can lead to crime prevention (Boba, 2005).

Rational choice theory is useful for crime analysis and policing because of the importance of determining why offenders choose to commit particular crimes systematically. If offenders choose to offend based on the perceived risks and anticipated rewards of their crimes, an understanding of the offenders' perceptions of risks and rewards can help police agencies and communities to take measures that can change opportunities for crime and deter offenses.

In conclusion, what is notable about routine activity theory and rational choice theory is that they begin with the premise that crime is a usual and normal aspect of modern life. In contrast to earlier criminological approaches, crime is understood as a series of events which require no particular motivation or pathology, but rather is seen as inscribed within the routines of contemporary social existence. Collectively, these theories represent what Garland (2001) calls “the new criminologies of everyday life,” for which crime is seen as a risk to be calculated and hence avoided or managed, rather than a moral abnormality in need of explanation. In particular, rational choice theory helps advocates of situational crime prevention to shift the focus of crime control away from an individual’s disposition and toward situational opportunity.

3. Situational Crime Prevention

The development of a situational approach to crime prevention, its theoretical premise, and basis of empirical research is closely associated with the work in the late 1970s and early 1980s by the Home Office Research and Planning Unit (Crawford, 1998). During these years, doubts about the effectiveness of treatment and rehabilitation programs had led to a major reappraisal of crime prevention strategies. Out of this debate emerged situational crime prevention, which involves the use of situational measures aimed to alter the environment in which crimes typically occur (Bennett and Wright, 1984). The introduction of the method indicates a radical shift in thinking about the nature of criminal behavior.

As discussed earlier, one of the underlying assumptions of traditional criminological approaches is that criminal behavior is caused by inherited or

acquired characteristics which predispose a person to commit a crime. Situational crime prevention, however, does not share this premise. Instead, it is based on the view that the motivation to offend is to some degree determined by situational factors. The offender is not seen as someone compelled to commit a crime, but someone who actively chooses and decides to commit a particular crime in response to particular situations (Bennett and Wright, 1984). Situational crime prevention approaches have provided a radical shift in criminological discussion and a new theoretical framework to study crimes and offenders for crime prevention.

Crawford (1998) notes that, in criminological terms, situational crime prevention represents a shift toward:

- ① The prioritization of the *control* of crime, through practical yet limited policy-oriented measures;
- ② An emphasis on alterations to the *physical* environment;
- ③ The significance of processes of *informal* social control; and
- ④ The *offense* rather than the offender as the primary focus of attention.

According to Clarke, (1997) situational crime prevention is defined as:

opportunity-reducing measures that (1) are directed at highly specific forms of crime, (2) involve the management, design or manipulation of the immediate environment in as systematic and permanent way as possible, (3) make crime more difficult and risky, or less rewarding and excusable as judged by a wide range of offenders.

Situational crime prevention is designed to reduce criminal opportunity for criminal acts. One of the key elements of this perspective is *opportunity*, which is regarded as a cause of crime (Felson and Clarke, 1998) to explain criminal offenses

and offenders. Opportunity may include both personal opportunities to offend, such as a person's age, sex, or occupation, and situational opportunities, such as the abundance of goods in circulation, the physical security of the objects involved in crime, and the degree to which objects are under surveillance (Bennett and Wright, 1984). Felson and Clarke (1998) explain the link between crime and opportunity through ten principles⁴. They maintain that opportunity causes all crimes – violent crimes, property crimes, white-collar crimes, and “victimless” crimes, such as drug sales and prostitution. Even the occurrence of suicide has been linked to opportunity (Clarke and Mayhew, 1988). Crime opportunities are highly specific to each offense and offender subset. For example, residential burglary has different motives, risks, rewards, and techniques than commercial burglary. Even if only residential burglaries are considered, subcategories must also be considered with respect to the target type (e.g., single-family homes, apartment dwellings, and duplexes), point of entry (windows versus doors, front or rear) or even the time of day (daytime versus nighttime).

Crime opportunities are not randomly distributed but concentrated in time and space. Certain locations and times are more dangerous than others. Crime opportunities depend on everyday movements of activity. One crime produces opportunities for another. For example, once a burglar has entered a home, additional opportunities to commit crimes may develop. If the offender comes across a gun and chooses to take it, the offender has now committed armed

⁴⁾ For a detailed discussion and description of the ten principles of opportunity and crime, see Felson and Clarke (1998).

residential burglary. If the homeowner suddenly returns to the residence, the burglary is now presented with the opportunity to commit robbery, battery, or rape. The commission of burglary may also lead to other opportunities, such as dealing in stolen goods (Felson and Clarke, 1998).

Thus, situational crime prevention approaches focus on “opportunity reduction,” which attempts to combat crimes by fundamentally reducing crime opportunities for offending. Within this schema, “opportunity reduction” can take several inter-related, and sometimes overlapping forms by either (1) increasing the amount of effort a motivated offender must exert, (2) increasing the level of risk of apprehension and detection, or (3) reducing the potential rewards for committing crimes.

Situational crime prevention approaches have become a major force in policy and research since the early 1980s. It has enjoyed a period of considerable political success and influence in the U.K. (Crawford, 1998). Also many situational crime prevention techniques have been developed by the private sector rather than the government (Hughes, 1998). For example, during the last three decades, several new crime prevention theories have been developed, such as “neighborhood surveillance” (Jacobs, 1962), “crime prevention through environmental design” (CPTED) (Jeffery, 1971), “defensible space” (Newman, 1972), and “environmental criminology” (Brantingham and Brantingham, 1991).

In short, situational crime prevention aims at reducing criminal opportunities in the routines of everyday life. It encompasses a wide range of crime reduction methods. According to Cornish and Clarke (2003), five broad categories

of opportunity-reducing techniques are implicit in the rational choice assumptions of situational prevention:

- ① Increasing the offender's perceived effort to commit a crime (which makes it more difficult for the offender to commit the crime);
- ② Increasing the offender's perceived risk in committing a crime (which makes the offender "think twice" because he/she perceives a possibility of apprehension);
- ③ Reducing the offender's anticipated rewards from committing a crime (which reduces the value to the offender of the crime itself);
- ④ Reducing provocations of an anti-social response (which reduces aversive emotional arousals); and
- ⑤ Removing excuses for crime (which is intended to change social practices as a way of encouraging compliance with the law).

Each of these five categories has an additional five specific preventive techniques, which together produce twenty-five crime prevention tactics⁵. For example, the first category of techniques is made up of those that prevent crime by increasing the offender's perceived effort to commit the crime. In other words, these techniques make it more difficult for the offenders to commit the crime, thereby addressing the offender's motivation and anticipated rewards. Practical prevention techniques can be divided into four types, which include:

⁵⁾ Cornish and Clarke (2003) presents a detailed description of those five categories and twenty-five preventive techniques.

- ① Target hardening (e.g., anti-robery screens, alarm systems, and steering-wheel locks);
- ② Controlling access to facilities (e.g., parking lot barriers, reducing numbers of entrances/exits, entry phones, and installing gated barriers);
- ③ Screening exits (e.g., ticket needed for exit, export documents, and electronic merchandise tags);
- ④ Deflecting offenders (e.g., closing streets, separate bathrooms for women, bus stop placement, street closures, and tavern location); and
- ⑤ Controlling tools/weapons (e.g., “smart” guns, disabling stolen cell phones, caller-ID, and restricting spray point sales to juveniles).

These detailed, specific applications of situational crime prevention seek to provide measures that are directly related to the immediate situations of criminal events, and just as the opportunities that facilitate crime may be unique, unique preventive measures may be needed to prevent those opportunities. An alarm system can be directly and powerfully utilized as a target hardening technique to reduce an opportunity of residential burglary, as National Advisory Committee on Criminal Justice Standards and Goals (1976) puts:

The major goal of alarm systems is to prevent crime by reducing ***criminal opportunity***... Another goal is to reduce crime through apprehension of offenders. A reliable alarm system increases the likelihood of apprehension and prosecution of criminals ... alarms can also provide protection against other criminal intrusions, as well as smoke, fire, and other life- and property-threatening hazards ... alarms provide a valuable, viable means of achieving overall security. (emphasis added)

In conclusion, as Garland (2001) argues that the present-day world of private-sector crime prevention exists in a reflexive relationship to these theories (e.g., rational choice theory, routine activity theory, CPTED, and defensible space) and prescriptions of situational crime prevention, one of the most popular target-hardening techniques for preventing residential burglaries has been the installation of burglar alarms (Repetto, 1974; LeBeau and Vincent, 1998). Several studies discussed later below have supported the theoretical underpinnings of situational crime prevention methods in relation to residential burglary and alarm systems.

II. Situational Crime Prevention and Residential Burglar Alarms

There has been a substantial body of research projects to study the problem of burglary. In particular, ever since a sudden increase of crimes in the United States after the 1960s and 1970s, many government-sponsored projects have been carried out, as well as some studies sponsored by private-interest organizations. In spite of a large amount of research and evaluation studies, few studies have examined the effectiveness of home burglar alarms or their impact on residential burglary. But these studies are typically part of other larger evaluation projects. In other words, there is no independent evaluation study or experimental test to examine the deterrent effect of the burglar alarm system on residential burglary.

What follows is a brief review of several burglary studies conducted since the 1970s. Only cases examining and discussing the impact of the burglar alarm system on crime and criminal behavior will be mentioned. There are more studies about residential burglary, but not all of them cover and discuss burglar alarm systems. In

addition, a few cases focus only on commercial burglary. Thus, the studies which do not examine and discuss the deterrent impact of burglar alarm systems on crime and which focus only on commercial burglary are excluded from this review. Most of the following studies were carried out in the United States, but a few were conducted in the United Kingdom.

1. The Conklin-Bittner Study (1973)

Conklin and Bittner (1973) conducted one of the earliest studies as a response to a recent crime wave of burglary in a large residential suburb during the 1960s. One of the problems of their study was that virtually nothing was known about burglary at an intermediate level and that they had no detailed information about the experience of a community with burglary. So they took the initiative to undertake a modest study of burglary in a suburb located in a large metropolitan area in the Northeast. Their efforts were directed toward the assembly of a relatively detailed cumulative picture of crime over a significant period of time.

The study was a secondary data analysis based on the records of the local police department for the period from July 1, 1968, to June 30, 1969. They had a total of 945 burglaries, which included 602 cases from private residences, 239 from commercial establishments, 63 from schools or churches, and 41 from other targets during the one-year period.

In relation to alarm systems, Conklin and Bittner (1973) found that only 53 of the burglary incidents in the 945 sample which constituted 5.6 percent of all cases, involved buildings with alarm systems. Among the 53 alarm systems, 32 (60.4 percent) were located in private homes, while 19 (35.9 percent) were in

commercial establishments and 2 were in schools. They argued that not only were few buildings protected by alarms systems, but even those that were protected were often burglarized because the alarm failed to work at the time of the crime. In 21 cases, an alarm was present but failed to sound because: 1) it had been turned off by the offender or by the victims; 2) the offender had circumvented the alarm system; or 3) the system was not in working condition. So the chance that an alarm would be present and functional was small. In fact, only 2.9 percent of the burglaries led to an alarm being activated.

Although it was difficult to assess the usefulness of burglar alarm systems on crime without knowing how many houses had alarm systems, Conklin and Bittner (1974) noted that the proportion of burgled houses in which no loss occurred was much higher among those with a burglar alarm than among those without one (three-quarters compared with one-third). They speculated that alarms might deter offenders after the alarms have been activated.

2. The Repetto Study (1974)

Crime has traditionally been studied by focusing on the offender and his background (Garland, 2001; Bennett and Wright, 1984; Clarke, 1997; Jeffery, 1972). The situational crime prevention approach has taken a new approach by focusing the offense rather than the offender in order to explicitly consider the effectiveness of alternative prevention strategies. The study carried out by Repetto (1974) is a good example of this approach. By evaluating the physical and situational circumstances of burglary (e.g., ease of access, frequency of police patrols, availability of loot, proximity to the burglar's own residence, and social composition

of the neighborhood), he placed the residential burglary in its context to suggest how criminal motivation interacted with opportunity and situational factors to construct a particular pattern of burglary (Reppetto, 1974).

Reppetto's study (1974) was conducted in the Boston Metropolitan Area and focused on residential burglary and robbery. The study sought to identify, describe, and explain in a systematic and quantitative manner the rates and patterns of these crimes and their correlation to key variables (e.g., housing type, race, income, and crime). The two major data sources were: (1) a survey of households which included both a detailed interview with nearly 1,000 victims and nonvictims of residential robberies and burglaries; and (2) interviews with 97 convicted burglars in order to obtain detailed information on how and why particular burglars attacked particular dwellings.

The interviews with 97 adjudicated burglars produced rich ethnographic information regarding residential burglary. In relation to target selection for offenses, single-family houses were selected more often than housing projects due to the apparent affluence of those homes was the prime factor in their choice of targets. About three-quarters of the interviewees indicated that they engaged in some kind of planning, and all of the groups were primarily concerned with whether or not the dwelling was occupied because they preferred to target unoccupied residences. One-third wanted to know whether a burglar alarm system was in use. One-half of the interviewees indicated their unwillingness to travel more than one hour from their homes to make a hit. Interviewees estimated the entry time required five minutes for a door and three minutes for a window, and they indicated

that they would not spend more than ten minutes on a door and five minutes on a window (Repetto, 1974).

In terms of burglar alarms, no evaluation could be made of their effectiveness as a detection measure because very few of the households surveyed possessed them. However, the information obtained from the offender interviews gave some insights so that a tentative assessment of the effectiveness of burglar alarm systems could be made. Repetto (1974) reported that approximately one-fifth of the burglars he interviewed said that they would advise householders to use a burglar alarm as a means of preventing burglary.

3. The Bennett-Wright Study (1984)

The dominant method of crime control was treatment and rehabilitation until the late 1960s and early 1970s, but several studies in the 1970s showed that rehabilitation was ineffective in the control of crime. Doubts about the effectiveness of treatment led to a major reappraisal of current crime prevention strategies. Situational crime prevention which aims to alter the environment in which crimes typically occur has emerged from this debate. A study conducted by Bennett and Wright (1984) applied this new crime prevention theory to residential burglary by focusing on the offenders' perspective into their perceptions and decision-making process.

In order to examine burglars' perceptions and decision-making process, Bennett and Wright (1984) employed a semi-structured interview. Interviews usually lasted two to four hours. In total, 309 offenders were selected from a number of prisons files; 128 participated in the semi-structured interview, 51 were

given a structured interview, and 130 took part in one of three experimental methods. In addition, they used a videotaping method, which was designed to discover which situational cues burglars used in their assessment of potential targets. A videorecording was made of 36 dwellings, comprising eight blocks of three or four houses and one block of three flats. The recoding was filmed from a van traveling along the road at a walking pace. The videotape was shown individually to 40 offenders currently serving sentences in prison for burglary of a dwelling. The researchers also took three photographs of different aspects of five houses⁶ in order to examine the influence of particular situational cues on offenders' choice of targets.

One of the objectives of burglar alarms is to increase the potential offender's perceived risk of detection and apprehension. In relation to burglar alarms, the assumption is that the offender would believe the presence of an alarm increases the risk of detection to an unacceptable level. In the photograph visualization experiment, the first three of the five situational factors (alarm, occupancy, cover, locks, and neighbors) had a substantial influence on the number of offenders deciding that the house was suitable for burglary. The most influential factor was the presence or absence of an alarm, which had a statistically significant effect on the number of offenders finding the house suitable ($p < .001$) (Bennett and Wright, 1984).

⁶) The different aspects of five houses are: a full shot from the front, a close-up shot of the front door, and a close-up shot of a ground floor window. Both of the close-up shots revealed details of locks and any other security devices fitted (Bennett and Wright, 1984).

Furthermore, during the semi-structured interview, the incarcerated burglars were questioned about their perceptions of a variety of situational factors and the influence that these had on their choice of targets. The most frequently mentioned factor was again the presence of a burglar alarm. Just less than three-quarters of the offenders said that an alarm would have deterred them during their last period of offending (Bennett and Wright, 1984). Overall, the study showed that the alarm system is an important deterrent.

4. The Rengert-Wasilchick Study (1985; 2000)

Rengert and Wasilchick (1985) interviewed 35 convicted burglars from the Delaware County Prison over the course of several months. The researchers questioned the offenders about burglaries they committed, their method of target selection, and their personal knowledge of the area and the area's potential as a burglary site.

Their study, however, mainly focused on the use of time and space in burglary and the techniques of burglary. Rengert and Wasilchick (1985, 20-21) analyzed time blocks by residential burglars and directions and familiarity of targeted spaces. In spite of the detailed information and insights regarding residential burglary in suburban areas, they did not touch on the impact of alarm systems on residential burglary.

In the second edition of their book, Rengert and Wasilchick (2000) included the results of a survey to residents in Greenwich, Connecticut, a suburb of New York City. The purpose of the survey was to reveal which houses burglars had chosen and to contrast them with houses that had never been burglarized while occupied

by the current residents. While their first study in Delaware County, Pennsylvania, focused on which communities attracted burglars by analyzing the time and space in residential burglary from the offenders' perspective, the second study in Greenwich, Connecticut, centered on which homes within a suburban community were chosen by residential burglars.

The data for analyses of the second part of the study were taken from a survey mailed to the 22,192 households in Greenwich. This method resulted in 3,014 questionnaires returned (14 percent). The most effective security precaution was an alarm system, with other precautions (e.g., dead bolt locks, dog, exterior lights, pins in window frames, and bars in windows) being significantly less effective. Another interesting finding was that those households taking precautions other than burglar alarms were more likely to be burglarized than the average household in the entire survey (Rengert and Wasilchick, 2000).

5. The Hakim-Buck Study (1991)

The installation of a burglar alarm system at a private residence indicates that the house is under the control and protection of a central monitoring system, but an alarm system does not necessarily protect the house from burglary or other criminal activities. It may or may not serve as a crime deterrent. The Hakim-Buck study (1991), which was supported by the Alarm Industry Research & Educational Foundation (AIREF), aimed to analyze whether this assumption rests on factual grounds. What makes this study unique is that it mainly focuses on the relationship between burglar alarm systems and residential burglary by examining homeowners'

motives for buying alarms, their experience and satisfaction with them, and the false alarm problem (Hakim and Buck, 1991).

For this project, three suburban communities in three different counties of Philadelphia's metropolitan area (Upper Merion Township in Montgomery County, Tredyffrin Township in Chester County, and Springfield Township in Delaware County) were analyzed in detail using data covering a two-and-a-half-year period. The research methods for this study were comprised of mailing questionnaires to burglary victims, alarm owners, and members of control groups, who were neither victims of burglary nor owners of an alarm. A total of 1,149 (766 in residential area and 387 in commercial area) of 2,730 mailed surveys were returned. Both residential and commercial establishments were surveyed. They matched the data they obtained via the survey with data from the associated police departments and municipal governments (Hakim and Buck, 1991).

Hakim and Buck (1991) calculated the probabilities of burglary of properties that had alarms, and of those that did not have alarm systems. The probability that a property protected by an alarm was a victim of burglary was considered to be the ratio of the number of properties which were burgled and alarmed to the number of alarmed properties in the community. Also the probability that the properties that remained unprotected by an alarm became a victim of burglary was the ratio of the number of burgled properties which did not have an alarm to the number of non-alarm-installed properties. The ratio of the two probabilities showed the degree to which non-alarm-installed residences were less/more at risk of burglary. They reported that the chance that a residence which was not protected by an alarm was

burgled was 2.71 greater than that of alarm-installed properties. The highest deterrent effect of alarm ownership was 2.94, occurring in Tredyffrin. The risk factor was down to 2.83 in Upper Merion, while Springfield obtained the lowest value of 2.26. The chance that a non-alarm-installed property would be burgled was at least 2.26 greater for the lowest-valued suburban homes, and became 3.117 greater for the homes with market value greater than \$100,000. Hakim and Buck (1991) concluded that alarm systems did deter intruders. The more expensive the home was, the more effective alarm systems were in deterring intrusion.

6. The Cromwell-Olson-Avary Study (1991)

The study conducted by Cromwell, Olson and Avary (1991) was carried out in an urban Texas metropolitan area. The primary purpose of this research concerned not only the understanding of the offenders' perceptions of the risks and rewards involved in criminal activity – particularly in residential property crime – but also how residential burglars selected targets, how the presence of co-offenders influenced decision-making processes, and what role drugs played in target selection and the risk-gain calculus employed by burglars.

Thirty active burglars comprised of 27 males and 3 females were recruited as research subjects, using a snowball sampling procedure. Three subjects were recruited initially by referral from local criminal justice agencies. For data collection, the researchers selected "staged activity analysis" as an alternative

strategy to ethnographic designs⁷. According to this “staged activity analysis” method, the subjects were asked to reconstruct and simulate their past burglaries as clearly as possible in the same manner in which they were originally committed. The researcher observed, questioned, and recorded the events and answers. This method consisted of extensive interviews and “ride alongs,” during which the subjects were asked to discuss and evaluate residential sites they had previously burglarized (Cromwell et al., 1991).⁸

In relation to the impact of burglar alarm systems, in general, burglars agreed that alarms were a definite deterrent to their activities. Other factors being equal, they preferred to identify a target which did not have an alarm rather than to take the additional risk involved in attempting to burglarize a house with an alarm system. More than 90 percent of the interviewees said that they would not choose a target with an alarm system. Furthermore, about 75 percent of the study subjects mentioned that they were deterred by a sign or window sticker which stated that the house was protected by an alarm system (Cromwell et al., 1991).

Based on these findings, Cromwell et al. (1991) argued that a burglar was more likely to respond to crime prevention strategies at the neighborhood, block, or individual residence level than to those at the community, state, or national level. For example, crime prevention programs at the community level (e.g., increased

⁷) There are two generally accepted methods for data collection within an ethnographic design: (1) direct participant observation and (2) the ethnographic interview (Cromwell et al., 1991).

⁸) For the detailed methodological discussion of the staged activity analysis, see Cromwell et al. (1991).

levels of prosecution) or at the state level (e.g., increasing statutory penalties for burglary) were not perceived by the convicted interviewees as being as effective as micro-level programs initiated by the residents of a potential target sites (e.g., buying a dog or installing an alarm system). The major reason for these results was that offenders were more concerned with the possibility of immediate detection and with immediate rewards.

7. The Wright-Decker Study (1994)

A study conducted by Wright and Decker (1994) focuses on the offender's perspective on the process of committing residential burglaries to understand how criminals make decisions in relation to (1) the threat of apprehension and official penalties, and (2) the alteration of situational features.

Their residential burglary study was conducted on the streets of St. Louis, Missouri. Wright and Decker (1994) were able to locate and interview 105 currently active offenders, focusing specifically on their thoughts and actions during burglaries. They employed a "snowball" sampling strategy to locate the active offenders, which began with the recruitment of an initial subject who then was asked to refer further participants. They avoided seeking referrals from criminal justice officials. The interviews were semi-structured and conducted in an informal manner, which allowed the offenders to speak freely using their own words. Interviews usually lasted between one-and-a-half and three hours. The questions asked to the offenders were: motivation, target selection, gaining entry to the dwelling, searching for valuables, and disposing of the goods.

In regards to the process of choosing a criminal target, the offenders were not willing to break into a dwelling where they perceived the odds of getting caught to be excessively high. In assessing risk, the burglars focused primarily on the issue of occupancy. They were disinclined to burglarize a residence while anyone was inside. Almost nine out of ten of the offenders interviewed said that they always avoided breaking into a residence when they knew or suspected that someone was at home (Wright and Decker, 1994).

It should also be noted that the offenders were cautious of “occupancy proxies” as substitutes for occupancy by the residents. Burglar alarms could function as such occupancy proxies, so many offenders wanted to avoid homes with alarms. Once the offenders decided to enter an intended target, they were still worried about the presence of a burglar alarm. However, alarm systems were seldom installed in residences containing little of value. Indeed, a few of the offenders reported that they regarded the devices not so much as deterrents as indicators of potential reward. Nevertheless, almost three out four of the subjects in the study were deterred by the presence of an alarm at least sometime in the course of choosing and entering a target (Wright and Decker, 1994).

8. The LeBeau-Vincent Study (1998)

The LeBeau-Vincent study (1998) focused on false alarm calls and repeat victimization of people, property, places, and situations. The purpose of the study was to numerically examine and cartographically display the relationships among burglar alarms, burglaries, repeat-address alarms, and repeat-address burglaries. Burglar alarm calls caused problems for the police because they were numerous and

usually turned out to be false. Responding to a large volume of burglar alarm calls drained police resources and essentially made the police the servant of the private security alarm industry.

This study used secondary data of alarms and burglaries from the computer-aided dispatch (CAD) files of the Charlotte, North Carolina, Police Department for 1990. The pertinent variables for mapping were the total numbers of alarm calls and burglary incidents, which included the sum of all forced and attempted burglaries. The variables were modified by ascertaining the number of calls and burglaries at the same address. The basic unit of analysis was the incident, or call, and its street-block address. In their study, it was not possible to determine the total number of commercial or residential alarms and burglaries (LeBeau and Vincent, 1998).

According to their research findings, during 1990, burglary alarm calls numbered 48,622 and constituted 12.7 percent of the total calls-for-service workload to the police department. The proportion of false alarms encountered by the police was almost 98 percent. There were 10,828 residential and commercial burglaries reported to the police. The alarm data indicated that 1.57 percent of the alarm calls accounted for 7 percent of all burglaries. Furthermore, only 117 on-scene arrests (81 for burglary) were made from alarm activation calls, while 130 on-scene arrests were made during burglaries that did not involve alarms. From these data, the authors concluded that alarms are *neither effective nor efficient* (LeBeau and Vincent, 1998).

9. The Budd Study (1999)

Budd's report (1999) was based on the results from the 1996 and 1998 sweeps of the British Crime Survey (BCS)⁹ regarding burglary against domestic dwellings. It provided rich information about burglary victimization. For example, the 1998 BSC surveyed the ownership of home security devices. The report estimated that almost half (48 percent) of all households installed either an external or internal security light which operated on a timer or sensor. Almost a quarter (24 percent) had burglar alarms installed. Since 1992, the ownership of security devices increased considerably. Between 1992 and 1998, the proportion of homes with security lights more than doubled (from 22 percent of households in 1992 to 48 percent in 1998) and the ownership of burglar alarm systems almost doubled (from 13 percent of homes in 1992 to 24 percent in 1998) (Budd, 1999, 36-37).

In relation to security devices (e.g., window locks, deadlocks, burglar alarm, security lights, or window grilles) at domestic dwellings, each of home security was strongly associated with the risk of burglary victimization. The risk of victimization increased with decreasing levels of security. Households without any of the security devices (no security) were most at risk. Those with only windows locks or

⁹) The British Crime Survey (BCS) began in 1982 and moved to an annual cycle from 2001/02, with over 50,000 interviews of people aged 16 or over now taking place per year. The latest full results are *Crime in England and Wales 2005/2006*. The first survey was carried out in England, Wales, and Scotland, but Scotland now has its own survey as has Northern Ireland. The BSC questions adults in private households about their experience of crime victimization in the previous 12 months. It covers not only crime counts but also other crime-related issues. But some types of crimes (e.g., crimes against those under the age of 16 and the homeless, victimless offences, and offences in which the victim is no longer available for interview) were not included. For the detailed information and a variety of reports of the BCS, see the Web site of the "British Crime Survey" and Budd (1999).

deadlocks reduced their risks of victimization substantially. Furthermore, those with a burglar alarm, security lights, or window grilles had even lower risks of victimization (Budd, 1999).

This report examined the effectiveness of burglar alarm systems on residential burglary, using an ex post facto comparison which might be done by comparing the security levels of non-victims with that of victims. According to the results (Budd, 1999), victims of burglary at domestic dwellings maintained lower levels of security than non-victims at the time the incident occurred. For example, 19 percent of victims of burglary with entry had a burglar alarm at the time the incident occurred compared to 24 percent of non-victims. In addition, the BCS measured the effectiveness of burglar alarm systems for households that had an alarm system installed within the last five years. The number of attempted burglaries at domestic dwellings per year after the installation of an alarm system was lower than before the alarm was installed. Budd (1999) concluded that burglar alarm systems at domestic dwellings were beneficial in reducing the risk of burglary at residential areas, although they did not completely prevent victimization.

10. The O'Shea Study (2000)

The O'Shea study (2000) sought to test the practical efficacy of home security measures. The primary data source was two telephone surveys in the jurisdiction of the Mobile County Sheriff's Office. There were two different sample groups: 326 non-victims from residential burglary and 231 victims of the crime.

There were four categories of independent variables (cohesion, confrontation, security, and surveillance) and a burglar alarm belonged to the

“surveillance” category. The dependent variable reflected the burglary victimization experience of the study subject, which included the two different sample groups. A logistic regression analysis¹⁰ was used to estimate the effects of a burglar alarm on crime. In relation to burglar alarm systems, an alarm system reduced the chances of a burglary. In other words, the odds of being burglarized were reduced when the respondent said to have a burglar alarm with the odds ratio 0.51, which had a significant difference at the .05 level (O’Shea, 2000). O’Shea (2000) concluded that the findings from the study supported earlier work that addressed some effective situational crime prevention programs, such as target hardening, property marking, and neighborhood watch program, including burglar alarm systems.

Figure 3.1 and Table 3.1 provide a concept map of effectiveness of crime prevention programs for residential burglary and a summary of prior studies conducted out previously focusing on residential burglar alarms.

III. Chapter Conclusion

The new style of criminologies of everyday life which embraces relevant theories (e.g., routine activities theory, rational choice theory, and situational crime prevention approach) is the theoretical foundation for this study. Burglary does not occur randomly across space and time. Both burglary opportunities and offender’s availability interact. Rational choice theory regards criminal acts as calculated,

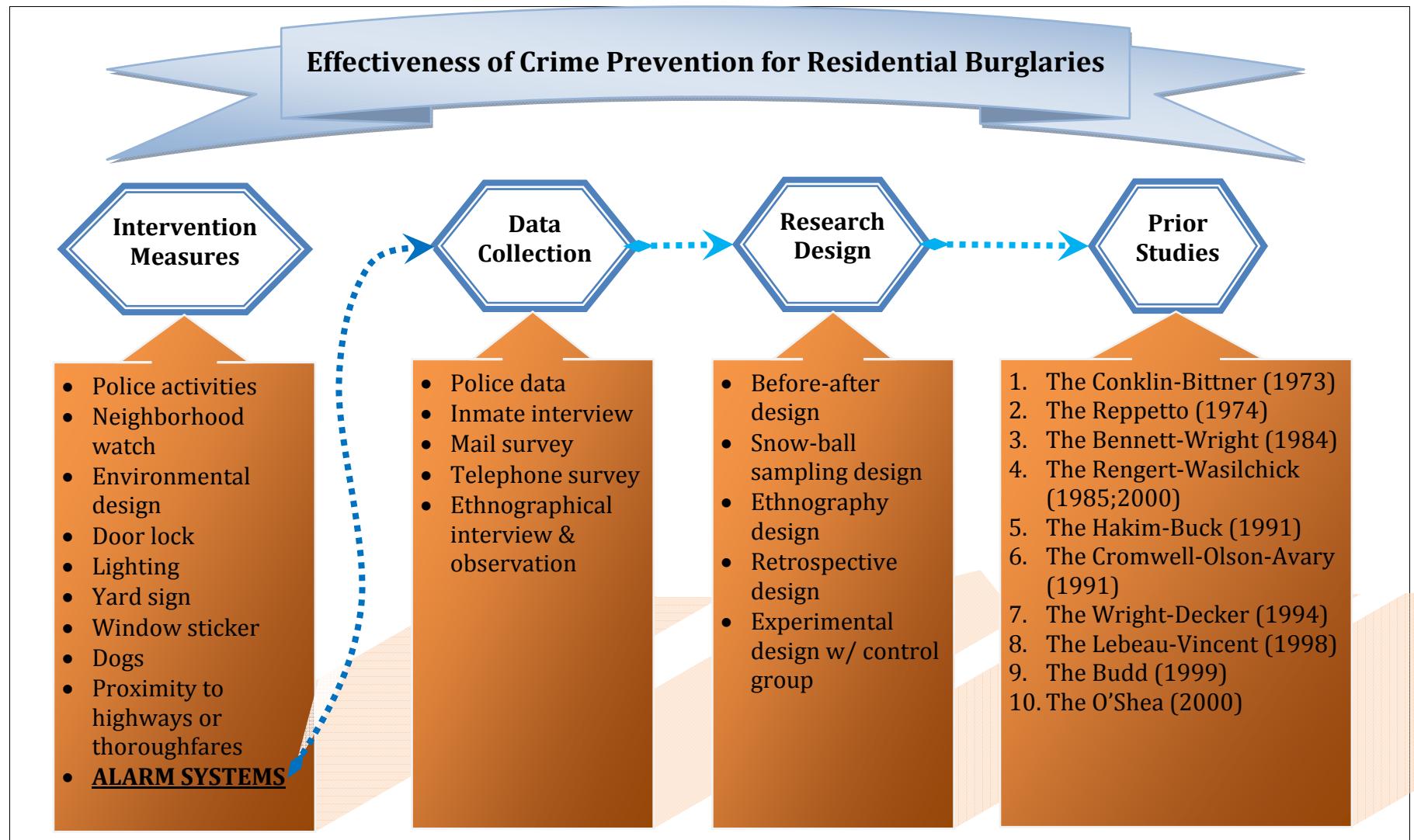
¹⁰) When dependent variables comes dichotomous, not continuous, percentages and proportions are a better way to measure variables. A logistic regression technique is employed to assess the association of relations when dependent variables comes dichotomous (Knoke, Bohrnstedt, and Mee, 2002).

utility-maximizing conduct based on a conscious decision between anticipated opportunities and rewards and probable risk to be seen and caught. Such a rational decision-making to commit a residential burglary is maximized when a motivated burglar observes the presence of suitable target for the crime after detecting the existence of inadequate surveillance or the absence of capable guardians in residential area.

A burglar alarm in residential area among available intervention security measures (e.g., door lock, lighting, yard sign, and dogs) is an example of target-hardening technique according to situational crime prevention approach. It is used to substitute for the absence of capable guardians against residential burglaries and the existence of inadequate surveillance to provide necessary protection over the property against residential burglary. Several prior studies supported the theoretical underpinnings of situational crime prevention methods in relation to residential burglary and burglar alarms.

In the following chapter, the limitations drawn from the discussion of prior burglary studies will be presented according to data source, research design, research method, and statistical analysis. Though this one study does not overcome all methodological limitations, several solutions will be sought and presented to remedy some of them. Then, given the review of relevant theories and prior studies on the effectiveness of burglar alarms on residential burglaries, six research questions and null hypotheses will be proposed.

[Figure 3.1] A concept map of the effectiveness of crime prevention for residential burglaries



[Table 3.1] Summary of Prior Studies

STUDIES	Year	Data Source			Research Design					Study Finding
		Police data	Interview	Survey	Secondary Data	Snow-ball Sampling	Inmate Interview	Ethnographic Interview	Survey Research	
Conklin-Bittner	1973	✓			✓					O
Repetto	1974		✓	✓			✓		✓	O
Bennett-Wright	1984		✓				✓			O
Rengert-Wasilchick	1985		✓				✓			O
	2000			✓					✓	O
Hakim-Buck	1991			✓					✓	O
Cromwell-Olson-Avary	1991		✓			✓		✓		O
Wright-Decker	1994		✓			✓		✓		O
LeBeau-Vincent	1998	✓			✓					X
Budd	1999			✓					✓	O
O'Shea	2000			✓					✓	O

CHAPTER 4. LIMITATIONS OF PRIOR RESEARCH AND RESEARCH QUESTIONS

I. Limitations of Prior Research

Despite rich information about burglary that previous studies have produced, and despite this information to policy, prior studies suffer from some methodological shortcomings. In particular, in most of these studies, the methods of evaluation employed meet minimal standards, follow-up is often short, and reliable control groups are generally absent (Clarke, 1995; Weisburd, 1997). These shortcomings are discussed in more detail below.

1. Data Source

(1) First, the studies aggregated all the data.

They put the data for one year, or sometimes several years, into one dataset and examined whether or not the homes with alarm systems were less victimized than the homes without alarm systems. The problem with this is that many of the homes, even in the same block or neighboring blocks, had installed home burglar alarm systems at different times. In addition, a few studies aggregated residential and commercial burglaries into one dataset. These two types of burglaries have different patterns and characteristics.

For example, on one particular block in 2004, “A” installed an alarm system in January, “B” installed a system in May, “C” installed in September, and “D” installed in November. Unfortunately, all of A, B, C, and D were burglarized in December. If we look at this data in aggregate, they would suggest that the system is not an effective deterrent. But if we look at the data only in the first half of the year,

we might say that it was effective. Even though it is the same data, it can be distorted due to the different dates of system installation. Some studies show that the system is effective (e.g., the Hakim-Buck study and the Rengert-Wasilchick study), and some studies show that it is ineffective (e.g., the LeBeau-Vincent study). Therefore, it is necessary to have separate datasets between commercial and residential burglaries and disaggregate the residential burglary dataset based on the installation date and different types of alarms by month or year.

(2) Second, the range of years which the data covered was not long enough.

A short time period may produce too few cases to run statistical tests to examine the impact of alarm systems on residential burglary. It is also not suitable to observe long-term patterns of alarm ownership changes, residential burglaries with/without burglar alarm systems, and the relationships between these changes and socio-economic factors in local areas. For example, the Conklin-Bittner study (1974) covers only a one-year period from July 1, 1968, to June 30, 1969, and has a total 53 burglary incidents which involved building with alarm systems. Among these cases, 32 cases were located in private homes, while 19 cases were in commercial establishments, and two were in schools. Thirty-two residential burglaries involving burglary alarm systems are too small for statistical analyses.

The LeBeau-Vincent study (1998) covers only 1990, which produces 762 burglary cases. Although this number is not small for analyses, the data do not distinguish residential burglary from commercial burglary. Without separating to different types of burglaries, it is not easy to argue that alarm systems on crime are

not effective. If the data are distinguished in this way, the total number of each type of crime may not be enough for statistical analyses.

In addition, when secondary data are used for analyses such as in the Conklin-Bittner study (1974) and the LeBeau-Vincent study (1998), these do not include non-reported burglary incidents. The police data do not include all crime incidents, but record only the incidents known to the police.

2. Research Design

(1) Third, lack of a control group to examine the impact of alarm systems.

As mentioned above, one of the problems of the previous studies when considering the relationship between an alarm system and residential burglary is to employ simple statistic tests. It is partly because of the nature of the data available to the researchers as discussed already and also because of the nature of study methods mostly using ethnographic interviews and surveys. The qualitative data are limited when conducting further statistical tests, such as the chi-square, correlation, and regression analyses.

Rubenstein et al. (1980) argued that there were two types of research designs which could help to study the deterrent effect of crime prevention strategies (which included “defensible space,” “CPTED,” and “situational crime prevention”): a pre-post study and an ex post facto comparison. The first method is to compare the collected data before and after the installation of the crime prevention strategy. The second type of study is to compare the houses or properties that have been victimized with ones that have not been victimized. The difference between the

target-hardening characteristics can provide some insight into the impact of various crime prevention programs on crime.

Among the reviewed studies above, no study applies the first method of the pre-post approach to examine the impact of an alarm system on residential burglary. But the Conklin-Bittner study (1973) and the Reppetto study (1974) employ the second method of ex post facto comparison on a partial scale. There is a need to study the impact of burglar alarm on residential burglary using a full-scale method with these two approaches. In addition, a quasi-experimental research¹¹ and a time-series design¹², which are experimental approaches, can be used to fully study the impact of burglar alarm systems on crime.

(2) Fourth, lack of research on the displacement and diffusion of benefits.

As discussed previously, the situational crime prevention approach seeks to alter opportunities for crime in particular contexts. But there is a side effect of this approach that crime prevention measures simply move offenders around without ever reducing criminal intent (Crawford, 1998). If crime were merely displaced to surrounding areas in space or time, then any crime prevention programs would appear to present weak or little evidence on crime. The issue of displacement has

¹¹) When randomization is not possible, a quasi-experiment is often used. One advantage of this design is to have comparison group and control group for before-and-after comparisons (Maxfield and Babbie, 2008; Pawson and Tilley, 2000).

¹²) A times-series design involves examining a series of observations on some variable over time (Maxfield and Babbie, 2008).

become a critical criticism for crime prevention programs.¹³ Thus, it is imperative to examine and discuss the displacement of crime prevention measures.

Among the studies reviewed above, few of them examined and discussed the displacement issue in relation to the effect of alarm systems on residential burglary. But they briefly discuss this issue based on anecdotal accounts from either the incarcerated offenders or the active burglars on the streets. For example, Reppetto (1974) argued that displacement, whether geographic or functional, loomed as one of the major obstacles to any strategy for the prevention of residential burglary. However, since the concerted programs for crime reduction in burglary for the most part originated in the 1970s, very little information exists.

The Bennett-Wright study (1984) discussed crime displacement based on interviews with 128 offenders imprisoned for domestic burglary, asking them what course of action they took if unable to complete a burglary. Nearly half of the respondents said that they had never experienced a situation in which they could not complete their burglaries. Of the remaining respondents, 43 percent of those who answered the question said that they usually committed another offense against another target during the same day, thereby displacing crime.

However, as Crawford (1998) discussed, there is a need to speculate that there is a diffusion of benefits from a crime prevention initiative. Displacement, which is the reverse of crime displacement, is not necessarily an undesirable

¹³) Displacement can take a number of forms, such as spatial, temporal, tactical, target, and type of crime (Cornish and Clarke, 1987; Gabor, 1990; Hakim and Rengert, 1981; Hamilton-Smith, 2002; Hesseling, 1994; Reppetto, 1976).

consequence of preventive intervention (Clarke and Weisburd, 1994). None of the reviewed studies examines or discusses the diffusion of benefit from crime reduction schemes. It seems that the term, the “diffusion of benefit,” is not discussed intensively in the crime prevention research and evaluation studies and does not have enough academic attention in crime prevention discourse. As Clarke and Weisburd (1994) argued, one possible reason for this is that the development of the forms of diffusion of benefits from the crime prevention scheme has been hampered by exaggerated concerns about displacement. It is imperative to pay some academic attention to the issue of diffusion of benefits, as well as the displacement of crime prevention schemes (Weisburd, 1997).

3. Research Method

(1) Fifth, most studies were conducted employing an ethnographic approach.

The essential program of ethnographic activity is to understand another way of life from a native point of view. Instead of collecting data about people, the researcher using the ethnographic approach seeks to learn from people directly through observation and dialogue (Spradley, 1979). Ethnographic interviews and observations have been used frequently in studying crimes and criminals, including residential burglary. To better understand the important contextual aspects of burglary, researchers have employed ethnographic interviews with active burglars on the streets or incarcerated offenders (O’Shea, 2000). Among the ten reviews above, the Reppetto (1974), the Bennett-Wright (1984), the Rengert-Wasilchick (1985), the Cromwell-Olson-Avary (1991), the Wright-Decker (1994), and the O’Shea (2000) have employed this research method. This unique approach provides

rich insight and information from the offenders' perspective about the decision-making process beginning with the motivation to commit a residential burglary, to the decision to carry out the crime, to offense planning, to target selection, to entering an intent target, and to subsequent disposal.

However, as Wright and Decker (1994) discussed, ethnographic approaches are open to criticism on several grounds. First, criminologists have long suspected that offenders do not behave naturally when they are in criminal justice settings. Except the Cromwell-Olson-Avary study (1991) and the Wright-Decker study (1994), other studies interviewed the convicted offenders in prisons, a criminal justice setting. The offenders might be exaggerating when conveying their experiences and skills to commit a residential burglary. Rengert and Wasilchick (1985) noted that they were surprised to realize that the offenders at the prison were willing to talk and discuss at length about their careers and burglary. The interviews were interesting and exciting. But they were also acutely aware of the problem of the validity. The statements and reports drawn from the convicted offenders might not be trustworthy enough. Thus, they verified the interview data with as much information as possible through police records.

Second, accounts offered by some incarcerated offenders are distorted because they are gathered in the prison environment. The credibility of their accounts may be in question because sometimes the offenders can have a problem recalling previous crime experiences. In addition, studies of incarcerated offenders are vulnerable to the charge that they are based on "unsuccessful criminals, on the supposition that successful criminals are not apprehended or at least are able to

avoid incarceration." O'Shea (2000) noted that attention should be paid to the potential for systematic difference between burglars who were caught and those who avoided detection and that an appreciation for differences between active burglars who volunteered for interviews and those who declined to do so.

(2) Sixth, research results were based on security precautions resulted in interviews and surveys.

Both police crime reports and victimization surveys can give at least some estimate of actual crime figures in local communities, though this figure does not reflect a true, precise number due to the dark figure of crime (Maxfield and Babbie, 2008). The majority of the studies on residential burglary and alarm systems are carried out by ethnographic interview and survey. As a result, the examination of the deterrent impact of burglar alarms on residential burglary relies on the reports of the interviewees and survey respondents. Thus, the findings are based on security precautions rather than the real figure of alarm ownership or permits.

For example, in both the Reppetto study (1974) and the Rengert-Wasilchick study (2000), the primary data source was a survey of households. The residents were asked whether they had a burglar alarm. In the Bennett-Wright (1984) and Rengert-Wasilchick (1985) studies, the incarcerated burglars were asked about their perceptions of security precautions on their choice of target selection. The Cromwell-Olson-Avary study (1991) and the Wright-Decker study (1994) used a snowball sampling method to recruit currently active burglars on the streets, asking them whether they might be deterred from committing a burglary by a burglar alarm.

4. Statistical Analysis

(1) Seventh, lack of statistical tests.

Several studies focusing on the relationship between alarm systems and residential burglary employed a simple comparison or a probability of being burglarized to examine the effectiveness of a burglar alarm system. For example, the conclusions drawn from the Hakim-Buck study (1991) are based on the probabilities of burglary of properties that have alarms and of those that do not have alarm, then, the ratio of the two probabilities exhibits the degree at which non-alarmed residences are less/more at risk of burglary. There are no statistical tests, except the simple comparison among three communities with the probabilistic ratios. There should be more data sources and advanced statistical analyses of the data to conclude that burglar alarm systems make a difference.

In the LeBeau-Vincent study (1998), the comparison was made between the numbers of on-scene arrests. Only 81 on-scene arrests for burglary were made from alarm activation calls, while 130 on-scene arrests were made during burglaries that did not involve alarm systems. Of course, among 81 of the on-scene arrests for burglary, there were no indications of how many cases were residential or commercial. Based on this simple comparison, the study concluded that alarms were neither effective nor efficient.

One reason for the lack of statistical tests is that many studies on residential burglary are based on ethnographic interviews with either the incarcerated offenders or active offenders on the streets. This approach is also related to the second issue discussed, the short-term coverage of the data. The ethnographic

interview may take a long time, but the time period covered is uncertain. The research findings of such an approach are primarily drawn from qualitative data, which are more anecdotal than numerical. In that case, advanced statistical tests (e.g., correlation and regression statistics), even sample tests, are not suitable. Percentages, proportions, and ratios would be the only available techniques.

(2) Eighth, the studies did not use an alarm ownership as a denominator.

The dichotomous analyses (e.g., percentage and proportion) require an appropriate denominator. But several studies which use percentages and proportions to examine the deterrent impact of a burglar alarm do not have the proper denominator. For example, Hakim and Buck (1991) did some adjustments of their raw data for the calculation of the probabilities for two different groups: the properties that had alarm systems and the properties that did not have the systems. The raw data were drawn from the number of alarm activations per system per year, including the number of false alarm activations. If the researchers relied solely on alarm activations identified by the police in order to count the ownership of burglar alarm systems, it would take them a long time to figure out the total number of alarms in the community. Thus, in order to improve the estimated alarm ownership, the researchers adjusted the number of alarms which were reported by local police departments by adding the number of alarm systems which surveyed residences reported having. This adjustment gives a better estimate of alarm ownership than the raw data with the number of alarm systems reported to the police. The primary reason for such an adjustment is that they did not have a real number for alarm ownership at the three research sites. But this corrected number still does not

accurately reflect alarm ownership. If there were at least a real number of alarm permits or ownership, the researchers would have a better estimation. As a consequence, any examination or test based on this estimated number may not reflect the true characteristic of the relationship between alarm systems and residential burglary.

In both the Conklin-Bittner study (1974) and the LeBeau-Vincent study (1998), the true number of alarm systems or even any close estimation of the burglar alarm ownership does not exist. Without knowing how many houses have alarm systems, it is almost impossible to conclude whether the burglar alarm system may actually deter or detect burglars.

II. Solutions to Methodological Issues

The current study is based on secondary data analyses, not on experimental approaches or from ethnographic interviews or observations. Thus, this one study does not deal with all methodological problems discussed in the previous chapter, but it does resolve several issues.

First, this study uses aggregated and disaggregated data for the analyses. Two separate approaches will be employed to examine the impact of burglar alarm systems on residential burglaries: macro-level and micro-level. Aggregated data will be used for the macro-level approach, and disaggregated data for the micro-level approach.

Second, the data collected from the police department cover a five-year range from 2001 to 2005. This range of data can be used not only for more statistical

tests, but also for the time-series analysis, which examines long-term patterned changes in alarm ownership, residential burglaries with/without alarm systems, and the relationship between these changes and socio-economic variables.

Third, both aggregated and disaggregated data and a five-year range of data can enable more numerically advanced statistical tests (e.g., binary/multiple correlations and bivariate/multiple regression analyses). In addition, using these data, crime mapping analyses, and spatial statistical analyses can be used to examine the impact of burglar alarms on residential burglary.

Fourth, the record of residential burglar alarm permits in Newark, N.J. is available for this study. Thus, alarm ownership will be used as the denominator when determining the rates of residential burglaries with burglar alarms. These rates are compared with rates of residential burglaries without alarm systems to examine the impact of the burglar alarm on crime.

Fifth, a non-equivalent quasi-experimental design using buffer and control zones is devised to examine the spatial displacement and diffusion of benefits. This study is not an experimental approach that has experimental and control groups to examine the effect size. The experimental research design is inappropriate when undertaking secondary data analysis. However, as discussed later, in this study, a research design similar to the experimental approach can be devised by using a buffering method and, thus, be used to examine the impact of burglar alarms on residential burglaries. In particular, this research design will be employed to investigate separately the displacement and diffusion of benefits of the alarm system on residential burglary.

III. Research Questions and Null Hypotheses

Given the previous review of the literature and prior studies on the effectiveness of residential burglar alarms on crime reduction, a discussion of relevant theories, and an overview of the rationale, the discussion of the impact of burglar alarm systems can be broken down into the following: (1) the overall relationship between burglar alarm systems and residential burglaries over the multiple years; (2) the correlated and regressed relationships between burglar alarms and residential burglaries according to demographic, socio-economic, and housing character indicators; (3) the overall spatial relationship between burglar alarms and residential burglaries; (4) the spatial autocorrelation and clustering analyses for burglar alarms and residential burglaries; and (5) the spatial displacement/diffusion of benefits of burglar alarms on residential burglaries. Thus, the research questions and testing hypotheses to be addressed in this study include:

Research Question 1: To what extent do home burglar alarms affect residential burglaries? Do alarm systems reduce the actual number of burglaries after their installation? What is the overall relationship between burglar alarms and residential burglaries? What is the relationship between the changes in burglar alarm installations and non-alarm-installed (NAI) residential burglaries?

Null Hypothesis 1: There is no significant relationship between the increase of burglar alarm installations and the decrease of residential burglary incidents.

This can be answered by comparing two different crime datasets; that is, alarm-installed (AI) residential burglary data and NAI burglary data. These data are drawn from police incident reports (PIRs) database in the police department. In order to find the rates of the two different conditioned residential burglaries, the two data are divided by the total number of alarm permits and the total number of households in Newark, N.J. The residential alarm permits data have been obtained from the Newark City Hall. The information on households has been retrieved from the U.S. Census data. The chi-square and changed rate and percentage statistics are used to answer the questions.

Research Question 2: To what extent do burglar alarm systems correlate to residential burglaries? Are there any significant correlations between burglar alarms and residential burglaries? To what extend do residential burglaries correlate to burglar alarms based on independent variables? Are there any significant correlations between residential burglaries and burglar alarms?

Null Hypothesis 2: There are no significantly correlated relationships between the increase of burglar alarms in use and the decrease of residential burglary incidents.

The police data show that since 2001 in Newark, N.J., the total number of incidents of residential burglaries without burglar alarms has decreased, whereas the total number of residential burglar alarm permits has increased. Gradual increases of residential burglar alarm systems may or may not affect slow decreases

of residential burglaries. The relationship between these two observations may be inverse, direct, or none. It may explain the impact of burglar alarms on residential burglaries. Bi- and multivariate correlation statistics need to answer the questions.

Research Question 3: To what extent do burglar alarms regress with residential burglaries and other relevant variables? Which indicator has a significant relationship to the increase of burglar alarm installations? To what extent do residential burglaries regress with burglar alarms and other variables? Which variable has a significant relationship to the decrease of residential burglaries over the years? What is a regressed relationship between burglar alarms and residential burglaries?

Null Hypothesis 3: There are no significantly regressed relationships between burglar alarms and residential burglaries and between them and other relevant variables.

Supposed the reverse relationship exists between the increase of residential burglar alarm installations and the decrease of NAI burglaries. In other words, the more burglar alarms have installed, the less residential burglaries have been committed. But crime is social problems, and many other factors affect crime changes over the years. Socio-economic variables should be included in examining the impact of alarm systems on residential burglaries. The U.S. Census data are incorporated with the data of residential burglaries and alarm permit records. Bi- and multivariate regression statistics are used to answer the questions.

Research Question 4: To what extent are burglar alarms installed spatially throughout the city? What are spatial statistics of burglar alarms? Are burglar alarms installed evenly geographically across the city? What are the spatial relationships of burglar alarms with residential burglaries and other independent variables? To what extent do residential burglaries occur throughout the entire city? What are the spatial statistics of residential burglaries? Do hotspots of residential burglaries exist? What are the spatial relationships of residential burglaries with burglar alarms and other relevant variables?

Null Hypothesis 4: There are even distributions of burglar alarms and residential burglaries across the city and no spatial relationships of them with other variables.

Descriptive spatial analyses are necessary to verify quantitative analyses of both burglar alarms and residential burglaries with other various variables and, in addition, to link these quantitative findings to geographic approaches on the city map. Such analyses will present not only spatial statistics for distributions of burglar alarms and residential burglaries, but also spatial relationships with other relevant variables being used in quantitative analyses. Using the geographic information system (GIS) program, point mapping and density methods to describe the distributions of burglar alarms and residential burglaries and to identify hotspots of both burglar alarms and residential burglaries will be employed to answer the questions.

Research Question 5: To what extent do residential burglar alarms and residential burglaries have the spatial impact on each other? In what degree are both burglar alarms and residential burglaries clustered or dispersed? In what degree do both burglar alarms and residential burglaries have spatial autocorrelation?

Null Hypothesis 5: Both residential burglar alarms and residential burglaries are randomly distributed throughout the city.

Displacement has been the Achilles' heel of crime prevention programs, but it is not inevitable. It is not necessarily an undesirable consequence of crime prevention intervention programs. It is imperative to examine a macro-level of spatial impact of burglar alarms on residential burglaries. This issue can be approached by looking at whether victimized houses by residential burglaries are spatially clustered together or isolated from each other through statistical tests. Spatial clustering may occur when a house without burglar alarm has once been victimized and neighboring houses have also been targeted because the victimized house produces a negative impact to surrounding houses. If it shows statistical significance, the issues of displacement can be argued. Using GIS program, simple and advanced spatial analyses (e.g., spatial centrographic, autocorrelation, and clustering methods) will be employed to answer the questions.

Research Question 6: To what extent do burglar alarms affect the spatial displacement of residential burglaries? To what extent do burglar alarms

impact to the diffusion of benefit on residential burglaries? Is there the potential for the diffusion of benefits arising from alarm systems whereby security effects may extend beyond the targeted area?

Null Hypothesis 6: There is no indication of displacement of residential burglaries due to burglar alarms and spatial diffusion of benefits from burglar alarms on residential burglaries.

The examination of either spatial displacement of residential burglaries or geographic diffusion of benefits of burglar alarms to residential burglaries in crime prevention circles has been given very little attention in research literature.

Acknowledging the absence of a standardized study design for the measurement of displacement/diffusion of benefits of criminal prevention programs, non-equivalent quasi-experimental research design will be discussed and devised. The weighted displacement quotient (WDQ) approach and the concept of buffer and control zones will be utilized and customized to develop research design to scrutinize either spatial displacement of residential burglaries due to burglar alarms or spatial diffusion of benefits of burglar alarms to residential burglaries. A land parcel map of the city, instead of a regular centerline city maps, will be used for the analysis at a single house level (non-equivalent quasi-experimental research design of this will be discussed in Chapter 5).

IV. Chapter Conclusion

There has been a substantial body of research projects to study the problem of burglary since the 1970s. Yet, few studies have focused on examining the

effectiveness of home burglar alarms on residential burglary. Even in those studies, the research designs and data sources employed met minimal standards and suffered from some methodological shortcomings. The quality of the data being analyzed was either few cases or just aggregated, and only basic and simple statistical tests were used. With regard to research design, control groups were not in use, and no design was devised to examine the displacement and diffusion of benefits of burglar alarms on residential burglaries. Furthermore, most studies were based on an ethnographic approach using interviews with incarcerated inmates and active burglars on streets and mail surveys. Finally, prior studies did not use an alarm ownership as a denominator. Thus, the comprehensive understanding of crime problem of residential burglaries and the rigorous examination of the impact of burglar alarms on residential burglaries were still far-off.

Though this one study does not overcome all methodological limitations, several solutions were sought and presented to remedy some of them. For example, the primary data of residential burglaries and alarm permits records covered a five-year range from 2001 to 2005 with both aggregated and disaggregated forms. The burglar alarm ownership would be used as the denominator. Furthermore, all addresses from the data of residential burglaries and burglar alarm permits were geocoded. Those developments upgraded the quality of the data compared to prior studies and made it possible of not only employing various advanced statistical tests but also conducting simple and advanced geographic analyses, as well as devising a

quasi-experimental research design to test spatial displacement and diffusion of benefits.

Then, given the review of relevant theories and prior studies on the effectiveness of burglar alarms on residential burglaries, six research questions and null hypotheses were proposed. They addressed the overall relationship between burglar alarms and residential burglaries; correlations of and between burglar alarms and residential burglaries with various independent variables; regressions of and between burglar alarms and residential burglaries with several indicators; the overall spatial relationship between alarms and residential burglaries with independent variables; the spatial autocorrelation of both burglar alarms and residential burglaries; and the spatial displacement of residential burglaries and the diffusion of benefit of burglar alarm on residential burglaries.

In the following chapter, the data sources and research design for this study will be discussed. The three primary databases (e.g., residential burglar alarms permits, residential burglaries, and U.S. Census information) are prepared by retrieving from the Newark Police Department, City Hall, and U.S. Census. A non-equivalent quasi-experimental research design will be discussed briefly.

CHAPTER 5. DATA SOURCES AND RESEARCH DESIGN

I. Overview of the Research Design

The research design for this study involves several sequential steps, the major procedures being numerical and spatial analyses. The statistical power analysis will be included from the outset as the general guideline for this study. Detailed description and discussion of each step and method will follow in Sections III and IV.

1. Statistical power analysis

One crucial issue in many studies on crime prevention is whether a particular research design for a study is powerful enough to detect any impact of a particular crime prevention program and, thus, to fairly test both null and research hypotheses. Many studies often fail to identify the impact of crime prevention programs and falsely test both hypotheses not because of inappropriate theories explaining the context of crime prevention programs but because of research methods designed by researchers. Statistical power analysis concerns the development of powerful and sensitive research design.

One core point of this issue is to determine the minimum number of cases for the groups (e.g., residential alarm permits, non-alarm-installed [NAI] residential burglary, and alarm-installed [AI] residential burglary) according to the different crime reduction levels (e.g., 10, 20, or 30 percent reduction of NAI burglary) for this study. This procedure will determine whether the datasets of the current study have enough case numbers for powerful research design and for numerical and spatial statistical analyses. The next step will involve numerical statistical analyses.

2. Descriptive analyses of burglar alarms and residential burglaries

Descriptive analyses of the residential burglaries with two conditions (NAI and AI) and burglar alarms will be presented. They will include temporal analyses and general trends over multiple years, using a time-series method. They will present the patterns and characteristics of both residential burglaries and burglar alarms.

3. Relationship between burglar alarms and residential burglaries

Because data testing in this study (i.e., whether an incident of residential burglaries involves a burglar alarm and whether a house has installed a burglar alarm) are categorical, the chi-square statistical test will be used to examine whether the change in burglar alarms and residential burglaries over multiple years is statistically significant or simply due to random fluctuation. Testing will compare the change rates of burglar alarms with the change rates of residential burglaries over five years using the chi-square test. Then, bi- and multivariate correlation analyses will be employed to see the strength of one variable (e.g., year and alarm permit) as it is related to other variable (e.g., AI and NAI burglaries). Both chi-square and correlation statistics will provide insight into the relationship between burglar alarms and residential burglaries.

In addition, bi- and multivariate regression analyses will be used to examine the possible causal factor(s) to explain the relationship between burglar alarms and residential burglaries. The variables included for the analysis are demographic variables (e.g., white, black, and other population races), socio-economic variables (e.g., unemployment, poverty level, and income level), and housing characteristic

variables (e.g., householder's race, house occupancy, and occupancy by owners and renters). These variables are from U.S. Census information.

4. Descriptive spatial analyses of burglar alarms and residential burglaries

For spatial analyses, first, descriptive spatial analyses will be used to see the spatial distributions and geographic patterns of burglar alarms and residential burglaries. These analyses will be based on both the single-house address and census tract levels. All addresses of burglar alarms and residential burglaries will be geocoded according to census tract levels. There are 90 census tracts in Newark, N.J. The numbers and rates of burglar alarms and residential burglaries will be counted and calculated in each census tract. These data will be shown on the city map to examine the patterns and characteristics of burglar alarms and residential burglaries. In addition, several spatially statistical techniques (e.g., centrographic statistics and spatial dependence statistics) will be employed to test spatial relationship. The spatially descriptive analyses will be used to visualize the distributions of burglar alarms and residential burglaries on the city map and to identify the hotspots of the alarms and burglaries for further analyses.

5. Spatial analyses of the impact of burglar alarms on residential burglaries

To measure the impact of burglar alarm systems on residential burglaries, two approaches will be used: macro-level and micro-level. Macro-level analysis will be employed to examine the impact of alarm systems on crimes at a city-level. For this approach, the clustering (or density) function will be used to identify hotspots of burglar alarms and NAI burglary, using computer mapping software (e.g., ArcGIS).

This method is useful in analyzing the pattern between residential burglaries and alarm systems and in examining visually whether the hotspots for burglar alarms and residential burglaries overlap. Further spatial statistical analyses (e.g., cluster statistic and nearest neighbor index) will be used to test statistical significance of this pattern. This analysis will show the macro-level impact and its directionality (e.g., positive or negative impact) of burglar alarms on residential burglaries. One shortcoming of the macro-level approach with aggregated data is that it lacks a micro-level analysis at the address or street-block level. It is necessary to have more sensitive spatial analyses with disaggregated data at a micro-level in order to examine the impact of alarm systems on crime.

6. Measurement of displacement and diffusion of benefits of burglar alarms on residential burglaries

To measure the impact of alarm systems on crime at a micro-level, a non-equivalent quasi-experimental research design, incorporating the buffer zone approach at single-house levels with the weighted displacement quotient (WDQ) will be devised. The nested buffer and control zone approach will be generated to detect the displacement/diffusion of benefits of burglar alarms on crime over time. The nested buffer and control zones have three areas (the inner target area [i.e., house with burglar alarm], middle buffer area, and outer control area). To measure the extent to which burglar alarms have an impact on residential burglaries, the WDQ will be used. The WDQ examines the rates of burglar alarms and crime in the buffer zones and compares them with the previous rates. WDQ values will show the size (e.g., net

effect, no effect, or no benefit) and directionality (e.g., positive, negative, or no effect) of the impact of burglar alarms on residential burglary.

II. Data Sources

There are five different data sources for this project: (1) the calls-for-service (CFS) database from the Newark Police Department; (2) the database of police incident reports (PIRs) from the Newark Police Department; (3) the alarm permit records from the Newark City Hall; (4) the database of AI burglary; and (5) the U.S. Census data. These five different data sources consist of the full dataset for the analyses of the project.

1. The CFS Database

The many activities carried out by police include responses to noncriminal activities, such as motor vehicle accidents, loud parties, and burglary alarm calls. Citizens call a police department's 911 emergency number to request police services. All citizen calls to which an officer does respond, whether criminal or noncriminal, are termed "calls for service." Calls can be "citizen-generated calls for service" or "officer-generated calls for service." The data represent the initial reports of crime and problems to police departments. By nature, the majority of the calls are not directly related to crimes. So the CFS data are a rather crude measure of the level of criminal activity in any jurisdiction. They include such information as the number of calls, the preliminary nature of the call, the time that the call was received, and the

location of the complaint. Police departments mostly classify such CFS into several categories based on the disposition¹⁴ (Boba, 2005).

Although criminologists know of the methodological limitations of official police record data, especially in regard to their failure to capture crimes unreported to authorities (Maxfield & Babbie, 2008; Sorensen, 2004), agency data remain important to research. As Sherman, Gartin, and Buerger (1989, 36) noted, the CFS data may “provide the most extensive and faithful account of what the public tells the police about crime, with the specific errors and biases that entails.”

From the Newark CFS data, several sub-datasets covering the five-year period from 2001 to 2005 were created. These datasets are: (1) the entire residential burglaries record which is not involved with alarm systems; and (2) the entire residential burglaries record which is involved with alarm systems. Both datasets are based on the “RPT” category among several disposition outcomes (e.g., cleared by arrest, pending, unfounded, checked, and secured). The “RPT (an acronym for “report”)” is the case which a report was submitted. The datasets include such variables as date, time, case number, the name of the CFS offense (e.g., burglary residential, and burglary commercial), address, deposition (e.g., report, check, no response, and unfound), location type (e.g., residence, government building, and church building), weapon used (e.g., physical force, knife, and handgun), and damage amount.

¹⁴⁾ Examples are robbery in progress, burglary in progress, burglary report, rape in progress, theft, homicide, shoplifting, family fight, assault, suspicious vehicle, loud noise, dog barking, accident, 911 hang-up, burglary alarm, neighbor dispute, criminal trespassing, and speeding in a neighborhood.

However, the CFS data do not include detailed information about each case. As a result, some variables (e.g., damage amount, the point of entry, the point of exit, the method of crime, and start and end time¹⁵) do not have the necessary information needed to answer all the research questions this study addresses. In these cases, the police incident reports can provide more detailed information.

2. The Police Incident Reports (PIR) Database

Whenever there is a CFS, the police are supposed to respond. Their response can be done by either dispatch or deployment. If a deployed patrol police is available on the spot, the police call operator can ask for a response to the call as soon as possible. But when a police officer is not available immediately, the call operator will ask any available police officer for dispatch to respond to the call. In either case, police officers will check the place where the call originated and interview the caller if possible. If there is no suspicious activity or crime, the police officer may not take further action or record further information for the report. In such cases, the CFS data is the best information on the particular case.

But if there is any suspicious activity or if a crime occurred, the police officer will take some action, such as collect evidence, investigate the crime, or interview victim(s) and/or witness(es). The police officer will then prepare a report with this information. The report, known as “police incident reports (PIR),” will be a new document within a new database. This database is based on the disposition, which

¹⁵) “Start time” is the date and time residents report having last left their homes intact and “end time” is date and time residents discovered their burglaries. These variables will be used to analyze temporal patterns of residential burglary.

is the outcome of the incident, in the “RPT” category. It is assigned when the initial report is written and is then updated if and when an investigation leads to an arrest or other status change.

The volume of PIRs database is less than the CFS, but the database includes richer information than the CFS. This database stores information about each crime reported, such as the time range of crimes committed, item(s) taken by the offender, point of entry, point of exit, relationship between the victim and offender if possible, and other situational factors, as well as, how, when, and where the crime occurred.

The information is crucial to studying crime problems.

The Newark Police Department has kept and maintained a separate database of burglary records. This database will be incorporated with the CFS database to recreate the full range of the dataset for this project. Table 5.1 (on page 108) shows the total number of incidents of residential burglary at NAI houses in Newark.

3. The Alarm-Installed (AI) Residential Burglary Database

As discussed, the CFS database contains information on residential burglaries in general whether each case involves alarm systems or not. From this database, information on alarm-installed residential burglary can be obtained, but the content is not in-depth. From the police incident reports database, a new dataset of AI burglary is built. Table 5.1 presents the total number of incidents of residential burglary at AI houses in Newark.

4. The Alarm Permit Records Database

In Newark, those who want to install home burglar alarms have to fill out an alarm permit application. There is no application fee to apply or annual fee for renewal. The Division of Tax Abatement and Special Taxes handles all government permits in the city, including home and commercial burglar alarm permits. The division does not deal with any violation of alarm permits or issuing of a summons to those who are charged with penalties.

All such duties belong to the Alarm Section of the NPD because police officers are the first respondents to the CFS. The duties of the Alarm Section of the NPD include: (1) to enforce alarm-related ordinances; (2) to testify in a court; and (3) to build and maintain the residential burglary alarm database. The most important of the three is to enforce the ordinances. To build and maintain the burglar alarm database is just a supportive task for ordinance enforcement. For example, a citizen may call the police for service through either 911 or a person's home phone. Many citizens also use a cellular phone for the CFS. Also, when a burglar alarm is activated, the signal may go to the police department either directly or after being verified by a security company. In either case, the police are the first to respond to such calls. As a consequence, the police department has a lot of information regarding crime-related calls.

The Division of Tax Abatement and Special Taxes has provided alarm permit records from 2001 to 2005. Though City Hall cannot provide personal information and other critical information by law (e.g., the names of the alarm companies), the dataset contains some information crucial for this project. The database is well

maintained and timely updated by designated personnel. Table 5.1 shows the number of residential burglar alarm permits in Newark.

The total number in the “alarm permit” category in Table 5.1 is the combined number of legitimate alarm permits and expired and unlicensed alarm systems. For this study, not only the number of legitimate alarm permits, but also the number of the two types of illegitimate alarm systems are included, the rationale for this being that the total number of AI burglary also may include some number of illegitimate alarm systems in use. If these numbers are excluded from the total number of alarm permits in use, the actual number of AI burglaries may be underestimated. Thus, these numbers should be included in this study for both numerical and spatial analyses.

5. The U.S. Census Database

U.S. Census data, in conjunction with the four previous databases, are necessary for advanced statistical analyses. It is a public information source and can be accessed and retrieved via the Internet. A new database for Newark from the U.S. Census was built, including population, income levels, number of households, poverty rate, unemployment rate, ethnicity, etc. The census tract data are incorporated with the geocoded NAI and AI burglaries, and alarm permit datasets for advanced spatial statistical analyses.

[Table 5.1] Total numbers of population, household, household w/o burglar alarm, residential burglary w/o alarm, residential burglar alarms in use, and residential burglary w/ burglar alarm annually in Newark, NJ.

	2001	2002	2003	2004	2005
Population estimated¹	272,537	250,782	262,504	251,352	254,217
Household estimated¹	99,989	96,150	102,128	100,690	101,040
Presumed household w/o burglar alarm²	98,429	94,683	99,919	98,063	98,211
Residential burglary w/o burglar alarm³	2,621	2,570	2,331	2,254	1,568
Presumed residential burglar alarm in use⁴	1,560	1,467	2,209	2,627	2,829
Residential burglary w/ burglar alarm⁵	107	108	75	54	57

Source:

1. The U.S. Census
2. The presumed number was calculated by subtracting the number of residential burglary w/o alarm from the total number of household.
3. Newark Police Department
4. Newark Police Department and City Hall
5. Newark Police Department

6. Data Transformation

Databases are vital tools for conducting crime analysis and crime mapping because they allow analysts to use computers to analyze large numbers of observations efficiently. But the data from agency records have been collected for purposes other than crime analysis. Thus they are not always adequate to fully examine research topics. Under these circumstances, data transformation is a necessary process for further crime analyses.

A huge database of police files from the Newark police department will be broken down by applying the “pattern identification methodology” (Boba, 2005) in order to obtain records of household burglary and alarm-involved household

burglary. A deduction process may be a proper approach to complete the task. This process will start with all crime categories, then with burglaries, and then with a focus on residential burglaries. Commercial burglaries or burglaries in government buildings will not be part of the study. Burglary is a type of property crime (e.g., theft from vehicle, auto theft, residential and commercial burglaries, criminal trespass, and criminal damage) in which property is the target. Because witnesses are typically not present when such crimes are committed, there is usually little or no suspect information available to use in identifying patterns of property crime. Therefore, the variables included in the recreated dataset are from examining information on types of crimes (e.g., residential versus commercial burglaries), types of targets (e.g., office buildings, apartments, and single-family homes), address, point of entry, other crimes committed in the course of burglary (e.g., assault and rape), property taken, and damage amount.

In order to analyze the tabular datasets of household burglaries along with geographic data, the tabular data must be geocoded. Geocoding is the process of linking an address (e.g., an incident address or the address of the victimized household) with its map coordinates (Boba, 2005). After converting text-based documents into database format files, the geographic and tabular files will be prepared and matched within GIS. The success rates of the geocoding for this study were in excess of 93 percent, where an acceptable minimum is 85 percent (Ratcliffe, 2001a).

7. Unit of Analysis

Several different units of analyses throughout this study can be used to examine the impact of burglar alarms on residential burglary at macro- and micro-level analyses. A single address of households in Newark can be a unit of analysis. There are three different types of addresses of households: addresses of residential burglaries without burglar alarms, addresses of residential burglaries with alarms, and addresses of residential burglar alarm permits. These addresses are used for different levels of approach. For example, for macro-level analysis, aggregated data of single addresses from residential burglaries with and without alarm systems and residential burglar alarm permits can be utilized to identify hotspots of crimes and high concentrated areas of alarm permits and to examine distinctive patterns of them. For micro-level analysis, disaggregated single addresses of residential burglaries with and without alarm systems and residential alarm permits are units of analysis and can be buffered in several various rings and clustered by the nearest neighbor index technique to examine the relationship between home alarm permits and residential burglaries and the diffusion of benefits of alarm systems on residential burglaries.

Furthermore, at the group level, both police beat boundaries and census tracts may also be used as units of analysis. A police beat and census tract can be described in terms of the total number of incidents of residential burglaries, the total number of alarm permits, the total number of residents, and other variables within its boundary (e.g., the number of households, annual income level, youth population, etc.). For example, in Newark, N.J., 90 census tract boundaries exist.

The three different types of addresses of households will be geocoded, and separate datasets were constructed according to census tracts. Then, they will be used for randomized sampling to have proper sample sizes with medium and large effect sizes.

III. Research Designs

1. Research Design and Statistical Power Analysis

One of the most important questions in a study is how the researcher can design a powerful study, which allows for a fair test of its research hypothesis. Research designs employed by the researcher often make it difficult for a study to obtain statistical support for the research hypothesis. Weisburd (1993) noted that such studies may be seen as being “designed for failure,” not because of inadequacies in the theories or programs evaluated, but because of the methods employed by researchers. When a study is underpowered, it is unlikely to yield a statistically significant result even when a relatively large program or intervention effect is found. Thus, research should be designed to be sensitive enough to detect an effect. This issue is directly related to statistical power, which concerns a Type II error (P)¹⁶. Statistical power is defined as $1 - P$. The value of the Type II error (P) should be as small as possible so that the power of the test of significance should be as large as possible for a reliable research design to detect any study effect. At minimum, it is generally recommended that a statistical test have a power level greater than 0.05,

¹⁶) Type II error refers directly to the risk of accepting the null hypothesis and occurs when the researcher fails to reject the null hypothesis when it is false in the population of interest (Bachman and Paternoster, 2004).

which indicates that the test is more likely to show significance result than not. But it is generally accepted that the most powerful studies seek a power level of 0.80 or above.

There are four factors making research design powerful: significance criterion, directionality (either a “one-tailed” or “two-tailed” test), effect size, and the size of the sample. One way to increase the statistical power of a test is to change the significance level used in the study. For example, a test with a significance level of 0.05 is more powerful than a test with a significance level of 0.01 because it is easier to reject the null hypothesis using a more lenient significance criteria. However, any benefit gained in reducing the risk of a Type II error is offset by an increase in the risk of a Type I error¹⁷. In criminal justice research, generally a 0.05 level of statistical significance is used as a threshold with a nondirectional test.

Another method to increase the statistical power of a test is to have a higher effect size.¹⁸ Effect size measures the difference between the actual parameters in the population and those hypothesized in the null hypothesis. Thus, when the

¹⁷⁾ Type I error is concerned with rejection of the null hypothesis and occurs when the researcher rejects the null hypothesis on the basis of sample statistics, but it is in fact true. The amount of Type I error is the significance level in a test of statistical significance. In criminal justice a 5% level of statistical significance is generally considered rigorous enough for testing a hypothesis (Cohen, 1988).

¹⁸⁾ Effect size measures the difference between the actual parameters in the population and those hypothesized in the null hypothesis. It is calculated by first subtracting the population difference as stated in the null hypothesis from the difference between the true means in the population. This value is then divided by the common standards deviation for the two populations studies (for the equation, see Weisburd, 1993, 573).

population parameters differ strongly from the null hypothesis, researchers are more likely to observe a significant difference in a particular sample. There is a direct relationship between effect size and statistical power. Studies that examine a larger effect size will, all else being equal, have a higher level of statistical power. In addition, effect size is unrelated to the criteria for statistical significance used in a test. In this sense, effect size increases the statistical power of a study and, thus, reduces the risk of Type II error, while minimizing the risk of Type I error. However, although effect size is often considered the most important component of statistical power, it is generally very difficult for the researcher to manipulate it in a specific study because in many cases the researcher either has no influence over the raw differences or no influence on the variability of the scores of the measures examined (Weisburd and Britt, 2003). At minimum, it is generally recommended that a statistical test have a power level greater than 0.50, which indicates that the test is more likely to show significance. But it is generally accepted that the most powerful experiments seek a power level of 0.80 or above. Such studies are highly likely to provide evidence for significant findings.

The method used most often to manipulate statistical power is to vary the sample size because (1) it is directly related to statistical power, (2) it is a factor usually under the control of the researcher, and (3) it can be manipulated without altering the risk of a Type I error in a study (Cohen, 1988; Brown, 1989; Weisburd and Britt, 2003). Thus, sample size often is a primary concern in statistical power analysis, and, in most cases, researchers maximize the statistical power of a study by increasing sample size, with other assumptions (e.g., statistical power level,

statistical significance level, and effect size) being held constant. Here, the relationship between statistical power and sample size is straightforward because larger samples lead to smaller standard errors and smaller standard errors lead to larger test statistics.

Based on four factors for powerful and sensitive research design (Cohen, 1988), it is possible to determine the minimum number of cases necessary to detect not only statistically significance, but also the specified meaningful impact for this current study. There should be a priori four assumptions of other thresholds of statistical analyses in order to have the minimal sample size: (1) the chi-square statistical test; (2) a statistical significance level of 0.05; (3) a nondirectional test; and (4) a statistical power level of 0.80. Effect size is directly connected to sample size, and sample size varies depending on effect size.

For example, assuming that 2,000 residential burglaries were reported in 2004, a local police department initiated a new program to combat this crime problem during 2005. As a result, in 2005, 1,600 incidents were reported. The null hypothesis here would be that the new program had no impact on the crime problem in 2005. In other words, the effect size of the program is zero. In this case, due to the new program, the total number of residential burglaries decreased from 2,000 to 1,600, a 20 percent reduction. The effect size is -20 percent. If the total number of incidents had dropped to 1,800, the effect size is -10 percent.

Sample size varies also according to different statistical tests. The primary statistical test for this study is the chi-square with two groups (e.g., the number of residential alarm permits and the number of non-alarm-installed residential

burglaries). Accordingly, the following sample size is based on the chi-square test, which has categorical variables with different numbers of categories of these variables (e.g., 2X2, 2X3, 3X3, or 3X4 tables).

[Table 5.2] Overall minimum number of cases for a variable for the 2X2 table chi-square test ($df=1$) with different degrees of effect size (ES) with the 0.80 statistical power (SP) and the 0.05 significance level

	10 % ES	20% ES	30% ES
Chi-square	785	196	87

(Source: Cohen, 1988: 258)

[Table 5.3] The 2X2 dummy table (4 cells) with minimum number of cases for a variable with the 0.80 SP and 10% ES

		Variable 2		Row Marginals	TOTAL
		3 *	4 *		
Variable 1	1 *	A **	B **	A+B	
	2 *	C **	D **	C+D	
Column Marginals		A+C	B+D		785 (=A+B+C+D)

* Two categories of each variable.

** Cell frequencies. In the chi-square test, the number of row marginals ($A+B+C+D$) is the same to that of column marginals ($A+C+B+D$), which is also the total number of the sum of 4 cells ($A+B+C+D$). The minimum expected frequency for each cell is generally 5.

[Table 5.4] The chi-square test between burglar alarms used in house and victimization of residential burglary with the 0.80 SP and 10% ES in Newark, NJ, 2001*

		House Burglarized		Row Marginals	TOTAL
		Yes	No		
Burglar Alarms Used in House	Yes	107	1,453	1,560	
	No	2,621	95,808	98,429	
Column Marginals		2,728	97,261		99,989

* The chi-square value of this test is 101.887, and it is statistically significant at the .001 level.

Table 5.2 clearly shows that the minimum sample sizes for the 2X2 chi-square ($df=1$) decrease with a higher ES and SP. More sensitive designs have larger sample sizes with higher statistical power and lower effect size. Table 5.3 displays

how the guideline in Table 5.2 can be applied in a typical 2X2 table with two binary variables. For example, each cell with A, B, C, and D can have a different number of cases, but the added number of either the row marginals or the column marginals is 785, which is the same number to the total number. Thus, in the 2X2 table, there should be a minimum of 785 cases in total. Another requirement for the chi-square test is to have the minimum expected frequency for each cell. In 2X2 tables, the requirement for having all expected frequencies should be at least equal to 5.

Table 5.4 demonstrates the application of the principle of Tables 5.2 and 5.3, using the data from the current study. In the present study, there are three groups of datasets: (1) residential burglar alarm permits, (2) NAI burglary, and (3) AI burglary. Among them, AI burglary has the smallest number of total cases. As seen in Table 5.1, there are a total of 401 cases of AI burglary over five years with 107 cases in 2001. Burglar alarms in use have 2,138 cases on average over the years. NAI burglary has 2,269 cases on average over the years. Therefore, the current project has large numbers of cases with other thresholds fully satisfying the guidelines of minimal case numbers for statistical analyses to examine the impact of alarm systems on residential burglary.

In addition, it should be noted that studies in which the sizes of the groups examined are relatively similar are more powerful than those in which the sizes of the groups are markedly different. It can be large when the number of cases included in different groups examined in a study differ widely, even though the total

minimum size is large enough.¹⁹ Thus, when the sizes of the groups in a study do not vary greatly, statistical analyses would be more powerful and sensitive. For the current study, as seen in Table 5.1, the total numbers of burglar alarm permits and NAI burglary are not markedly different, indicating that this study is powerful enough to detect any impact of burglar alarms on residential burglaries because of the large total numbers of cases and little difference of total numbers of cases between the two groups.

Therefore, the first four assumptions, together with impact size and minimal case numbers of the two groups, may lead the current project to be powerful enough to examine the impact of alarm systems on residential burglary. In other words, it may be sensitive enough to reject the null hypothesis if an effect of a certain size exists in the population under study.

2. Descriptive Analyses of Burglar Alarms and Residential Burglaries

One method to examine any change after launching a new crime prevention scheme is to do a time-series analysis (Ratcliffe and Makkai, 2004). Time-series analysis has been employed to examine the effectiveness of crime prevention schemes by public police departments because it is relatively easy to collect the pre-post data. For

¹⁹⁾ This issue is based on a formula for standardizing sample size in studies (Cohen, 1988; Weisburd, 1993). The equation is:

$$\frac{2(N_1)(N_2)}{N_1 + N_2} \quad [\text{Equation 5.1}]$$

For example, if there are a total of 500 subjects in a study, but 400 are in one group and 100 in another, the standardized sample size (N) per group used in statistical power and significance calculations is only 160, while the N for a two-group study equally divided is 250. The overall sizes of both studies are the same, but the design of the latter is more powerful.

example, once local police departments decide to tackle crime problems (e.g., residential and commercial burglaries, auto theft, and robbery) after analyzing the current crime data, they develop a new targeted crime prevention initiative and implement it to tackle crime problems in the community. After implementing the program, they would evaluate whether or not the program is effective at reducing crime rate. The time-series analysis is one useful method to evaluate.

However, unlike the public police's crime control initiatives, the installation time of burglar alarm systems cannot be pinpointed. The decision of the burglar alarm installation is purely at the hands of homeowners. It seems to be difficult to collect the alarm permit records on a "before and after" basis. But, if the installation data are available for several years, the time-series analysis can be possible by year-to-year bases with percentages, proportions, and rates.

For the present study, a series of datasets is necessary: residential alarm permit records, AI residential burglary, NAI residential burglary, and the total household number. In addition, all these data should cover several years. Five years (from 2001 to 2005) of the first three categories of data are available from the Newark City Hall and Police Department. The total household number is available from the U.S. Census data. Then, each year's data can be compared to examine any significant changes. The chi-square, multiple correlation, and bi- and multi-nominal logistic regression statistical tests can be used to examine the significance of yearly changes between residential burglaries with and without burglar alarms and alarm permits.

3. Relationship between Burglar Alarms and Residential Burglaries

(1) Chi-square analyses

Since the important variables of data (i.e., whether an incident of residential burglary involves a burglar alarm and whether a house has installed an alarm system) are categorical (e.g., nominal or ordinal level), the chi-square test (χ^2) is used to examine the statistically significant relationship between NAI and AI burglaries over times.

Three approaches will be employed using the chi-square test. The first is to check the statistical significance of changes between NAI and AI burglaries over multiple years. Over the years, the number of both NAI and AI burglaries had decreased. The test will determine whether such changes are statistically significant. The raw numbers of both categories according to year will be used in the statistical test. The second approach is to examine the statistical significance of the rates of NAI and AI burglaries over five years. The former can be found by dividing the total number of AI burglary by the total number of alarm permits. The latter will be calculated by dividing the total number of NAI burglary by the total number of households. Then, these change rates over multiple years will be compared using the chi-square test to check whether a statistically significant relationship exists. The third test is to compare the changed proportions of alarm permits and NAI burglary over multiple years. The former values will be calculated by subtracting the value of the previous year (e.g., 2001) from a given year (e.g., 2002) and, then, dividing the subtracted value by the previous year's raw number of counts. All three

tests concern the statistical relationship between burglar alarms and NAI and AI burglaries.

(2) Correlation analyses

The chi-square statistical test is useful as a way to determine whether there is a statistically significant relationship among variables. But it is limited in providing a measure of the strength of the relationship among variables. Correlation analysis is a descriptive statistical approach that defines the strength of one variable as it is related to other variable(s). Several variables (e.g., year, NAI burglary, AI burglary, and residential alarm permits) will be used in the correlation statistical test to check for significant relationships and the strength of such relationships. For example, the relationship between the increase of burglar alarms and the decrease of NAI burglary over years will be tested. Both chi-square and correlation tests will provide some insight of statistical relationships among burglar alarms and residential burglaries.

4. Descriptive Spatial Analyses of Burglar Alarms and Residential Burglaries

For the spatial analyses in this study, spatially descriptive analyses will be conducted to see the distribution of burglar alarms and residential burglaries. Two separate approaches will be used. The first will be based on the single-house address levels of burglar alarms and residential burglaries. All addresses of residential burglar alarms and NAI and AI burglaries will be pinpointed on the city parcel map over multiple years, using GIS computer software (e.g., ArcGIS). The temporal factors described above will be included in the analysis of residential burglaries to examine the spatial patterns and characteristics of residential

burglaries. The second approach will use the census tract level. All 90 census tracts in the city were identified, and all addresses of both burglar alarms and residential burglaries were geocoded with a more than 90 percent address matching rate on average for mapping purposes. The addresses were re-grouped according to census tracts. Each census tract includes the total number of addresses of burglar alarms and NAI and AI burglaries. This information will be used to calculate the rates of NAI and AI burglaries to examine the patterns and changes over the years. In addition, several spatially statistical methods (e.g., centrographic statistics and spatial dependence statistics) will be employed to analyze the spatial relationship. The spatially descriptive analyses will provide visualizations of the distributions and be used to identify the hotspots of burglar alarms and residential burglaries for further analyses.

5. Spatial Analyses of the Impact of Burglar Alarms on Residential Burglaries

The issue of how to measure the impact of crime prevention schemes is critical. For example, situational crime prevention through the manipulation of environmental factors has been plagued with the issue of whether or not crimes prevented are simply displaced to other types of crime, times, places, and/or targets (Cornish and Clarke, 1987; Gabor, 1990; Hakim and Rengert, 1981; Hamilton-Smith, 2002; Hesseling, 1994; Reppetto, 1976). The study of displacement may provide critical research findings and useful insights into the effectiveness of crime prevention programs. In addition, it is also possible that crime reduction schemes may have a diffusion of benefits (Gabor, 1990; Hesseling, 1994; Clarke and Weisburd, 1994). Displacement has been the critical problem of crime prevention programs, but it is

not inevitable. It is not necessarily an undesirable consequence of crime prevention intervention programs.

This section and the section that follows discuss the topic of how the impact of burglar alarms on residential burglaries can be measured. The two approaches to examine the spatial impact of burglar alarms on residential burglaries using various crime mapping techniques are macro- and micro-level analyses.

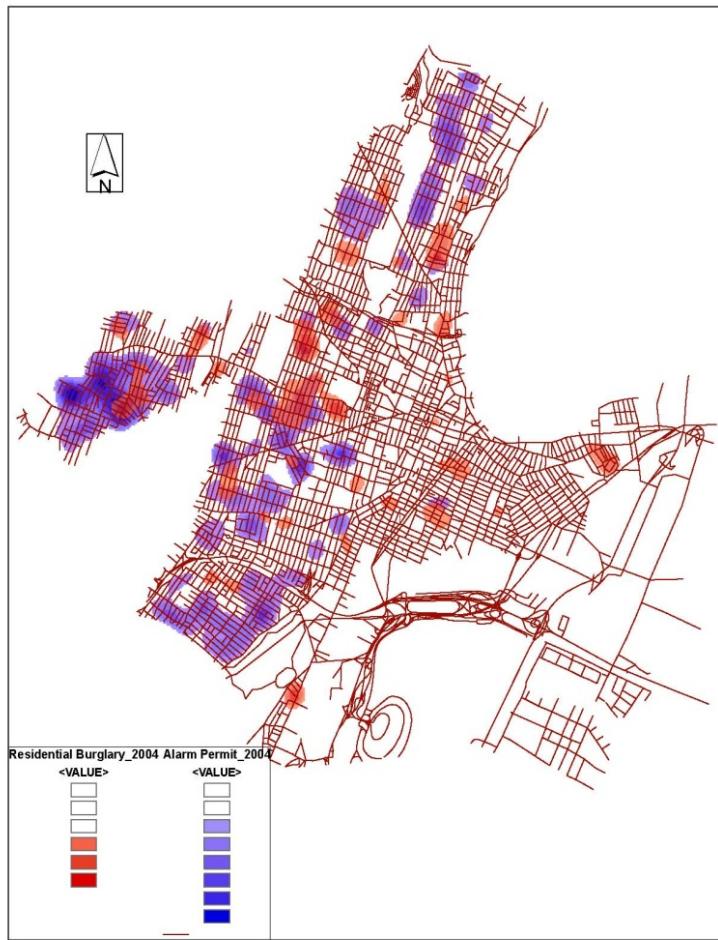
(1) Hotspot analyses at the macro-level

A hotspot is identified in a geographic distribution either when features are found in close proximity or when groups of features with similarly high or low values are found together (Mitchell, 2005). In the context of spatial analysis, the concept of cluster of features is similar to that of a hotspot. For example, when similarly high values of features (e.g., the numbers of residential burglary and robbery) are found closely being clustered, these values can be identified as hotspots. It can be applied to NAI and AI burglaries and burglar alarms.

Clustering at the macro level will be used to examine the impact of burglar alarms on crimes at a city-level and can be done by using the density function (or smoothing-out) from ArcGIS. With this method, the individual data points depicting the addresses of either residential burglaries or burglar alarm are “smoothed out” to create an image that shows the areas with the highest density or concentration. Two comparison density estimations (i.e., burglar alarms and NAI burglary) are produced. The outcomes are two separate images of hotspots. An examination of distinctive distribution patterns can determine if they overlap, and statistical tests can show their relationship. Seeing the impact of alarm systems on residential

burglaries can be useful. Figure 5.1 is one example of a density map of residential burglary without alarm system over burglar alarm in the city in 2005. The map visually displays that there are multiple hotspots of NAI burglary (red color) and multiple hotspots of burglar alarms (blue color). In both cases, darker colors show a greater number of incidents and alarms in use.

[Figure 5.1] A density map of NAI burglary over burglar alarms in Newark, NJ, 2005



Further spatial analyses (e.g., cluster statistic and nearest neighbor index [NNI]) will be used to test statistical significance of this pattern. This analysis will show the macro-level impact and its directionality (e.g., positive or negative impact)

of burglar alarms on residential burglaries. For example, the NNI technique can be used to identify clusters of hotspots. The outcome can be applied to estimate changing crime patterns and to examine the impact of burglar alarms on residential burglaries. Moran's *I* is a classic measure of global spatial dependence to measure where there is significant clustering for a given variable.

One drawback of the macro-level approach with aggregated data is that it lacks a micro-level analysis at the address or street-block level. As observed in Figure 5.1, the overlapping hotspots between NAI burglary and burglar alarms may exist (e.g., in west and center areas of the city). This phenomenon can mislead the impact of alarm systems on residential burglaries. In other words, because of the overlapping hotspots, issues of displacement and diffusion of benefits cannot be examined or it may be concluded that no relationship between residential burglary and burglar alarms exists. Thus, more sensitive spatial analyses with disaggregated data at the micro level are required in order to examine the impact of alarm systems on crime.

6. Measurement of Displacement and Diffusion of Benefits of Burglar Alarms on Residential Burglaries

In the context of studying the impact of burglar alarms on residential burglaries, it is imperative to examine the nature of crime displacement caused by alarm systems in the targeted area and to investigate the potential for a diffusion of benefits from alarm security measures, which has been given little attention in research literature. As Barnes (1995) argued, however, the measurement of displacement is notoriously

difficult, and in the absence of a standardized approach, several researchers have used a variety of techniques to quantify the phenomenon.

For this measurement, the buffer function as a micro-level spatial analysis at the single-house levels will be used. The applied nested buffer and control zone approach will be generated to detect any impact of burglar alarms on crime over time, using the WDQ. WDQ values will show the size (e.g., net effect, no effect, or no benefit) and directionality (e.g., positive, negative, or no effect) of the impact of alarm systems on residential burglary. The detailed description of research design, theoretical explanation, and measuring process will be discussed in Chapter 10.

IV. Chapter Conclusion

The three primary databases (e.g., residential burglar alarm permits, residential burglaries, and U.S. Census information) from several different data sources are prepared by retrieving from the Newark Police Department, City Hall, and U.S. Census. The databases of alarm permit records and police incident reports were accessed to gain the information of residential burglar alarms and residential burglaries. The census data, in conjunction with the databases of burglar alarm permits and residential burglary incidents, were retrieved. After building the primary databases, geocoding process was done with all addresses of both burglar alarm permits and residential burglary incidents for the descriptive and advanced geographic analyses.

The issue of statistical power analysis was discussed to see whether statistical tests and research design in this study are powerful enough for a fair test

of research hypotheses by chiefly checking the minimal sample size of statistical tests. It demonstrated that the present study was powerful enough to examine the impact of burglar alarms on residential burglary.

Research methods for numerical analyses, descriptive spatial analyses, and measurement of spatial displacement and diffusion of benefits of burglar alarms on residential burglaries was discussed. In particular, a nonequivalent group quasi-experimental research design was adopted to measure geographic displacement and diffusion of benefits.

In the following chapter, temporal analyses and general trends both burglar alarms and residential burglaries over multiple years will be presented.

CHAPTER 6. PATTERNS AND CHARACTERISTICS OF BURGLAR ALARMS AND RESIDENTIAL BURGLARIES

I. Introduction

In this section, descriptive analyses of residential alarm permits and two differently conditioned (non-alarm-installed [NAI] and alarm-installed [AI]) residential burglaries will be presented. Such analyses are necessary to observe general trends of burglar alarm permits and residential burglaries before applying any analytical approaches. They will include temporal analyses and general trends over multiple years, using a time-series method.

II. Trends of Residential Burglar Alarms

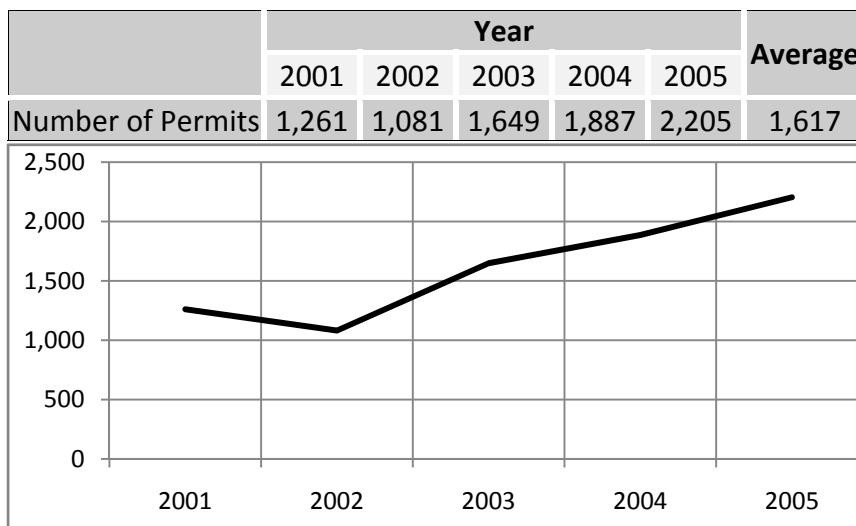
According to the Newark city ordinance, it is voluntary for business owners to install a burglar alarm system on their premises. Once they decide to do so, they are required to pay a fee for the initial application for the burglar alarm and for renewal. It also is voluntary for homeowners to apply for a burglar alarm permit. However, there is no initial application or renewal fee. Due to the regulations, a certain number of home owners or occupants either had installed and used the burglar alarm systems in the past but did not renew the systems on a regular basis (expired burglar alarms), or have installed and used the system without the city's license (unlicensed burglar alarms).

1. Residential Burglar Alarm Permits Records

A legitimate alarm permit is issued from Newark City Hall. But the number of expired and unlicensed burglar alarms is mostly identified by police officers, who

responded to 911 calls when a burglar alarm was activated. These records are stored at the Newark Police Department. According to data from Newark City Hall, in 2005 there were 2,205 residential burglar alarm permits applications.

[Table 6.1] Number of residential burglar alarm permits annually in Newark, NJ



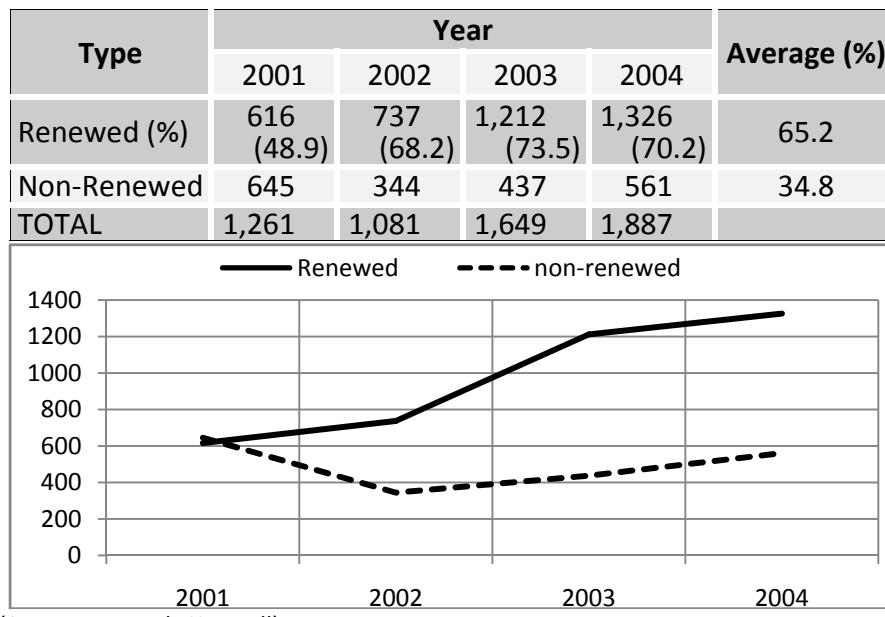
(Source: Newark City Hall)

Table 6.1 shows that during the last 5 years, the total number of alarm permits has increased from 1,261 in 2001 to 2,205 in 2005, an increase of 74.9 percent. These numbers represent the legitimate residential alarm permits from city hall. Of course, as previously stated, some proportion of illegitimate alarm usage exists in the city. It is difficult to estimate the number of non-registered residential alarm permits in use.

In addition, Table 6.2 presents the percentage of renewed alarm permits and the percentage of the first-time notices of residents who did not renew their permits. According to the Newark city ordinance, July 1 is the expiration date for all previously licensed alarm permits. However, if a permit was granted two months

before July (anywhere from May 1 to June 30), it would expire on July 1 of the following year. Thus, Table 6.2 does not include the 2005 record because the researcher received the data from Newark City Hall on May 8, 2006.

[Table 6.2] Number and proportion of the renewed and non-renewed residential alarm permits annually in Newark, NJ (%)



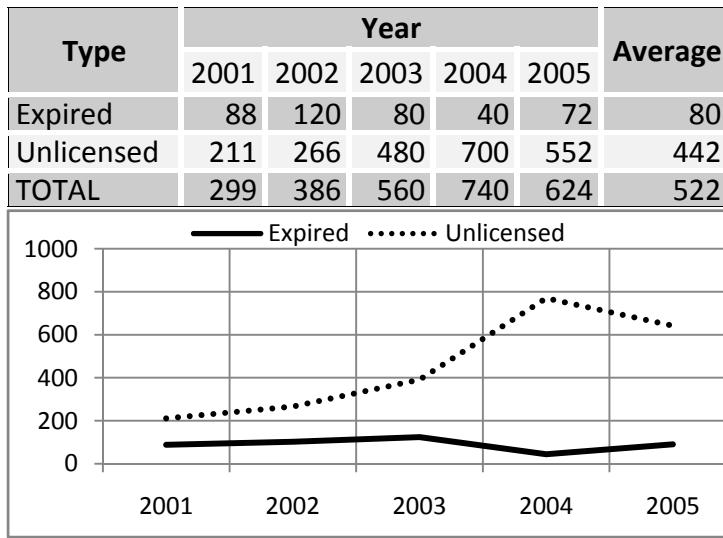
(Source: Newark City Hall)

The proportion of the non-renewed residential alarm permits is 34.8 percent on average from 2001 to 2004. Though this number is somewhat substantial, the Office of Tax Abatement and Special Taxes at Newark City Hall does not have enforcement power and thus cannot force residents to renew their alarm permits, increasing this proportion. The office only sends a renewal letter to those who did not renew their permits. There is no follow-up activity.

2. Non-Registered Residential Burglar Alarms

The Alarm Section within the Newark Police Department has several duties. Among them, the primary responsibility is to enforce alarm ordinances, specifically issuing a summons to those who violate an ordinance. According to the Alarm Section, there are three categories of residential burglar alarm users: (1) the legitimate burglar alarm user with a city permit; (2) the expired alarm user who once applied for the city permit but did not renew it; and (3) the unlicensed burglar alarm user who has installed an alarm system but has never applied for a city permit.

[Table 6.3] Number of the expired and unlicensed burglar alarms annually in Newark, NJ



(Source: Newark Police Department)

As Table 6.3 shows, the proportion of users in the second category is substantial. For example, in 2001, 51.1 percent of alarm users did not renew their permits the following year. The responsibility for enforcement against those who do not renew alarm permits and those with unlicensed alarm systems belongs to the Newark Police Department. If a police officer finds either a non-renewed alarm or

an unlicensed alarm after responding to the CFS, the police officer will report it to the Alarm Section. The Alarm Section then will investigate and issue a summons, if necessary.

Table 6.3 presents the total number of summons by the type of residential burglar alarm user from 2001 to 2005. It shows that the number of summons issued to those who have an unlicensed alarm system is higher than other categories. Even though these numbers are high, the fact is the police department and city hall cannot estimate even the approximate total number of unlicensed alarm users.

Although some research has been conducted on false alarm problems (Sorensen, 2003), studies on the usage of expired and unlicensed alarm systems are limited. It is not known why many homeowners have installed and used burglar alarm systems without a city permit. As seen in Table 6.3, the proportion of this type of alarm user is substantial. It also is not clear why some homeowners would not renew the permit for their current alarm system, even when they receive a notice from city hall.

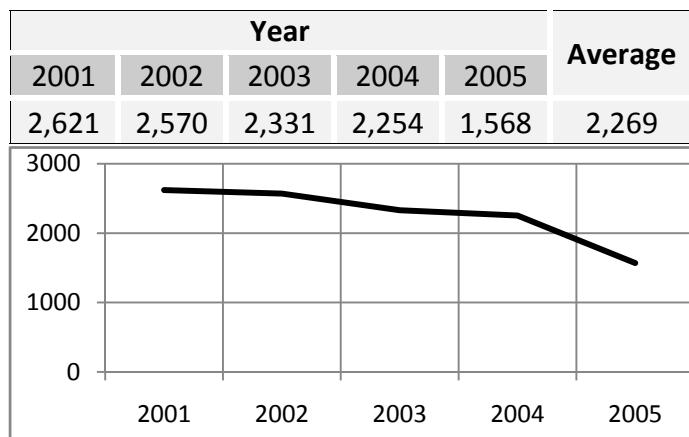
III. Trends of Residential Burglaries

1. Trends in NAI Residential Burglary

The nature of residential burglaries will be examined both at the NAI and AI houses, including the extent of residential burglaries from 2001 to 2005 and trends in residential burglaries from 2001 to 2005, such as when the burglaries occur and the temporal variation.

The CFS records contain a total of 1,568 residential burglaries at NAI houses and 57 residential burglaries at AI houses in 2005. For example, in Newark between 2001 and 2005, the total number of residential burglaries at NAI houses was 11,344. The number decreased by 40 percent from 2,621 incidents in 2001 to 1,568 in 2005. There may be several factors to bring such a drop in the crime rate in the city, including burglar alarm systems at residential houses (Blumstein and Wallman, 2000).

[Table 6.4] Number of residential burglaries at NAI homes annually in Newark, NJ

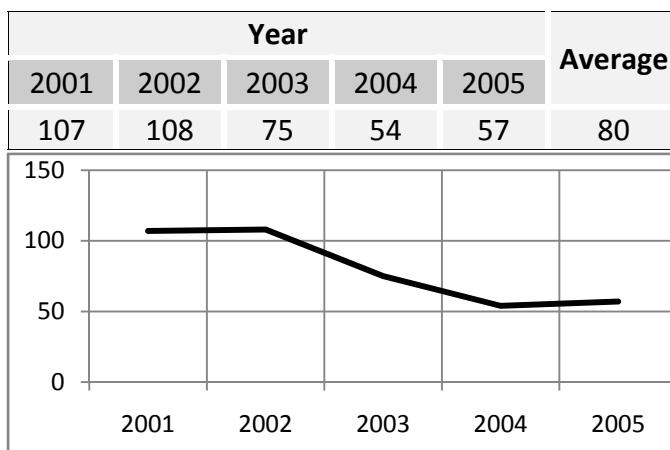


(Source: Newark Police Department)

2. AI Residential Burglaries

Between 2001 and 2005, there were 401 residential burglaries that involved burglar alarms. The total number of residential burglaries at AI homes decreased by 46.7 percent, from 107 incidents in 2001 to 57 in 2005. The incidents of residential burglaries at AI homes decreased together with NAI burglaries.

[Table 6.5] Number of residential burglaries at AI homes annually in Newark, NJ



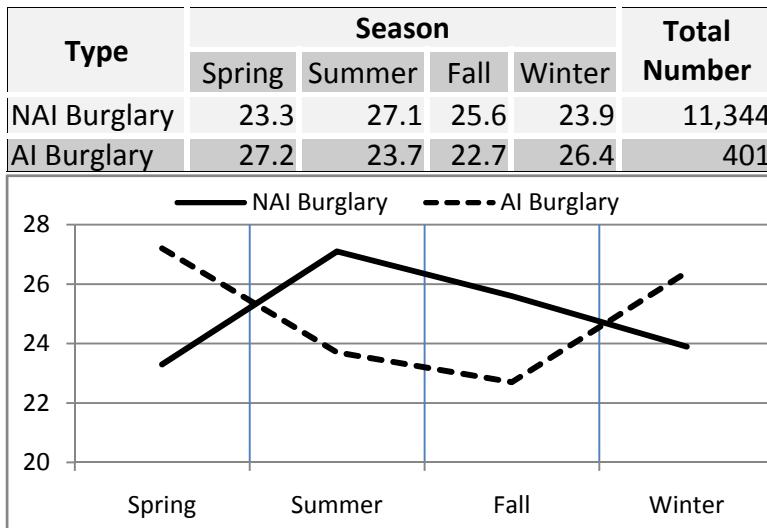
(Source: Newark Police Department)

IV. Temporal Patterns of Residential Burglaries

1. Burglaries by Season

Until recently, the temporal component of the criminal event had been neglected in criminological studies (Andresen and Jenion, 2004). Table 6.6 shows residential burglaries from 2001 to 2005 distributed by season at both NAI and AI houses. In general, burglars struck less frequently at NAI houses during spring and winter. The peak season for NAI burglary is summer, presumably due to a combination of higher temperatures and longer hours of daylight. Warmer, lighter seasons usually are characterized by informal surveillance of garden users, difficulty judging home occupancy on the basis of interior lighting, and the lack of cover of darkness. In addition, the absence of residents who vacation during the summer months may account for the increase. On the other hand, for AI burglary, spring and winter maintained a higher number of incidents, with the peak season being spring.

[Table 6.6] Proportion of NAI and AI residential burglaries seasonally in Newark, NJ



(Source: Newark Police Department)

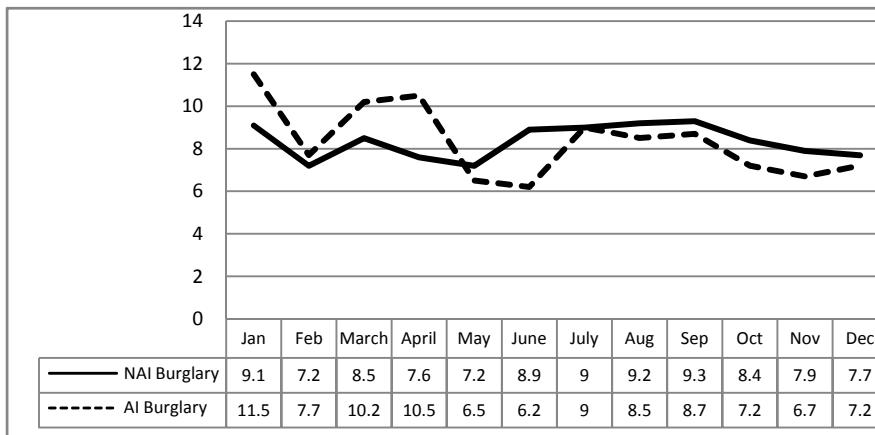
It should be noted that the trends between NAI and AI burglaries seem to be crossing. The trend of NAI burglary is close to that described in the literature on residential burglary, in that burglary has limited seasonal variation and tends to increase significantly in June and July (Shover, 1991). But less is known about AI burglary, particularly as it displays seasonal variation opposite of that of NAI burglary.

2. Burglaries by Month

Table 6.7 displays the proportion of residential burglaries recorded by the police department by month from 2001 to 2005. With NAI houses, September is the peak for residential burglaries. July, June, and August also maintain higher proportions of occurrences. This trend matches the seasonal variation patterns, with a lower proportion of incidents in February (see Table 6.6). On the other hand, the lowest number of AI burglary occurred in June, but the highest number existed in January,

followed by April and March. As discussed in the previous section, seasonal patterns in occupancy, daylight hours, and temperature for outdoor activities can all be likely explanations for these patterns.

[Table 6.7] Proportion of the NAI and AI residential burglaries monthly in Newark, NJ



(Source: Newark Police Department)

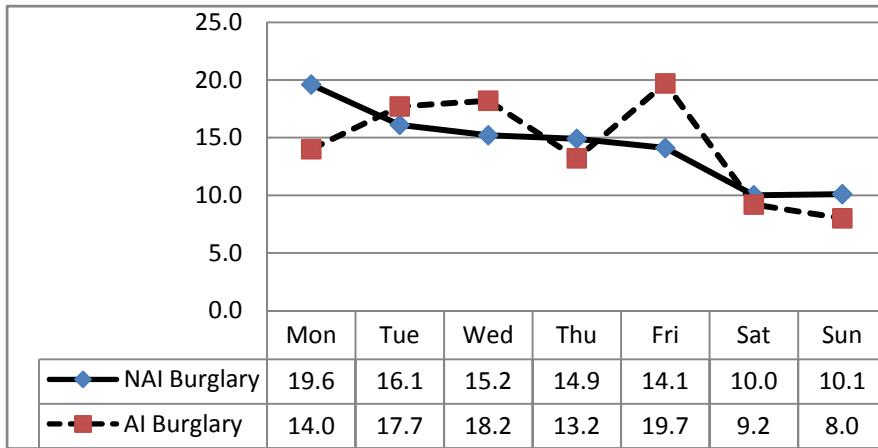
3. Burglaries by Week

Table 6.8, which shows the proportion of residential burglaries reported by the day of the week, clearly demonstrates that differences in the number of burglaries are dependent on the day. For example, both NAI and AI houses have a much lower proportion of burglaries during the weekends. In particular, Saturday and Sunday record the lowest proportion for NAI burglary and Sunday for AI burglary. This trend could be interpreted as the burglars' period of rest after the busy weekdays and prior to the busy day, Monday.

On the other hand, there is a substantial difference between the peak days for NAI and AI houses. For example, Monday is the peak day for NAI burglary, after which the proportions decline. At AI houses, a similar trend occurred, but the peak day is Friday with a sudden drop to the lowest point on the weekends. The reason

for this pattern is unclear, though it may be due to a lower residential occupancy.

[Table 6.8] Proportion of NAI and AI residential burglaries weekly in Newark, NJ



(Source: Newark Police Department)

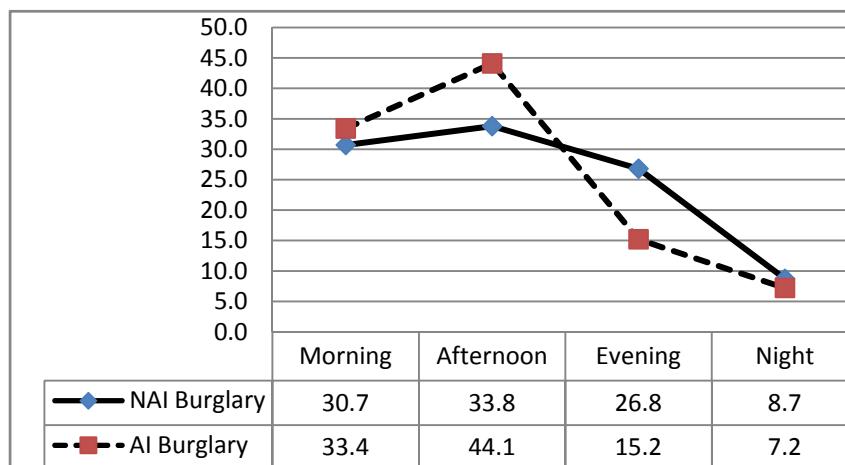
4. Burglaries by Time of Day

Table 6.9 presents the proportions of burglaries by the time of day. The day is broken down into four, six-hour segments. Morning is the period from 6:00 a.m. to 11:59 a.m.; afternoon, 12:00 p.m. to 5:59 p.m.; evening, 6:00 p.m. to 11:59 p.m.; and night, 12:00 a.m. to 5:59 a.m.

Burglars try to avoid contact with residents. Residential burglary tends to be a diurnal affair, and the proportion of daytime burglaries has risen sharply with the rate of female employment because more houses are now completely unoccupied during the day. Burglaries are most common during the morning and afternoon. For NAI houses, 64.5 percent of burglary incidents occurred during daylight hours. More or less the same trend occurred at AI houses, with 77.5 percent of burglaries taking place during daylight hours. A possible theory to explain the increase in burglaries during the day is that houses are more likely to be unoccupied during

these hours. Nighttime burglaries, on the other hand, are less likely to be committed. The lower proportion of nighttime burglaries may reflect a greater effort for burglars to avoid contact with their victims.

[Table 6.9] Proportion of the NAI and AI residential burglaries by time of day in Newark, NJ



(Source: Newark Police Department)

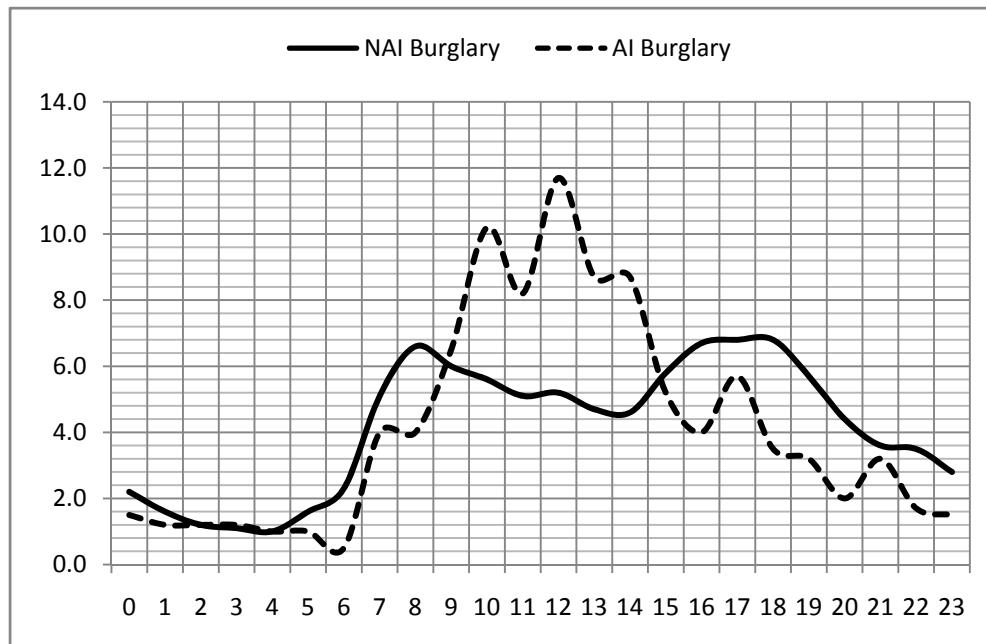
5. Burglary by Hour of Day

As discussed previously, a higher proportion of residential burglaries occur in the morning and afternoon, and the peak time frame is the afternoon between 12:00 p.m. and 5:59 p.m. Table 6.10 shows precise temporal estimates for residential burglaries within that time frame, with the proportion of burglaries broken down according to the hour of the day.

For example, the peak hours for NAI burglary are 8:00 a.m. and 4:00 p.m. to 6:00 p.m. The lower occupancy due to residents commuting to and from work could explain the higher rates in these time frames. Newark is located near New York City. More of Newark's population leaves home early in the morning to travel to work, and more of the female population works than in other suburban cities. Such a

lifestyle may result in lower occupancy.

[Table 6.10] Proportion of NAI and AI residential burglaries hourly in Newark, NJ



(Source: Newark Police Department)

Residential burglaries at AI houses, on the other hand, show a different trend.

During the lunch hour, there is higher proportion of residential burglaries, which also can be explained by lower occupancy because a smaller proportion of Newark residents stay or return home during this hour.

Overall, residential alarm usage has steadily increased over the five-year period. More residents in the city have bought and installed residential alarm systems for protection. At the same time, both NAI and AI burglaries have progressively decreased. The overall decrease in residential burglaries might occur as a result of the increase in alarm system usage in residential areas. However, these simple descriptive illustrations do not indicate that alarm systems have any

substantial impact on residential burglaries. It is necessary to further examine the impact by using other analytical approaches.

Temporal variations—by season, day, time of day, and hour—largely reflect a combination of time-specific changes in occupancy, level of security (e.g., windows left open), and nocturnal cover. While all of these factors are theoretically amenable to prevention (e.g., stay home, close windows, increase outdoor lighting), it is difficult to convince people to change their lifestyles. Nonetheless, examination of temporal trends in residential burglary can aid in addressing specific crime problems and possible policy implications.

V. Chapter Conclusion

The general trend analyses showed that residential burglar alarms in use had steadily increased over the five-year period, while both of NAI and AI burglaries had progressively decreased. More residents in the city had bought and installed residential alarm systems for protection. This finding is a benchmark directly relevant to later rigorous analyses in the following chapters because the antithetical trends between burglar alarms and residential burglaries over the multiple years indicate that the overall decrease in residential burglaries might occur as a result of the increase in alarm system usage in resident areas.

Temporal analyses showed that the peak season for NAI burglary was summer. In particular, September was the peak with July, June, and August maintaining higher proportions of occurrences. Monday was the peak day for NAI burglary, while Saturday and Sunday recorded the lowest proportion. Residential

burglaries were most common during the morning and afternoon with 64.5 percent of NAI burglary incidents being occurred during daylight hours. More specially, the peak hours for NAI burglary were 8:00 a.m. and 4:00 p.m. to 6:00 p.m. Temporal variations—by season, day, time of day and hour—largely reflect a combination of time-specific changes in occupancy, level of security, and nocturnal cover.

In the following chapter, the overall and correction relationships between burglar alarms and residential burglaries will be analyzed and discussed, which link directly to Research Questions 1 and 2. Question 1 is to examine the overall statistical relationship between the increase of burglar alarms in use and the decrease of residential burglary incidents and between the changes in alarm installations and NAI burglary. On the other hand, Question 2 is to examine the correlated relationships between burglar alarms and residential burglaries. Various numerical statistics, such as chi-square and bi- and multivariate correlation tests will be employed.

CHAPTER 7. QUANTITATIVE ANALYSES OF THE IMPACT OF BURGLAR ALARMS ON RESIDENTIAL BURGLARIES

I. Introduction

In the previous chapter, the general trends of residential burglar alarms and residential burglaries were analyzed and discussed. This chapter primarily focuses on quantitative analyses for the relationship between burglar alarms and residential burglaries. This topic is related directly to Research Questions 1 through 3. Question 1 is about the overall relationship between burglar alarms and residential burglaries over the multiple years, whereas Questions 2 and 3 are linked to correlation and regression analyses, respectively.

The number of residential burglar alarms in use has increased for the last five years. More residents have bought and installed burglar alarms in their homes for safety. According to police data, progressive decrease in residential burglary incidents has occurred, but fewer homes in Newark, N.J., have suffered from the crime. There has been a gradual decrease in the number of residential burglaries at non-alarm-installed (NAI) homes. Furthermore, residential burglaries at alarm-installed (AI) homes also have decreased during the same period. At first glance, the increase in the use of residential burglar alarms and the decreases of NAI and AI burglaries seem to correlate. In order to verify this relationship, statistical tests are required. Several numerical statistical analyses (e.g., chi-square, bi- and multivariate correlations and regressions, and advanced multiple regression statistics) will be used and discussed.

II. Overall Relationship between Burglar Alarms and Residential Burglaries

1. Chi-Square Analyses

Since the important variables of data (i.e., whether an incident of residential burglary involves a burglar alarm and whether a house has a residential burglar alarm installed) are categorical (e.g., nominal or ordinal level), the chi-square statistical test is used to examine whether the change in burglar alarm use and residential burglaries over multiple years is statistically significant or due to a random fluctuation. Two approaches will be employed using the chi-square test.

(1) The relationship between NAI and AI residential burglaries according to the raw numbers

The first approach is to check the statistical significance of changes between NAI burglary and AI burglary over multiple years. Over the years, the number of both different conditioned residential burglaries decreased. The chi-square test can determine whether such changes are statistically significant. The raw numbers in both categories, according to years, were used in this statistical test.

Table 7.1 presents how the chi-square test is employed in the present study (see Appendix 1 on page 318 for tables with chi-square tests from 2002 to 2005). Two variables are included in the test, using the data from Table 5.1 (see page 106). Table 7.2 shows the chi-square values over five years, as well as their statistical significance. Though 2004 and 2005 do not show significant relationships, the first three years have substantially strong relationships between the two variables.

[Table 7.1] The chi-square test between residential burglar alarms and residential burglaries in Newark, NJ, 2001^a

		House Burglarized		<i>Row Marginals</i>
		No	Yes	
Burglar Alarms Used in House	No	95,836	2,631	98,467
	Yes	1,453	107	1,560
<i>Column Marginals</i>		97,289	2,738	100,027

^aThe chi-square value of this test is 99.52, and it is statistically significant at the .001 level.

[Table 7.2] Values of chi-square tests between burglar alarms and residential burglaries annually in Newark, NJ (df=1)^a

Value	Year				
	2001	2002	2003	2004	2005
Chi-square	99.52 ***	115.246 ***	11.840 ***	1.063	3.040

^aA series of chi-square tests is based on data from Table 5.1 from the data source section and on 2x2 tables (df=1).

*** Statistically significant at the .001 level.

It should be noted that the values of the chi-square tests from 2003 to 2005 suddenly drop, as compared with the values from 2001 and 2002, and they are not statistically significant. One possible reason for the drop off is the number of cases in each cell in Table 7.1. In other words, the total number of housing units and houses without burglar alarms, which produce marginal rates of NAI burglary, is too large, whereas the total number of estimated burglar alarms in use is too small relative to that of housing units, which consequently have a relatively higher proportion of AI burglary. This fact may skew the relationship of the chi-square statistics between burglar alarms and residential burglaries. Though the chi-square test is useful to examine a statistical relationship and shows statistical significances in this study, it is necessary to conduct advanced statistical analyses to scrutinize this relationship.

Two possible approaches may disentangle this issue: (1) to have the true number of residential burglar alarms in use in the city; and (2) to use the rates (which range from 0 to 1 regardless of the volume of actual cases) rather than raw numbers for further statistical analyses. For the current study, the first option is impossible; only the estimated number based on residential burglar alarm permits from City Hall is available. The second option is plausible and available. Many of the following statistical and spatial analyses use the rates based on raw numbers of NAI and AI burglaries and burglar alarms. The unit of analysis for this is the census tract.

(2) The relationship between NAI and AI residential burglaries according to the changed rates

In Newark, N.J., police data show that the incidences of both NAI and AI burglaries have decreased since 2001. The question is whether the differences in the degree of change are statistically significant over the years. The second approach is to examine the statistical significance of these changed rates of NAI and AI burglaries over a five-year period. The former will be calculated by dividing the total number of the NAI burglaries by the total number of households. The latter can be found by dividing the total number of the AI burglary by the total number of residential burglar alarm permits. Then, these change rates will be compared using the chi-square test to determine whether a statistically significant relationship exists.

Table 7.3 illustrates the results of the chi-square analysis. The chi-square value is 14.021 with four degrees of freedom, demonstrating that even though the two differently conditioned residential burglaries have decreased over the years, the differences in the degree of decrease are statistically significant at the 0.01 level.

The result suggests that the decrease in incidences of residential burglary at AI houses is greater than that of NAI houses. This finding confirms the argument that there have been substantial decreases in residential burglary incidents at both NAI and AI houses since 2001.

[Table 7.3] The chi-square test by year and NAI/AI residential burglaries in Newark, NJ

Type	Year					TOTAL
	2001	2002	2003	2004	2005	
NAI Burglary	2,621	2,570	2,331	2,254	1,568	11,344
AI Burglary	107	108	75	54	57	401
TOTAL	2,728	2,678	2,406	2,308	1,625	11,745
Chi-Square Test	$X^2 = 14.011^{**} (df=4)$					

** Statistically significant at the .01 level.

In addition, it should be noted that these analyses only consider two variables (year and NAI/AI burglaries). It is not clear whether these statistically significant relationships between the two types of residential burglaries are solely based on the two variables or whether there are other factors influencing the relationships. It is expected that if other socio-economic factors are included, the statistical analysis may show different results. Further advanced statistical analyses are necessary with more relevant variables.

2. The Relationship between Burglar Alarms and NAI Burglary according to the Changed Proportions

Together with the chi-square test, the changed proportions of residential alarm permits and NAI burglaries can be compared over multiple years. The former values will be calculated by subtracting the value of the previous year (e.g., 2001)

from a given year (e.g., 2002), and then dividing the subtracted value by the previous year's raw number.

Table 7.4 shows the percentage of residential burglaries at AI houses from 2001 to 2005. For example, in 2005 there were 2,937 burglar alarm systems and 57 reported residential burglaries at AI houses, translating into only 1.94 percent, or two out of 100, of the AI houses were victimized by residential burglary. On the other hand, in 2005 there were 1,568 NAI burglaries. Based on the estimated number of total housing units, the proportion of NAI burglaries is 1.6 percent. This number is lower than that of AI burglaries, and thus it may be argued that a house with a residential burglar alarm system is no better protected.

There are several possible explanations to consider that may have caused this result. The total number of residential burglar alarms is based on the alarm permit records from City Hall. As discussed briefly in Chapter 5, the records come from voluntary permit applications by residents. But these records do not reveal the true number of burglar alarms in use. Some Newark, N.J., residents have installed alarm systems in their houses, but did not apply for an alarm permit. There is no way even to estimate the total number of burglar alarms in use without a door-to-door survey. Thus, the total number of burglar alarms in use may be much higher, and the percentage of AI burglaries may be far lower than the numbers shown in Table 7.4.

[Table 7.4] Changed percentages and proportions of AI and NAI residential burglaries annually in Newark, NJ

Type		Year				
		2001	2002	2003	2004	2005
Alarm-installed (AI) Burglary	Total Burglar Alarms	1,560	1,476	2,164	2,701	2,937
	AI Residential Burglary	107	108	75	54	57
	<i>Change over Year (%)</i>	-	+ 0.93	- 30.56	- 28.00	+ 0.06
	Percentage of AI Burglary	6.86	7.32	3.47	1.99	1.94
	<i>Change over Year (%)</i>	-	+ 7.71	- 52.60	- 42.65	- 2.51
Non-alarm-installed (NAI) Burglary	Total Housing Unit	98,429	94,683	99,919	98,063	98,211
	NAI Residential Burglary	2,621	2,570	2,331	2,254	1,568
	<i>Change over Year (%)</i>	-	- 1.95	- 9.30	- 3.30	- 30.43
	Percentage of NAI Burglary	2.66	2.71	2.33	2.30	1.60
	<i>Change over Year (%)</i>	-	+ 1.88	- 14.02	- 1.29	- 30.43

(Source: Newark Police Department)

Although this consideration may show bias against the true picture of changed proportions of AI and NAI burglaries, these numbers still give some insightful information about the relationship between burglar alarms and residential burglaries. For example, numbers and percentages of AI burglary have persistently decreased, while the percentage of NAI burglary has remained relatively stable over the years. In particular, the fact that alarm permits have increased rapidly and AI burglary occurrences remain stable may indicate that the relationship between the installation of burglar alarms and NAI burglary is statistically substantial.

III. Correlated Relationship of Burglar Alarms and Residential Burglaries

1. Multiple Correlation Analyses with Variables

The chi-square statistical test is useful as an approach to determine whether a statistically significant relationship exists among variables, but it is limited in providing a measure of the strength of the relationship among variables.

Correlation statistics are descriptive statistical analyses that define the strength of one variable as it is related to another variable or variables. Several variables (e.g., year, NAI burglary, AI burglary, and residential burglar alarms) are used in correlation statistics to check for significant relationships and the strength of such relationships (e.g., the relationship between the increase of residential burglar alarms and the decrease of AI burglary over the years). Then multiple correlation analysis will be employed to test the strength of one variable (e.g., year and alarm permit) as it is related to other variables (e.g., NAI and AI burglaries).

Table 7.5 displays multiple correlation statistics between year and several other variables. As discussed previously in chi-square tests, the statistical significance exists between the year and the two differently conditioned residential burglaries, but the test does not explain the magnitude and direction of such statistical relationships. Table 7.5 shows both statistical relationships using multiple correlation statistics with the year and other variables through the use of raw numbers and rates of burglar alarms and burglaries. Both correlation statistics reveal very similar results.

For example, as discussed previously, the number of residential burglar alarms (Burglar Alarms [2]) in use had increased over the years with a positive and very strong statistical significance at the 0.05 level. On the other hand, three categories of burglaries (e.g., Total Burglary [3], NAI Burglary [4], and AI Burglary [5]) have negative and very strong significances at the 0.05 or 0.01 levels.

Correlation statistics between burglar alarms [2] and the NAI burglary [4] show a negative direction, suggesting that whereas the number of burglar alarms in use increases, the number of NAI burglary decreases over the years (though there is no statistical significance using the raw numbers). The same relationship is found between burglar alarms [2] and the AI residential burglaries [5]. But the correlation value for the latter is higher than the former, indicating that the magnitude of the decrease is larger.

[Table 7.5] Multiple correlation statistics between year and burglar alarms and NAI/AI residential burglaries in Newark, NJ

Variable	By Raw Numbers					By Rates				
	(1)	(2)	(3)	(4)	(5)	(1)	(2) ^b	(3) ^c	(4) ^d	(5) ^e
Year (1)	1					1				
Burglar Alarms (2)	.953*	1				.936*	1			
Total Burglary ^a (3)	-.922*	-.882*	1			-.968**	-.934*	1		
NAI Burglary (4)	-.909*	-.863	.999**	1		-.962**	-.912*	.998**	1	
AI Burglary (5)	-.930*	-.986**	.797	.774	1	-.914*	-.956*	.881*	.864	1

^a It is calculated by adding numbers of both NAI and AI burglaries.

^b It is calculated by dividing the number of alarm permits by the total number of households.

^c It is calculated by dividing the total number of burglaries by the total number of households.

^d It is calculated by dividing the number of NAI burglary by the total number of non-alarm-installed households.

^e It is calculated by dividing the number of AI burglary by the total number of burglar alarm permits.

* Statistically significant at the .05 level

** Statistically significant at the .01 level

Unlike the previous chi-square statistics, Table 7.5 shows the directions and magnitude of these statistically significant relationships among variables. Thus, though both statistics are preliminary to further statistical analyses, together with Tables 7.2, 7.3, and 7.5, chi-square and multiple correlation approaches play a role in the fundamental analytical rationale and assumption for this study and further analyses.

However, the issue of a causal relationship among the variables must be noted. For example, correlation statistics in Table 7.5 show that over the years the number of burglar alarms in use increased, while the number of NAI burglary decreased. Though a significant relationship exists between these two variables, which one comes first is uncertain. Does NAI burglary decrease because of an increase of burglar alarms being installed in neighborhoods or is the causal relationship just the opposite? The cause cannot be explained using these statistical methods, and it may be too early to make any suggestions about those relationships. Advanced multiple regression analysis may give some insights and answer these questions.

2. Binary Correlation Analyses for Burglar Alarms and Burglaries in the Census Tract

For binary correlation analysis, 90 census tracts in the city were used, and all incidences of burglar alarms and NAI and AI burglaries were regrouped according to each census tract, producing a table with rates of burglar alarm installations and NAI/AI burglaries for 90 census tracts. Table 7.6 presents the numbers for 2001. Five more tables were prepared for further analyses, including the remaining four

years and an overall five-year table (see Appendix 2 on pages 319-320). Thus, statistical results from correlation and regression tests are presented for each year and the overall period from 2001 to 2005. The unit of analysis here is the census tract ($N=90$).

[Table 7.6] Rates of alarm installation¹ and NAI/AI residential burglaries² for 90 census tracts in Newark, NJ, 2001

Tract ID	Alarm Installation	NAI Burglary	AI Burglary	Tract ID	Alarm Installation	NAI Burglary	AI Burglary	Tract ID	Alarm Installation	NAI Burglary	AI Burglary
1	0.016	0.013	0.056	31	0.079	0.129	0.056	61	0.004	0.018	0.000
2	0.093	0.022	0.043	32	0.007	0.037	0.728	62	0.009	0.009	0.000
3	0.008	0.014	0.000	33	0.035	0.033	0.136	63	0.004	0.015	0.000
4	0.004	0.016	0.364	34	0.017	0.047	0.081	64	0.012	0.015	0.049
5	0.025	0.018	0.000	35	0.053	0.036	0.070	65	0.008	0.066	0.000
6	0.018	0.011	0.000	36	0.014	0.023	0.073	66	0.008	0.034	0.000
7	0.009	0.023	0.097	37	0.008	0.037	0.000	67	0.003	0.028	0.000
8	0.014	0.011	0.000	38	0.038	0.029	0.045	68	0.004	0.015	0.000
9	0.004	0.015	0.182	39	0.008	0.021	0.104	69	0.010	0.013	0.000
10	0.025	0.029	0.061	40	0.038	0.032	0.000	70	0.003	0.013	0.000
11	0.027	0.035	0.073	41	0.034	0.026	0.045	71	0.004	0.018	0.000
12	0.010	0.041	0.182	42	0.026	0.019	0.058	72	0.000	0.074	0.000
13	0.010	0.027	0.000	43	0.028	0.026	0.029	73	0.001	0.022	0.728
14	0.019	0.014	0.000	44	0.041	0.014	0.042	74	0.002	0.011	0.000
15	0.006	0.029	0.000	45	0.014	0.029	0.146	75	0.017	0.109	0.000
16	0.003	0.029	0.000	46	0.006	0.024	0.073	76	0.002	0.009	0.000
17	0.022	0.056	0.056	47	0.026	0.009	0.022	77	0.014	0.056	0.000
18	0.023	0.053	0.052	48	0.031	0.040	0.000	78	0.011	0.026	0.000
19	0.011	0.021	0.097	49	0.017	0.011	0.000	79	0.004	0.025	0.364
20	0.059	0.037	0.111	50	0.042	0.035	0.052	80	0.001	0.008	0.000
21	0.015	0.009	0.094	51	0.029	0.027	0.000	81	0.013	0.029	0.000
22	0.039	0.017	0.097	52	0.007	0.019	0.104	82	0.010	0.047	0.121
23	0.041	0.034	0.148	53	0.012	0.104	0.437	83	0.010	0.040	0.121
24	0.023	0.025	0.000	54	0.008	0.023	0.000	84	0.021	0.011	0.020
25	0.016	0.020	0.128	55	0.018	0.020	0.038	85	0.008	0.008	0.156
26	0.007	0.047	0.000	56	0.019	0.021	0.121	86	0.012	0.033	0.000
27	0.087	0.047	0.036	57	0.001	0.014	0.000	87	0.007	0.014	0.162
28	0.030	0.055	0.000	58	0.002	0.026	0.000	88	0.037	0.452	0.000
29	0.014	0.050	0.364	59	0.011	0.045	0.081	89	0.006	0.026	0.291
30	0.007	0.037	0.000	60	0.009	0.027	0.000	90	0.000	0.020	0.000

¹ The alarm installation rate is calculated by dividing the number of alarm permits by the number of housing units in each census tract.

² The rate of NAI burglary is calculated by dividing the number of NAI burglaries by the number of housing units in each census tract, while the rate of AI residential burglaries is calculated by dividing the number of AI burglaries by the number of the total number of alarm installations in census tracts.

[Table 7.7] Binary correlation coefficients (Pearson's r) for burglar alarms with NAI/AI burglaries for 90 census tracts annually in Newark, NJ

Variable	NAI Residential Burglary						AI Residential Burglary					
	Year	2001	2002	2003	2004	2005	Overall	2001	2002	2003	2004	2005
Pearson's r	.217*	.247*	.320**	.259**	.137	.257*	-.123	-.081	-.095	-.022	-.004	.030

* Statistically significant at the .05 level

** Statistically significant at the .01 level

The first approach is a binary correlation analysis between the installation rates of residential burglar alarms and the rates of NAI/AI burglaries on a census tract. Table 7.7 presents the binary correlation coefficient and statistical significances. The value of Pearson's r for the overall period (2001-2005) with the NAI burglary is 0.257 with a statistical significance at the 0.05 level, demonstrating that the correlation between burglar alarms and NAI burglary is positive and moderate. As the rate of residential alarm installations increases, so does the rate of NAI burglary in the tracts. In other words, the positive correlation between these variables indicates that tracts with higher rates of alarm installations also tended to have higher rates of NAI burglary, whereas tracts with lower rates of alarm installations tended to have lower rates of NAI burglary. The strength of this relationship each year is 0.236 on average and 0.257 with the overall period. As Cohen (1988) suggests, a correlation around 0.30 may be defined as a moderate relationship. Thus, the relationship between the rates of alarm installations and NAI burglary is not a strong one. But this moderate relationship may explain that even though an increased rate of alarm installation can be a positive causal factor to NAI burglary, its relationship is not direct. Other factors might more plausibly explain this relationship. However, as discussed before, these statistics do not show a

causal relationship. It is still uncertain if an increase of NAI burglary caused an increase of residential burglar alarms, or vice versa.

IV. Bivariate Regressions of Burglar Alarms and Residential Burglaries

The bivariate regression analysis uses the rates of burglar alarm installations and NAI burglary. Table 7.8 shows the values of bivariate regression model of NAI burglary. For example, in a regression model of burglar alarms on NAI burglary, the regression coefficient β , which estimates how the change in an independent variable (NAI burglary) influences change in a dependent variable (burglar alarm), is around 0.14 on average, indicating that a change of one unit (i.e., 1 percent increase/decrease) in the NAI burglary rate can produce a change of β units in the estimated value of the installation rate of burglar alarms. In other words, on average, for every one-unit increase in the NAI burglary rate in a census tract, the installation rate of residential burglar alarms increases by about 0.14 percent. Furthermore, β values increase over years. In 2001, β value was 0.08, but in 2005, it was 0.179, showing that with the same one-unit increase in the NAI burglary rate at the census-tract level, the installation rate of burglar alarms has more than doubled from 8 percent to 17.9 percent throughout the years.

[Table 7.8] Bivariate regression coefficients of burglar alarms on NAI residential burglary annually in Newark, NJ¹ ($N=90$ census tracts)

Variable	NAI Residential Burglary					
	Year	2001	2002	2003	2004	2005
R²	.048 *	.062 *	.103 **	.067 *	.019	.066 *
b	.015	.014	.018	.025	.028	.019
Coefficient (β)	.080 *	.111 *	.203 **	.120 *	.179	.138 *
Standard Error	.038	.046	.064	.048	.138	.055
Beta	.219	.248	.321	.258	.137	.257
t	2.10 *	2.40 *	3.18 **	2.51 *	1.30	2.50 *

¹ Dependent variable is the rate of alarm installation.

* Statistically significant at the .05 level

** Statistically significant at the .01 level

*** Statistically significant at the .001 level

In addition, the values of R^2 , which is the percent of variance explained, for NAI burglary are, on average, 0.06, indicating that about 6 percent of the variance in installation rates of residential burglar alarms in Newark census tracts is explained by the rate of NAI burglary. As a general rule in criminal justice, regression models seldom result in R^2 values greater than 0.40. If its value is larger than 0.40, it is usually assumed that the prediction model is a powerful one. Conversely, when the percent of variance explained is less than 0.15 or 0.20, the model is likely to be viewed as relatively weak in terms of prediction (Weisburd and Britt, 2003). Since R^2 values for rates of burglar alarm installations and NAI burglary is 0.06, the prediction model would be considered weak. However, in this bivariate regression analysis of burglar alarms on NAI burglary, the R^2 value clearly shows that the installation pattern of burglar alarms can somehow be explained by NAI burglary. Furthermore, though this regression analysis indicates a weak predictive power, the statistical test for the overall regression model is significant at both 0.05 and 0.01 levels.

V. Multiple Regression Analyses of Burglar Alarms and Residential Burglaries

As observed, though there were significant relationships in the bivariate regression analyses for both burglar alarms and NAI burglary, the values of R^2 were too small to be powerful predictors that explain relationships. Of course, it is not surprising in the social science field that one independent variable has a rather weak magnitude and thus weak ability to explain the dependent variables. The weak power of one independent variable on a dependent variable in a bivariate regression analysis indicates that other dependent variables that have more explanatory and predictive power exist. It is necessary to conduct multiple regression analyses to complement the shortcomings of the bivariate regression analyses and to disentangle the various potential factors that have an impact on the dependent variable. Such an approach can provide a better and more accurate understanding of the relationship of burglar alarms and NAI residential burglary with other variables.

Multiple regression approaches here have three aims. The first is to identify which variable(s) is the most powerful or more powerful among the various independent variables to explain the dependant variables (e.g., burglar alarms or NAI burglary). The second aim is to examine the relationships or changes of independent variables in regression models on dependant variables (e.g., burglar alarms and NAI burglary). The third aim is, holding constant the two dependant variables, to examine how much independent variables can explain and predict the dependant variables.

There are several methods of multiple regression analysis to estimate a causal relationship and prediction level between a dependant variable and independent variables that can be used. For example, four different methods are available to put independent variables into a regression model (e.g., enter, stepwise, backward elimination, and forward selection using SPSS statistical software). They can be incorporated with a blocking technique of the independent variables. One advantage of the blocking technique (over other entering methods of independent variables) is that it holds important independent variable(s) constant during further analyses so that variations of the important independent variables on the dependant variable can be easily observed and examined.

As discussed earlier, the primary concern of this study is to examine the relationship between residential burglar alarms and residential burglaries. The chi-square and correlation statistics show that these two variables constantly maintained a statistically significant relationship over multiple years with some of the independent variables. For the following two advanced multivariate regression models, burglar alarms and NAI burglary are used as dependent variables among with several independent variables, which are statistically significant in correlation and regression analyses (see Appendices 4 and 5) among the lists of the variables for correlation and regression analyses (see Appendix 3).

Among the various linear regression variable selection methods, all of which have advantages and disadvantages when used, forward selection and hierarchical selection are used here. For example, enter method is a procedure for variable selection in which all variables in a block are entered in a single step (SPSS Inc.,

2004). One disadvantage of this approach is that if there are too many independent variables, multivariate regression analyses will be inconsistent and pointless because not all variables may show significant relationships with the dependent variable, and, thus, the overall regression model may be misleading concerning the relationship between the dependent variable and independent variables.

The forward selection regression approach will be used with residential burglar alarms as the dependent variable, and the hierarchical selection regression method will be used with NAI burglary as the dependent variable for further multivariate regression analyses. These methods can disentangle the relationship between burglar alarms, NAI burglary and other independent variables, as well as provide a clearer understanding of that relationship.

1. Forward Selection Multiple Regression Analyses of Burglar Alarms

Forward selection is a stepwise variable selection procedure in which variables are sequentially entered into a regression model. The first variable considered for entry into the equation is the one with the largest positive or negative correlation with the dependent variable. This variable is entered into the equation only if it satisfies the criterion for entry. If the first variable is entered, the independent variable not in the equation that has the largest partial correlation is considered next. The procedure stops when there are no variables that meet the entry criterion (SPSS Inc., 2004). The backward elimination method²⁰ is opposite to it. The advantage of the

²⁰⁾ The backward elimination method is a variable selection procedure in which all variables are entered into the equation and then sequentially removed. The variable with the smallest partial correlation with the dependent variable is considered first for removal.

forward selection approach over the backward elimination approach is that it can identify sequentially which independent variable is the most powerful predictor of the dependent variable among various independent variables.

Table 7.9 shows the forward selection regression models to scrutinize the effect of independent variables on the dependent variable burglar alarm. The analyses for each year from 2001 to 2005 are presented in Appendix 6. At first, nine independent variables²¹, which showed statistical significance from the Pearson correlations, were entered into this regression method. Among them, five variables were included in the forward selection models, while others were excluded. The selection of the independent variable in each regression model is based on the statistical significance from higher to lower value.

The five models are included with each model having a different number of independent variables. Each regression model adds one more variable sequentially. Thus, the final model has five independent variables. Black population is included in the first model, being followed by house occupied by homeowner, householder age group from 25 to 34, NAI burglary, and general population age group under 14 years old.

If it meets the criterion for elimination, it is removed. After the first variable is removed, the variable remaining in the equation with the smallest partial correlation is considered next. The procedure stops when there are no variables in the equation that satisfy the removal criteria (SPSS Inc., 2004).

²¹) They are NAI burglary, black population, non-black population (both white and others populations), population with ages under 14, unemployment, black householder, non-black householder (both white and others householder population), householder ages 25 to 34, and home occupied by owner.

[Table 7.9] Forward selection multiple regression of burglar alarms for overall (2001-2005) in Newark, NJ ($N=90$ census tracts)

Independent Variables	Dependent Variable (=Burglar Alarm)																			
	Model 1				Model 2				Model 3				Model 4				Model 5			
	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	<i>b</i>	<i>SE</i>	Beta	<i>t</i>
Black Population	.021	.006	.354	3.55 **	.021	.006	.355	3.74 ***	.025	.005	.424	4.70 ***	.024	.005	.406	4.59 ***	.015	.006	.253	2.47 *
Owner Occupied					.045	.014	.303	3.19 **	.051	.013	.340	3.82 ***	.049	.013	.327	3.77 ***	.058	.013	.389	4.47 ***
Householder Ages 25-34									.141	.037	.343	3.78 ***	.137	.036	.335	3.78 ***	.113	.036	.276	3.13 **
NAI Residential Burglary													.107	.047	.200	2.30 *	.161	.049	.299	3.27 **
Population Ages <=14																	.092	.034	.293	2.69 **
<i>F</i>	12.590 **				12.054 ***				14.034 ***				12.377 ***				12.073 ***			
Constant	.011				.000				-.031				-.033				-.049			
<i>R</i> ²	.125				.217				.329				.368				.418			

* Statistically significant at the .05 level

** Statistically significant at the .01 level

*** Statistically significant at the .001 level

Some insightful findings are worth discussing in the installation pattern of residential burglar alarms. The first model is a bivariate regression with black population as the independent variable. The regression coefficient β for the effect of black population on burglar alarms is 0.011, indicating that with every 1 percent increase in the black population in the city, the installation rate of burglar alarms increases by more than 1 percent. The R^2 value for the variable is 0.125, which indicates that the black population explains, on average, about 13 percent of the variation in burglar alarms. The statistical test of this first regression model is significant at the 0.01 level. Though the black population is the variable among the independent variables that has the largest positive correlation (Pearson $r = 0.354$) with the dependent variable of burglar alarms, the R^2 value is relatively low.

In the following models in Table 7.9, the regression coefficient β for the effect of other independent variables on the dependent variable of burglar alarms shows a wide range of values, but is consistent among different models. For example, the β value for black population in the five regression models is, on average, 0.028. The β value of owner-occupied houses in the four regression models is, on average, 0.051. Each β value of the other independent variables, which are included in Models 2 to 5, maintains a similar range, indicating that each variable has a comparable impact on the dependent variable, though it is joined with other variables in the different regression models.

These β values provide a method for estimating how change in an independent variable influences a dependent variable, and can be used to make predictions in the multiple regression equation, though it often does not provide a

solid basis for predictions beyond a certain range. For example, in a series of regression models, β values show that the householder age group from 25 to 34 and NAI burglary produce the most impact on the dependent variable burglar alarms with the highest values in models four and five, respectively. The variable, owner-occupied housing also has substantial impact on burglar alarms. But the black population does have a higher β value compared with the other independent variables. The population age group under 14 years old has a relatively high β value, but it is included only in the last regression model. Thus, this regression approach based on various β values shows that among the independent variables, owner-occupied houses, householder age group 25 to 34, and NAI burglary consistently have a greater impact on burglar alarms over the other variables.

Another way to compare the impact of the different independent variables examined in the regression models is to check the standardized regression coefficient *Beta*. Table 7.9 also shows values of *Beta*, which is used to compare the influence the independent variable examined in the regression model has on the dependant variable, using the standardized regression coefficients. Unlike the regression coefficient β , which is used for both explanation and prediction on the dependent variable, *Beta* values mostly compare which independent variable, among multiple variables, has the largest effect on the dependent variable. It is not used for prediction in the regression equation. In the first model, the black population is included because this variable has the highest correlation value among the group of independent variables, implying that it has the greatest impact on the dependant variable of burglar alarms. In the following four regression models,

which enable the comparison of *Beta* values among the independent variables within and among the models, the black population generally has the greatest impact on the dependant variable over the other independent variables. For example, in Models 2, 3, and 4, the black population variable has the highest *Beta* value. But in Model 5, it ranks third after owner-occupied housing and NAI burglary.

*R*² values in the regression models increase from 0.125 to 0.418, indicating, in general, that a regression model with more correlated independent variables has a higher percent of the variation in the burglar alarm installation. The more independent variables that are included in regression models, the higher the explanatory power of the model. In addition, the *F* values show that overall statistical significances of the five regression models are statistically significant at the 0.01 level for the first model and 0.001 level for the remaining models.

Considering the above statistics, it is possible to list the best variable(s) to explain and predict the dependent variable of burglar alarms. In particular, the β values among the regression models indicate that NAI burglary, householder age group 25 to 34, and population age less than 14 years old have a greater impact in predicting and explaining the dependent variable. On the other hand, *Beta* values show that the black population, owner-occupied houses, householder age group 25 to 34, and NAI burglary have a greater impact on the dependent variable.

As for the prediction of installation patterns of residential burglar alarms in Newark, N.J., the best predictor among the group of independent variables can be owner-occupied housing. Yet, other variables—such as black population, householder age group 25 to 34, and NAI burglary—also are substantially important

in predicting the installation pattern of residential burglar alarms. It may be more plausible to suggest that a group of powerful indicators rather than a single independent variable best explains and predicts the dependent variable because some variations exist in the β and *Beta* values for each variable in the different regression models. Thus, singling out the most influential variable on the dependent variable may be disputable. But it is conceivable to suggest that a group of variables share a relatively great impact on the dependent variable. Therefore, owner-occupied housing, black population, householder age group 25 to 34, and NAI burglary are the group of independent variables that best explain and predict the dependent variable burglar alarm in Newark, N.J.

For example, from 2001 to 2005, the number of residential burglaries decreased steadily, whereas the number of residential burglar alarms installed had increased progressively. As discussed earlier, one of the research questions was about the relationship between the decrease of residential burglaries and the increase of burglar-alarm installation. The previous correlation statistics show that this relationship is statistically significant. But it does not explain the causal relationship. In other words, does the steady increase of residential burglar-alarm installation directly produce the consistent decrease of residential burglaries?

The above forward selection regression approach can answer this question. Only the fourth and fifth models include the NAI burglary variable in the regression analyses. Although the β value of NAI burglary is the highest in Model 5, *Beta* values in Models 4 and 5 show that NAI residential burglary does not have the highest value. Thus, NAI burglary does not have the greatest impact on the dependent

variable in this regression model. In other words, residential burglaries, among the group of independent variables, is not the most powerful (or influential) predictor for the residents to decide to install burglar-alarm systems in their houses. But as discussed, it is more plausible to suggest a group of independent variables, rather than to single out one variable to explain and predict the dependent variable. NAI burglary is one variable of this group.

The results imply that some positive causal relationship exists between burglar alarms and NAI burglary. People in neighborhoods with relatively higher numbers of NAI burglary are more likely to have burglar alarms installed. Even though the total number of residential burglaries had decreased in the city, the neighborhoods with a higher proportion of residential burglaries tend to have relatively more crimes. As a consequence, the level of fear of crime may be higher than neighborhoods with lower crime rates, and thus, it may boost house owners in these higher crime neighborhoods to have more residential burglar alarms installed. This observation is consistent in a sense that the bivariate correlation between burglar alarms and NAI burglary showed a strong positive relationship in the earlier analysis.

As discussed, the variable, owner-occupied houses, has a better explanatory and predictive power than NAI burglary. Homeowners definitely tend to be more concerned about the safety of their house residents and security in and around their houses than renters. Such concerns for safety and security may give some incentive for the owners to have burglar alarms installed. The variable also is related to

economic condition. In other words, homeowners are in a better financial situation to put their concerns into practice by installing residential burglar alarms.

In addition, for the last few years in the study, the number of residential burglar alarms installed in Newark, N.J., increased. But residential burglar alarms were not equally distributed throughout the entire city. In areas with a higher black population as the largest population category, burglar alarms were more likely to be installed. The reason for this behavior is unknown, but two possible answers exist. First, even though the overall number of residential burglaries had decreased from 2001 to 2005 throughout the entire city, the fear of crime among the black population in particular had not decreased, encouraging more residents in these neighbors to install residential burglar alarms at their homes. Second, these black-dominant neighborhoods, though the overall number of crimes had decreased, still have a relatively higher number of residential burglaries than communities with white or other races.

Furthermore, the householder age group of 25 to 34 is a substantial variable in explaining the dependent variable of burglar alarms, which implies that relatively younger householders tend to have more burglar alarm systems than older householder age groups, most likely because they tend to be concerned more about security and safety within and around their houses. This observation can be explained in several ways. First, though younger age groups, in particular, between 25 and 34 years old have houses, in general, they still need to work full-time due to financial responsibilities. Consequently, these houses are less likely to be occupied during the daytime on weekdays than the houses of the older owners. So, younger

householders tend to consider security a more serious concern and have residential burglar alarms installed as a guidance and deterrent. Second, younger people are more likely to have more expensive and portable electronic products (e.g., DVD players, HDTV, computer games, computers), which to residential burglars are hot items that are easy to carry and fence. Thus, houses with younger occupants and lighter and more expensive electronic products are more likely to be victimized by residential burglary. Third, younger householders tend to have more babies, toddlers, or children at their houses than older householders. They pay more attention to their children's safety by installing residential burglar alarms at their houses. All these factors may explain the relationship between the residential burglar-alarm installation pattern and the householder age group of 25 to 34. The arguments above have to be verified with further analyzed to have a better understanding of the relationship between the installation pattern of residential burglar alarms and other variables. A geographic analysis using a crime-mapping technique will be employed in Chapters 8 and 9.

Also, a series of the forward selection regression models implies that even though all statistically significant variables are included in the analysis, the overall R^2 value in the last model is 0.418, indicating that the regression model explains only about 42 percent of the variations in residential burglar alarms. In other words, this approach gives some insight into the pattern of residential burglar alarms, but the explanatory power is relatively weak. More than half of the variation (about 58 percent) in residential burglar alarms is unexplained by this forward selection regression approach, implying that there are other more relevant variables to better

explain the installation pattern of residential burglary alarms. Thus, further research is imperative to study the other independent variables in order to disentangle the relationship of burglar alarms.

2. Hierarchical Multiple Regression Analyses of NAI Burglary

As discussed above, several different methods to analyze the effect of independent variables on the dependent variable in multivariate regression are available, with the hierarchical multiple regression approach among them. As mentioned earlier, one of the primary purposes of this study is to examine the relationship between burglar alarms and NAI burglary. For the analysis of the effect of burglar alarms with other independent variables on NAI burglary, a hierarchical multivariate regression approach is employed. Thus, the independent variable, burglar alarms, was held constant in this analysis, while other independent variables were entered into further regression models.

Like the forward selection regression method, the hierarchical regression method incorporates a blocking technique with the independent variables, which holds important independent variable(s) constant during further analyses so that variations of the important independent variables on the dependant variable can be easily observed and examined. The hierarchical multivariate regression method can be used to determine which independent variable is more important than other independent variables in predicting the dependent variable. It is possible in the hierarchical regression method to manipulate the number of regression models and independent variables in each regression model, whereas in the forward selection regression approach the selection process of the number of models and

independent variables is carried out by SPSS software, according to the degree of statistical significance. Thus, instead of entering all the independent variables into multiple regression equation simultaneously, this approach enables the isolation of the influence of one particular independent variable.

The process for this hierarchical multiple regression is to enter one independent variable into the analysis, and then add the remaining variables by blocking the variables into a group, which will be entered in sequence. For instance, the independent variable burglar alarms is an important variable to explain the pattern of NAI burglary. Thus, burglar alarms would be entered into the hierarchical multivariate regression first, and then the four groups of independent variables, which are based on statistical significance, would be entered sequentially into the remaining analyses. The number of regression models depends on the number of the sequence.

Table 7.10 shows the results of the hierarchical multiple regression for the overall period (2001-2005) with five models to examine the effect of the groups of independent variables on the dependent variable, NAI burglary. The analyses for each year from 2001 to 2005 are presented in Appendix 7.

Seven independent variables, which showed consistent statistical significances from the Pearson correlation, were included in this regression approach with five different groups. Unlike the previous forward selection regression method, in the hierarchical regression approach the consecutive regression models do not necessarily add one independent variable in each model. For example, the first regression model includes one independent variable, burglar

alarms. Models 2, 4, and 5 also have one more variable added to the previous model. But Model 3 has three more variables added. The composition of each group of independent variables depends on the statistical significance and relevance. For instance, the general population age category has ten relevant variables, but not all of them show consistent statistical significance. These variables were regrouped according to the statistical significance and direction as discussed previously. Finally, three re-ordered (e.g., population age below 17, 25 to 44, and over 45 years old) were entered into Model 3 in this regression method.

[Table 7.10] Hierarchical multiple regression of NAI residential burglary for overall period (2001-2005) in Newark, NJ (N=90 census tracts)

Independent Variables	Dependent Variable (=NAI Residential Burglary)																				
	Model 1				Model 2				Model 3				Model 4				Model 5				
	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	<i>b</i>	<i>SE</i>	Beta	<i>t</i>	
Burglar Alarm	.479	.192	.257	2.50*	.715	.166	.384	4.32***	.731	.118	.393	6.190***	.565	.106	.303	5.34***	.566	.107	.304	5.32***	
Unemployment					.212	.034	.547	6.15***	.195	.024	.505	8.034***	.152	.022	.392	6.81***	.154	.023	.397	6.64***	
Population Ages <=17									-.153	.057	-.300	-2.672***	-.138	.049	-.272	-2.81**	-.136	.050	-.268	-2.74**	
Population Ages 25-44									.116	.065	.213	1.79	.075	.056	.138	1.34	.074	.057	.136	1.31	
Population Ages >=45									-.228	.058	-.371	-3.91***	-.241	.050	-.391	-4.80**	-.229	.063	-.371	-3.63***	
Householder Ages 60-64													.387	.070	.325	5.56***	.386	.070	.324	5.49***	
Householder Ages >=65																	-.014	.044	-.026	-.75	
<i>F</i>	6.236*			23.299***			40.206***			50.565***			42.885***								
Constant	.018			-.065			.010			.013			.012								
<i>R</i> ²	.066			.349			.705			.785			.785								

* Statistically significant at the .05 level

** Statistically significant at the .01 level

*** Statistically significant at the .001 level

Some observational findings are meaningful in discussing the pattern of NAI burglary. The independent variable burglar alarms, which has a positive but relatively weak significant relationship (Pearson $r = 0.257$), was included to examine the effect of it on the dependent variable, NAI burglary. The regression coefficient β for the burglar alarm variable is 0.479. The R^2 value is 0.066, which indicates that burglar alarms explain, on average, about 7 percent of the variation in NAI burglary. The statistical test with this model is significant at the 0.05 level. These values imply that though NAI burglary effects residential burglar alarms, its explanatory and predictive power is relatively weak in this first bivariate model of the hierarchical regression approach.

In the following four regression models, the regression coefficient β for the impact of the groups of independent variables on the dependent variable, NAI burglary, show a large range of values. But β values for each independent variable over the models are consistent in manner. For example, each β value for burglar alarms in the five models is highest over other independent variables, ranging from 0.479 to 0.731. The average β value for burglar alarms from all five models is 0.611, which is still the highest value over the other variables. The average β value of the population age over 45 years old is 0.233 among Models 3, 4, and 5, which have a close range of values. The results imply that though each independent variable is entered in different regression models with another independent variable, it maintains a consistent and certain degree of impact on the dependent variable of NAI burglary.

These β values can be used to estimate how change in an independent variable effects change in a dependent variable and predicts the multivariate regression equations. For instance, in a series of hierarchical regression models, β values for burglar alarms produce the highest dependent variable of NAI burglary among the Models. The independent variable for the householder age group 60 to 64 has a comparable impact on NAI burglary. In addition, the general population age group over 45 years old has a negative, but relatively higher impact, on the dependent variable, NAI burglary, when compared with the other remaining variables. Thus, this regression approach, based on the regression coefficient β values, shows that among seven variables, burglar alarms, householder age group 60 to 64, and population age group over 45 years old have a continual and greater impact over the other variables in explaining and predicting the dependent variable, NAI burglary.

In addition to the regression coefficient β , the standardized regression coefficient *Beta*, as discussed and used in the previous analyses, compares several independent variables in different regression models to examine which of the variables has the most influence on the dependant variable. Among the group of independent variables, unemployment has the highest *Beta* value throughout the five models with the average of 0.46, indicating that it has the greatest impact on the dependent variable. The population age group over 45 years old, householder age group from 60 to 64, and burglar alarms also have similar and relatively higher values compared with the remaining variables. Thus, the *Beta* values show that four of the seven independent variables (e.g., unemployment, population age over 45,

householder age over 65, and burglar alarms) have a significant and greater impact on the dependent variable, NAI burglary.

The R^2 values in the five regression models steadily increase from 0.06 to 0.785, indicating that, in general, the later regression models with more relevant independent variables cause a higher percentage of the variation in NAI burglary. The F values support the fact that the overall statistical tests of the five regression models are significant at the 0.05 level for the first model and at the 0.001 level for the remaining models.

Some of these insights need to be discussed. First, both β and *Beta* values from Table 7.10 disclose that burglar alarm, unemployment, population age group over 45, and householder age group 60 to 64 are the best predictors, though not necessarily in that order of degree of predictability, to explain and predict the dependent variable, NAI burglary, in Newark, N.J.

Second, unemployment is one of the most powerful variables in the hierarchical regression model, based on its *Beta* values, in explaining the phenomenon of NAI burglary. It is included in Models 2 to 5, maintaining the highest *Beta* value over the other independent variables in the regression models. A similar argument can be made to the one discussed in Table 7.9, which shows that the independent variable of owner-occupied housing is one of the powerful predictors for residential burglar alarms, in that economic condition also can be associated with unemployment. NAI burglary also is closely correlated to the economic condition of a neighborhood, in particular, as it relates to unemployment status. The literature on residential burglary persistently shows this positive

relationship (Cromwell and Olson, 2004; Shover, 1996; Bennett and Wright, 1984; Repetto, 1974). This study confirms that unemployment, to a degree, can predict residential burglary.

Third, the general population age group over 45 years old, though it covers a wide range of ages, is one of the more powerful predictors to explain and predict NAI burglary. In particular, unlike such other powerful independent variables as unemployment, burglar alarms, and householder age over 65, its relationship to NAI burglary is in a negative direction. In other words, if the number of NAI burglaries decreases, the number of residents in the population age group over 45 years old increases. This phenomenon can be explained in the way that younger age groups in this category (e.g., between 45 and 55 years old) with a higher population proportion than older age groups (e.g., over 60 years old) tend to live with their teenage children. These teenagers have electronic products and gadgets for music and games. These items are good targets to burglars because they are easy to carry and resell.

This argument can be interrelated with the earlier findings in Table 7.9, which shows that the general population age group under 14 years old is one of the predictive independent variables on the dependent variable, burglar alarms. In other words, an increase of this age group contributes to the increase of burglar alarm installations because parents are more concerned about safety and security for their children. Putting these results together, it can be concluded that where there are more residents over 45 years old with their children, there are more

houses with residential burglar alarms being installed and fewer houses being victimized by residential burglary.

Fourth, unlike any other category within the householder age groups, only the householder age group of 60 to 64 years old has some positive and substantial impact in explaining NAI burglary. The possible explanation for this observation is that the householders in this age group may only have two people in the house, a husband and wife, with any children now living lives elsewhere as adults. Most of those people have yet to retire or are preparing to do so. Those who have retired still may be busy doing other activities or volunteer work. As a consequence, their houses are more likely to remain unoccupied during the daytime when compared with much older age groups (e.g., over 65 years old). Thus, houses with occupants in the householder age range from 60 to 64 years old have a relatively higher chance to be victims of NAI burglary.

Finally, burglar alarms is one of the most substantial independent variables to explain and predict NAI burglary. Although it has relatively lower R^2 value in Model 1, in the consecutive regression models, burglar alarms keep a consistent and powerful relationship with NAI burglary. As discussed in previous analyses, the relationship between NAI residential burglary and burglar alarms is persistent.

It should be noted, however, that the findings from both the forward selection and hierarchical regression methods in Tables 7.9 and 7.10, regarding the relationship between burglar alarms and NAI burglary, may be contradictory. In other words, each of the two variables has a certain degree of impact on the other in the positive direction, indicating that burglar alarms have some contribution to the

effect of NAI burglary and vice versa. Thus, it is not certain which of the two comes first as an explanatory and predictive variable. Simple comparison of the β and *Beta* values does not answer this causal relationship. One possible solution to this issue is a spatial (or geographic) approach. According to the literature, the distribution of both NAI burglary and residential burglar alarms are not evenly dispersed throughout neighborhoods, implying that although quantitative analyses provide some insights into the research questions in this study, the relationship of burglar alarms and NAI burglary can be better understood through spatial (or geographic) analyses. These approaches will be presented in Chapters 8 through 10.

As for predicting NAI burglary in Newark, N.J., the best indicator among the group of independent variables is unemployment. Yet, other variables, such as burglar alarms, householder age groups from 60 to 64 years old, and population age groups over 45 years old, also are critical to explaining and predicting NAI burglary. As argued, it may be more plausible to suggest a group of powerful indicators, rather than listing a single independent variable that best explains and predicts the dependent variable, because some variation in the β and *Beta* values for each of these variables exists. Thus, it may be inappropriate to single out the most influential variable on the dependent variable. Therefore, burglar alarms, householder age groups from 60 to 64 years old, and the population age group over 45 years old are the group of independent variables to best explain and predict the dependent variable, NAI burglary, in Newark, N.J.

VI. Chapter Conclusion

Research Question 1 was to examine the overall statistical relationship between burglar alarms and residential burglaries and between the changes in alarm installations and NAI residential burglary over the multiple years. Chi-square and changed proportion statistics showed that the crossing relation between the increase of residential burglar alarms in use and the decrease of residential burglary incidents was statistically significant and persistent over the years, which indicated that burglar alarms impacted on the decrease of residential burglary incidents. These analyses were based on the raw numbers of total residential burglary incidents and burglar alarm permits. But advanced statistical analyses were necessary to scrutinize this relationship with more relevant variables.

Research Question 2 was to examine the correlated relationships between burglar alarms and residential burglaries. The bi- and multivariate correlation statistic confirmed the chi-square statistic finding that the statistical significance existed between the increase of burglar alarm installations and the decrease of residential burglary incidents.

Research Question 3 focused on the extent of the regression relationship of both burglar alarms and residential burglaries with other variables. Two primary purposes were served: (1) to identify the indicators to show significant relationships to the increase of burglar alarms in use and the decrease of residential burglary incidents; and (2) to estimate a causal relationship and prediction level between a dependant variable (e.g., either burglar alarms or NAI burglary) and independent variables. Bivariate regression statistic was used for the first analytical

purpose with NAI burglary as a dependant variables. In addition, the forward selection and hierarchical multiple regression statistics were used for the second analytical purpose with burglar alarms as a dependent variable for the former method and with NAI burglary as a dependent variable for the latter method.

With regard to bivariate regression statistics of the variables on NAI burglary as a dependent variable, only two independent variables were statistically significant: burglar alarms and unemployment. These analyses showed that as the correlated relationships between burglar alarms and NAI burglary were found to be statistically significant, the regressed relationships also were significant and had some explanatory power for regression models. Unemployment was closely related to the patterns of not only burglar alarm installations but also NAI burglary incidents.

Multiple regression statistics for burglar alarms as a dependant variable revealed that based on the *F* statistic the races of both general population and householders had an overall significant relationship. Its finding was consistent with the previous finding that, holding constant the impact of black variable, white and other variables were negatively related to the burglar alarm installation, indicating that neighborhoods with greater these populations groups were less likely to have burglar alarms installed than black neighborhoods.

On the other hand, multiple regression statistics for NAI burglary as a dependent variable showed that, based on the values of R^2 , the variables of burglar alarms, unemployment, population age groups (e.g., below 17, 25 to 44, and over 45), and householder's age groups (e.g., 60 to 64 and over 65) were statistically

significant. Among them, unemployment and householder ages 60 to 64 were more closely related to, and powerful predictors of, NAI burglary than other variables used in the analyses.

Two advanced multiple regression statistics (e.g., forward selection multiple regression and hierarchical multiple regression) were used being incorporated with a blocking technique of the independent variables. A chief advantage of its method is that it holds important independent variable(s) constant during further analyses so that variations of the important independent variables on the dependant variable can be easily observed and examined.

The forward selection regression approach capable of identifying sequentially which independent variable was the most powerful predictor of the dependent variable among various independent variables was employed with burglar alarms as the dependent variable. A series of annual forward selection regression models showed that only five variables were included (e.g., black population, owner occupancy, householder ages 25 to 34, NAI burglary, and general population age group under 14 years old). Considering several statistical values from the forward selection regressions (e.g., coefficient β , *Beta*, and R^2) with some variations in values, it might be more plausible to propose a group of powerful indicators rather than to single out the most influential variable on the dependent variable. Thus, owner-occupied house, black population, householder age group 25 to 34, NAI residential burglary, and population age group under 14 were the group of independent variables that best explained and predicted the installation pattern of residential burglar alarms.

In addition, the hierarchical selection regression method was used to analyze the effect of burglar alarms with other independent variables on NAI burglary as the dependent variable. Seven independent variables were included in this analysis (e.g., burglar alarms, unemployment, population age groups of under 17, 25 to 44, and over 45, and householder age groups of 60 to 64 and over 65) with five regression models. Among these variables, burglar alarms, unemployment, population age over 45, and householder age 60 to 64 were the best predictors, though not necessarily in that order of degree of predictability, to explain and predict the dependent variable, NAI burglary. In particular, unemployment was one of the most powerful variables in the hierarchical regression model in explaining the phenomenon of NAI burglary, whose finding was consistent with the previous analyses and the literature on residential burglary. The general population age group over 45 years old also was one of the more powerful predictors to explain and predict NAI burglary with a negative direction, that is, as the number of NAI burglary decreased, the number of residents in this population age groups increased. Its age group particularly with a higher population proportion of ages 45 to 55 tended to live with their teenage children whose parents were more likely to have burglar alarms installed and less likely to be victimized by residential burglary. Furthermore, the variable burglar alarms was one of the most substantial independent variables to explain and predict NAI burglary with a consistent and powerful statistical significance over the multiple years.

These findings and discussions, though providing rich and insightful information on the pattern and relationship of both burglar alarms and residential

burglary with other relevant variables, were limited in numerical analyses. Spatial approaches and analyses will follow in Chapters 8 to 10.

In the next chapter, spatially descriptive analyses will be conducted and discussed to answer Research Question 4, which has two primary focuses: (1) to examine the spatial distributions and patterns of both burglar alarms and residential burglaries; and (2) to verify quantitative analyses conducted and discussed in Chapter 7 in a spatial dimension. Using the geographic information system (GIS) computer program, point and density mapping methods will be employed for the analyses of burglar alarms and residential burglaries. These maps will be incorporated with and overlaid over the census tract-based maps generated from the demographic, socio-economic, and housing characteristic data (e.g., population race and age, unemployment rate, poverty level in population, householder race and age, and owner occupancy).

CHAPTER 8. DESCRIPTIVE SPATIAL ANALYSES OF BURGLAR ALARMS AND RESIDENTIAL BURGLARIES

I. Introduction

Prior to the spatial impact analyses of both residential burglar alarms and burglaries with other variables, spatially descriptive analyses are conducted to view the distribution and pattern of burglar alarms and residential burglaries. Research Question 4 is directly relevant to this chapter. There are two rationales behind such analyses. First, there have been substantial qualitative and quantitative analyses of residential burglary in literature, but few spatial analyses have been conducted. Such an analysis may produce more useful knowledge in explaining the distribution and pattern of residential burglaries and its relationship to burglar alarms and such variables as demographic, socio-economic, and housing characteristics.

Second, even simple spatial analyses for residential burglar alarms have not been conducted in literature. As discussed previously, there is a lack of research on this topic in general, and the existing studies are based on observational and anthropological approaches with little quantitative analyses. Spatially analytical approaches have not been used to examine the distribution and pattern of residential burglar alarms.

Two separate approaches are used here. The first method is based on the single-house address level. All addresses of residential burglar alarms and non-alarm-installed (NAI) and alarm-installed (AI) burglaries are pinpointed on the Newark street map, annually and for the period from 2001 to 2005, using the geographic information system (GIS) computer software. The unit of analysis for

this first approach is the individual address of houses victimized by residential burglaries with/without alarms.

The second approach is based on the census-tract level. All 90 census tracts in Newark were identified, and all addresses of both burglar alarms and NAI/AI burglaries were geocoded with about a 93 percent address-matching rate, on average, in the GIS geocoding process. Then, all the addresses were regrouped according to the 90 census tracts. Thus, each census tract was associated with the total number of addresses with alarm permits and NAI/AI burglaries in that tract. This information was used to calculate the rates of NAI/AI burglaries to examine patterns and change over the years.

Several spatial statistical techniques (e.g., point maps, density maps, centrographic statistics maps, and spatial dependence statistics) were employed to examine the spatial relationships of burglar alarms and residential burglaries with selective demographic, socio-economic, and housing characteristic variables. There are two primary purposes for these spatially descriptive analyses. First, they are used to visualize the distribution of burglar alarms and residential burglaries on the city map, as well as identify the high and low concentration areas of burglar alarms and burglaries for further analyses. Second, they are used to link the findings of previous quantitative analyses in Chapter 7 to spatial patterns. In other words, to answer the question: Are the statistically significant variables from various correlation and regression statistics also consistent with spatial distributions and patterns? The assumption is that it will be consistent because of issues of reliability and validity.

II. Macro-Level Spatial Patterns of Burglar Alarms and Residential Burglaries

As the first step of the descriptive spatial analysis, a city boundary around Newark is set to map residential burglar alarms and burglaries. Point maps and density maps are then added. The most common method for displaying geographic patterns of burglar alarms and residential burglaries is point mapping, which places pins representing events onto a map. On the other hand, a density map visualizes the distribution of crime and identifies highly concentrated areas by creating a smooth continuous surface to represent the density or volume of the events distributed across the city. A density map is based on the point map to display higher and/or lower concentrated areas within the city boundary.

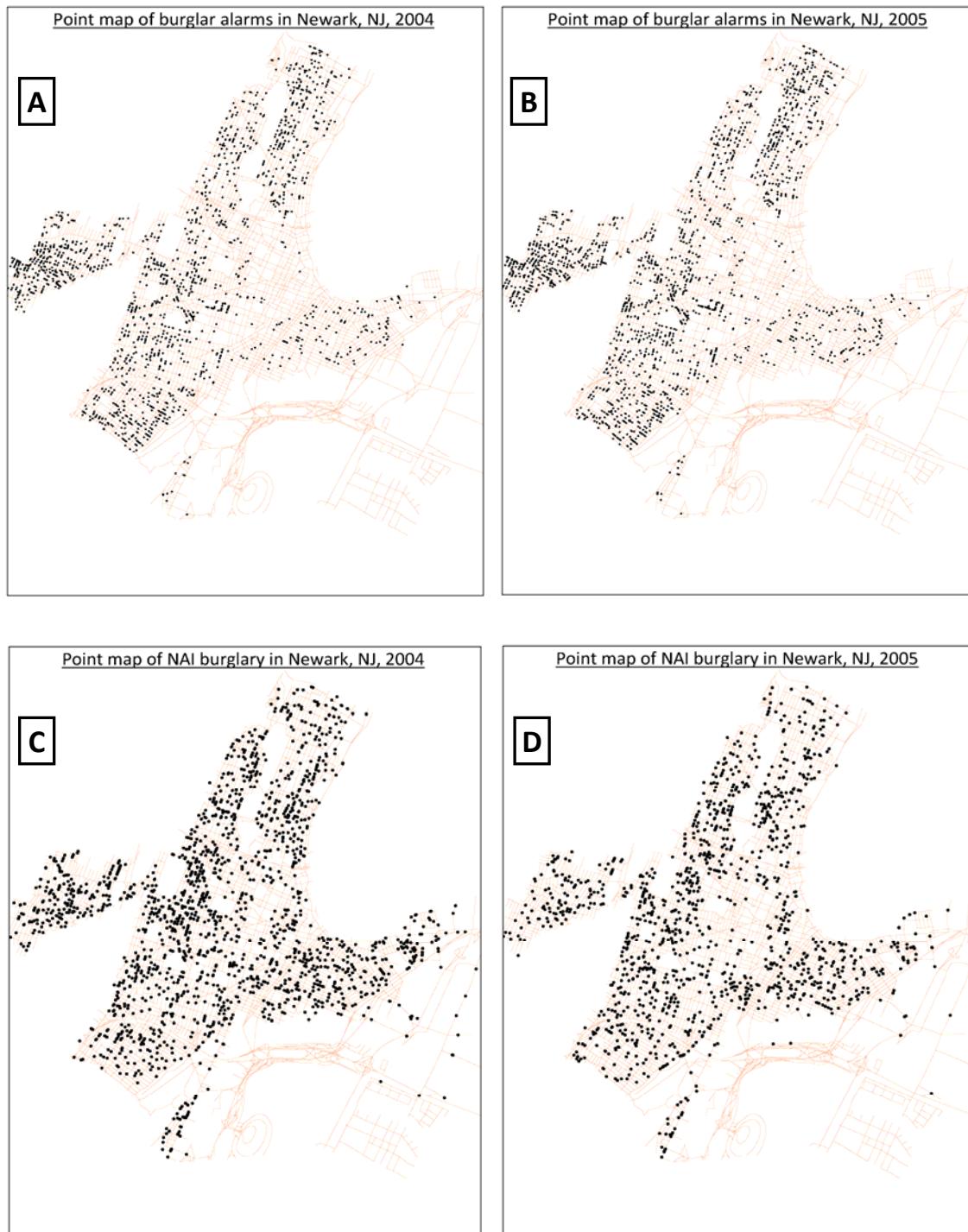
1. Point Maps of Burglar Alarms and NAI and AI Residential Burglaries

A series of point maps is displayed to see the distributions of residential burglar alarms, based on alarm permits, and NAI/AI residential burglaries. All the geocoded addresses of these three categories are pinpointed through the geocoding process, with a coordinate system, using ArcGIS computer software.

Figure 8.1 displays examples of the point maps showing residential burglar alarms (maps A and B), NAI burglary (maps C and D), and AI burglary (map E) on a city street map. Maps for other years are included in Appendixes 8 and 9. These maps show the overall distributions of these three variables. At first glance, both burglar alarms and NAI burglary are distributed citywide across many of the streets and street blocks in the city. In particular, in maps C and D, NAI burglary affected most parts of the city in 2004 and 2005. Burglar alarms, on the other hand, have

been installed across the city, but the western, northeastern, and southwestern areas have more points than the eastern and central parts of the city.

[Figure 8.1] Point maps for burglar alarms and NAI/AI residential burglaries in Newark, NJ, 2004 and 2005



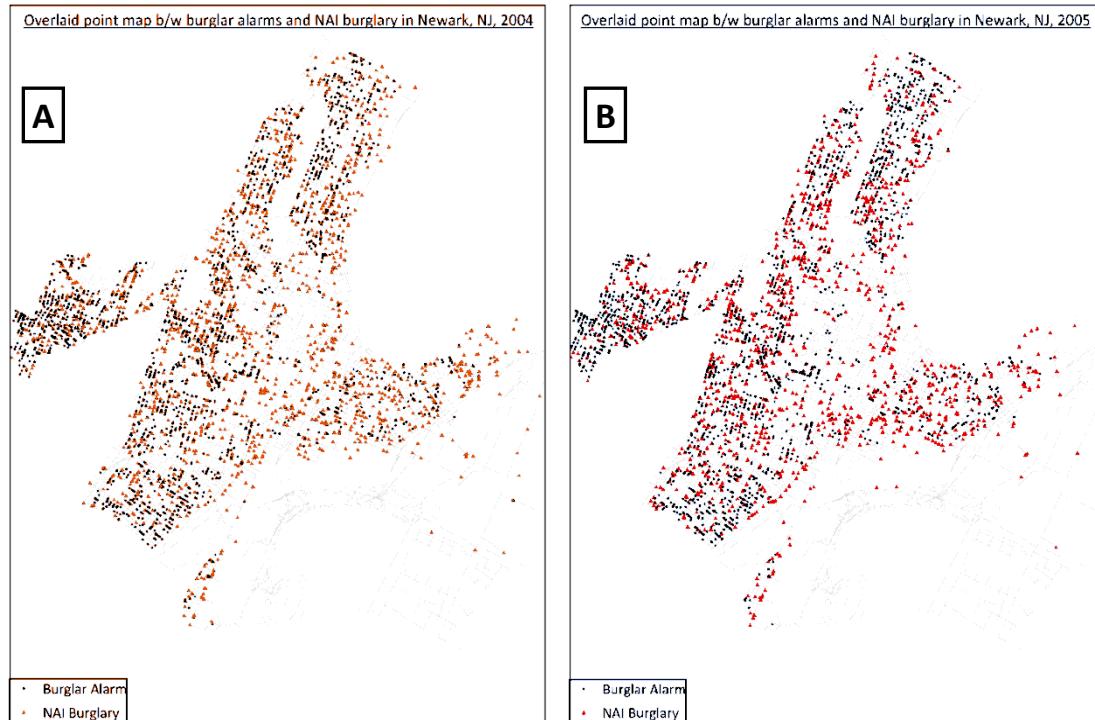


Map E displays the data from AI burglary. Since this category has a small number of cases, relative to NAI burglary and burglar alarms, the overall data from 2001 to 2005 are used for mapping, showing that AI burglary is spread across the city. But the map displays more points in the western part of the city, probably because these areas have more residential burglar alarms installed than other parts of the city.

In addition to these maps, which based on a single variable, it is possible to overlay two variables on a single map. Figure 8.2 displays superimposed point maps of both residential burglar alarm (black) and NAI burglary (red) in 2004 and 2005. Though many addresses with burglar alarms overlay those with NAI burglary, in particular in the western part of the city, there are still some non-overlaying neighborhoods (e.g., northeastern and eastern parts of the city). The distribution may indicate that on the macro-level, incidents of burglar alarms and NAI burglary

in some parts of the city, and many of the streets and street blocks, do not superimpose over one another. Many NAI burglaries are committed on the streets where no burglar alarm had been installed.

[Figure 8.2] Overlaid point maps of burglar alarms and NAI residential burglary in Newark, NJ, 2004 and 2005



However, these maps do not provide some information and insight about spatial distributions and patterns. Although these maps are useful to see both a general distribution of the three variables and some indication of isolated patterns between burglar alarms and residential burglary, they still do not demonstrate a particular spatial pattern over the years or illustrate higher or lower concentrated areas activity.

Two issues can account for these problems. First, the large volume of data that are used for the maps makes it difficult to visualize and interpret accurate patterns in the spatial distribution. Second, certain locations on the map appear to be a single point with a single crime incident, but may, in fact, have multiple events overlapped at the same address because multiple events at the same location have been geocoded by the same coordinating system. Thus, when only small numbers of events are displayed on a map, crime point maps may provide a snapshot-level view. But if the primary purpose of these maps is to conduct further in-depth analysis and identify highly concentrated areas of distribution, crime pinpoint maps may not be the best visually descriptive example or the best map design to interpret and discuss patterns. It is imperative to use additional mapping methods to examine the actual distribution of these variables and to discuss the patterns of burglar alarm and residential burglaries.

2. Density Maps of Burglar Alarms and NAI and AI Residential Burglaries

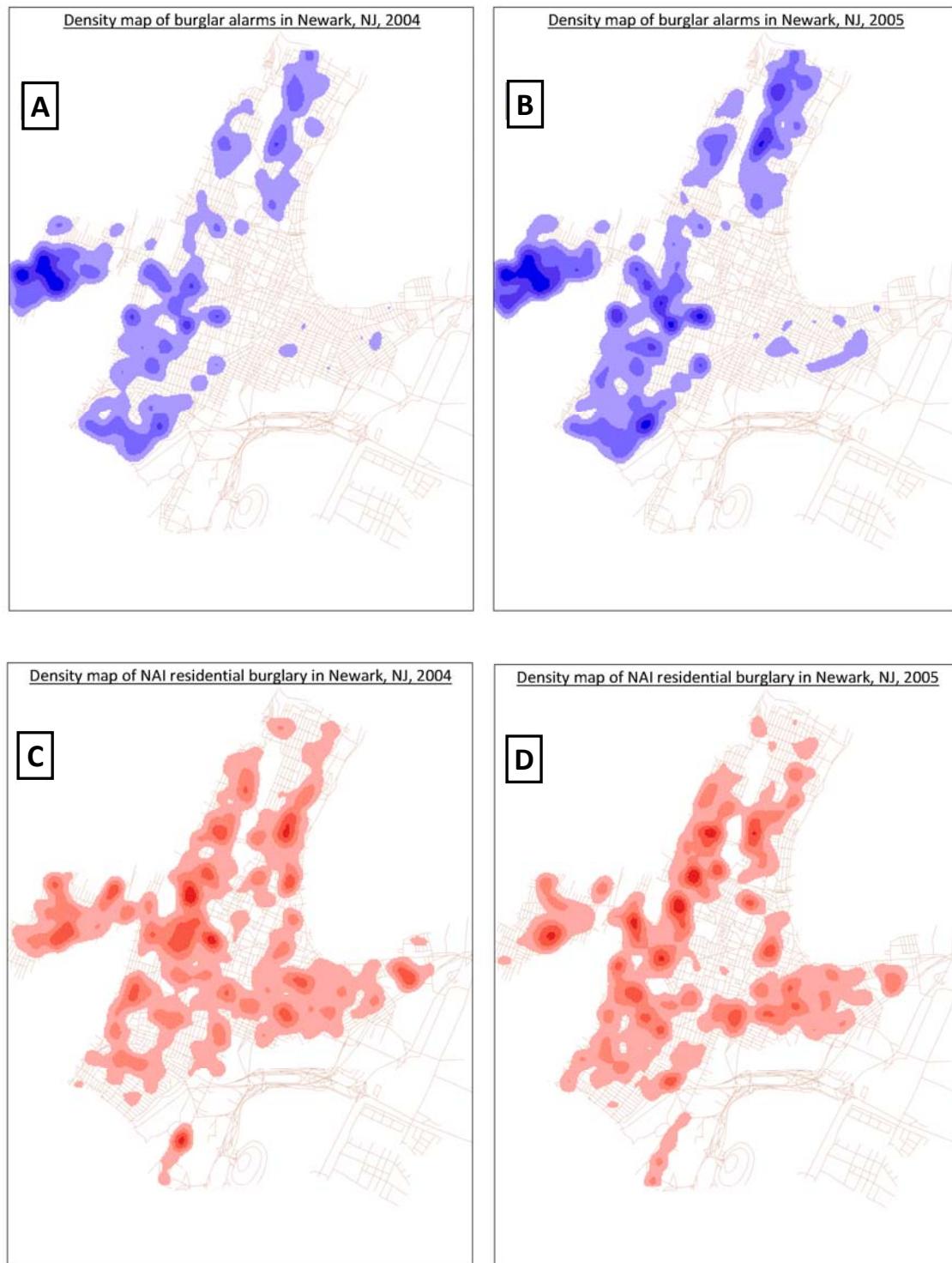
In this section, a series of density maps is presented to examine the distributions of residential burglar alarms and NAI/AI burglaries. Density maps are based on the data from the point maps above. While point maps pinpointed all addresses of burglar alarms and NAI burglary on the city street map, density maps display spatial concentrations of these variables.

Figure 8.3 displays several gradually concentrated areas of residential burglar alarms (blue) and NAI burglary (red), using a density function in ArcGIS. The darker the colors, the more highly concentrated the areas. As discussed previously, the simple and overlaid point maps show that burglar alarms and NAI

burglary are distributed citywide. But the density maps in Figure 8.3 illustrate that both residential burglar alarms and NAI burglary are not evenly distributed throughout the city. For example, with residential burglar alarms (maps A and B), the largest concentrations are located in the western part of the city. Several smaller scale concentrations also exist in the central and northeastern parts of city. On the other hand, most of the eastern part of the city does not have any concentrated areas of residential burglar alarms, illustrating installation patterns of residential burglar alarms across the city and that the residents in certain neighborhoods definitely tend to have more burglar alarms installed than other areas. Such observations are found consistently throughout the time period analyzed (see Appendixes 10 and 11).

For NAI burglary in maps C and D, several concentrated areas exist across the city, except for sections in the central and northern parts of the city. In particular, several concentrated areas are located alongside the northern boundary of the city. Though many of streets and city blocks have been affected by residential burglary, there are certain areas or neighborhoods with more incidents than others, implying that the distribution and pattern of NAI burglary does not necessarily evenly distributed across the city and that it is influenced by a neighborhood's conditions, such as demographic, socio-economic, and housing characteristics.

[Figure 8.3] Density maps for burglar alarms and NAI residential burglary in Newark, NJ, 2004 and 2005



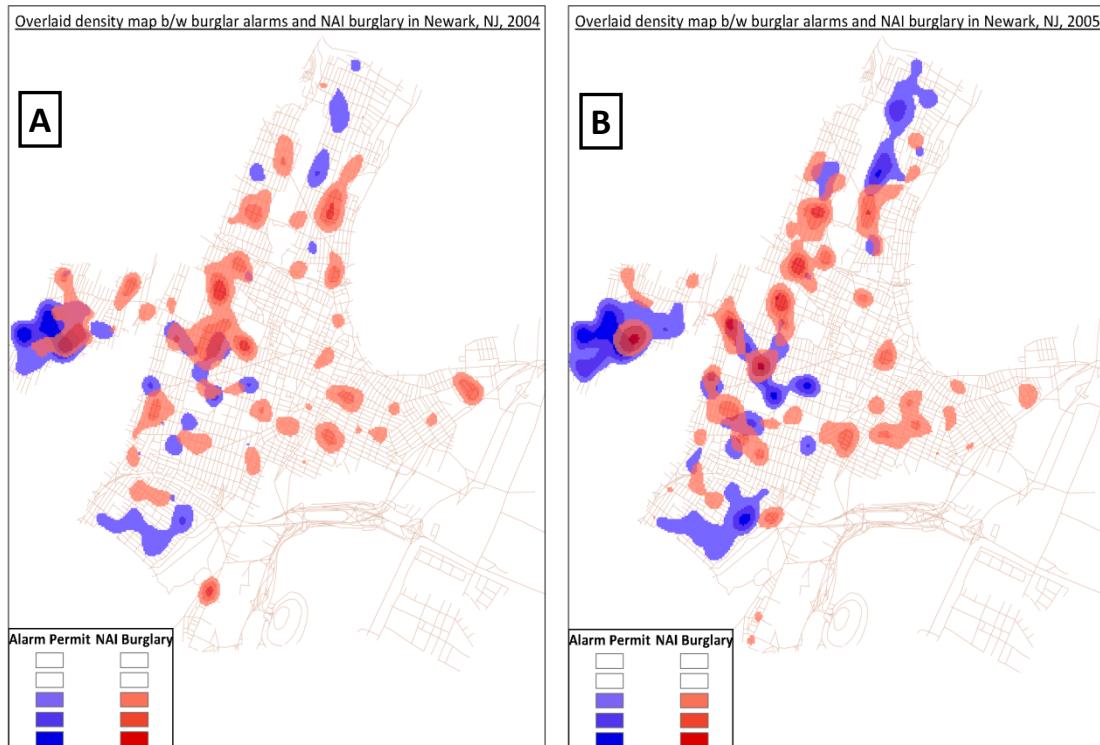
In addition to the density maps above, Figure 8.4 shows superimposed density maps between residential burglar alarms (blue) and NAI burglary (red), with the primary purpose being to examine whether highly concentrated areas of burglar alarms and NAI burglary coincide. One of the core questions of this study is to examine the impact of residential burglar alarms on residential burglaries. In other words, do burglar alarms have a positive impact on residential burglary or a negative impact? The rationale for the overlapping analysis is that if burglar alarm systems have a positive impact on residential burglary, the concentrated spots of both alarm systems and residential crime should be isolated, indicating that the city blocks or neighborhoods with burglar alarm systems may push away potential burglar(s) and prevent crime. Thus, in such a case, it may indicate that there is either possible spatial diffusion of benefits from burglar alarms over residential burglary or displacement of NAI burglary from the highly concentrated areas of burglar alarms to the areas with less concentrated levels of burglar alarms.

On the other hand, if the highly concentrated areas of burglar alarm systems and NAI burglary are not isolated but overlay each other, it may imply that there is no noticeable impact of burglar alarm systems on residential burglary or that the occurrence of residential burglary is not affected by burglar alarm systems. In other words, a burglar alarm may not be a powerful deterrent to residential burglary.

Figure 8.4 plainly illustrates that in most parts of the city, the heavily dense spots of both burglar alarms and NAI burglary do not overlap (see Appendix 12). They are separate from each other, though some less concentrated areas do overlap. Street blocks or small sectors of the city with high installation rates of burglar

alarms tend to have less NAI burglary, especially in some western, southern, and northeastern parts of the city. Street segments or some sectors of the city with higher residential burglary tend to have less burglar alarm systems installed—a pattern obvious in the central and eastern part of the city. It may be rudimentary to be conclusive and considerably indicative that, at first glance in the density maps, residential burglar alarms may show some positive impact on residential burglary by pushing away potential burglar(s) from the highly concentrated areas because the area with densest spots of burglar alarms have almost no, or definitely less dense areas, NAI burglary.

[Figure 8.4] Overlaid density maps between burglar alarms and NAI residential burglary in Newark, NJ, 2004 and 2005



As discussed above, density maps, in comparison with point maps, allow for an easier interpretation of where both burglar alarms and NAI burglary cluster. The maps also more accurately reflect the location, relative scale, and spatial distribution of highly concentrated areas, compared with the point maps. Thus, this mapping method can produce more accurate results when identifying the location and orientation of areas of concentration.

However, certain issues with density crime mapping are worth discussing. For example, density maps are a smoothing technique, where a research radius determines the level of smoothing. This can result in these variables being smoothed over and into areas where no burglar alarms and/or NAI burglary have occurred, and, thus, exaggerate the distribution of burglar alarms and NAI burglary.

In addition, a map showing the distribution of data as a density estimation can have a various number of highly concentrated areas, depending on the ranges selected by the researcher. The source of the data for both burglar alarms and NAI burglary remain the same, but the number of highly concentrated areas can vary. Thus, such spatially analytical maps should be incorporated with other variables (e.g., demographic, socio-economic, and housing characteristics) at a micro-level for more accurate and reliable analyses.

Furthermore, the degrees of the density levels for both burglar alarms and NAI burglary, which are illustrated by color brightness, are based on rates, rather than actual counts. For example, the two densest spots of burglar alarms and NAI burglary do not necessarily have the same number of points. The actual number of points in the densest spot for burglar alarms may have larger numbers, or smaller,

than that of NAI burglary. Thus, it is important to understand the shortcomings of density maps. At the same time, it is necessary to do statistical tests on the distributions of those dense areas, which will be examined and discussed in the following chapter.

III. Spatial Characteristics of Burglar Alarms and Residential Burglaries Based on Census Tracts

In the above sections, point and density maps were presented by pinpointing the addresses of burglar alarms and NAI burglary on a city map to view spatial distributions and patterns. In this section, the focus is on spatial characteristics of the patterns between burglar alarms and residential burglaries. The unit of analysis is the census tract. There are 90 tracts in the city, and all addresses of residential burglar alarm records and NAI/AI burglaries were geocoded according to the census tracts.

The primary purpose of this analysis is to link the previous findings from the correlation and regression statistics in Chapter 7 into a spatial dimension. Such an approach is necessary and valuable in two ways. First, it can further examine the consistency and reliability of the early observations, which are based on quantitative analyses. Several variables showed statistically significant relationships with both burglar alarms and NAI/AI burglaries. If spatial analyses can be incorporated with these quantitative analyses, showing similar observations and findings, the research design and analytical method behind this study can be found more trustworthy, and the results more reliable. For example, in the multiple regression analyses in Chapter 7 variable black population has a moderate and

positive statistical relationship with burglar alarms, whereas both white and others populations maintain the same moderate but negative significant relationship. Thus, do those observations demonstrate the same pattern in the spatial dimension as well? Some variables also do not have statistically significant relationships for burglar alarms and NAI/AI burglaries, and thus, further argument with quantitatively nonsignificant variable(s) are not needed. But analyses of quantitatively nonsignificant variables may be significant from a spatial approach. Such an approach may illustrate meaningful patterns for burglar alarms and residential burglaries.

Second, the spatially analytical approach can give further knowledge and insight into the relationship between burglar alarm and burglaries with various explanatory variables within spatial dimensions. A quantitative approach produces useful and valuable knowledge, as discussed in Chapter 7. But it involves many various values and numbers, and it requires an intensive focus on, and enough background of, those values and numbers to correctly understand and interpret the results. In addition, in most cases only statistically significant variables tend to be included in an analytical process. Thus, some important variables, which show no statistical significance, would be ignored. On the contrary, a spatially analytical approach can visualize the distribution and pattern on the map, in a simple and clear way, to see and understand relevant variables because it is straightforward and easier to interpret observations being depicted on a map.

Four categories of independent variables (see Appendix 3) were used for this spatially analytical approach. As discussed, the information for those variables was

retrieved from the U.S. Census based on the 90 census tracts in the city. Then, this information was combined with the data of all addresses of burglar alarms and NAI/AI burglaries, according to the 90 census tracts, using the joins and relates function in the ArcGIS software.

1. Spatial Characteristics of Residential Burglar Alarms

(1) Burglar alarms and demographic composition

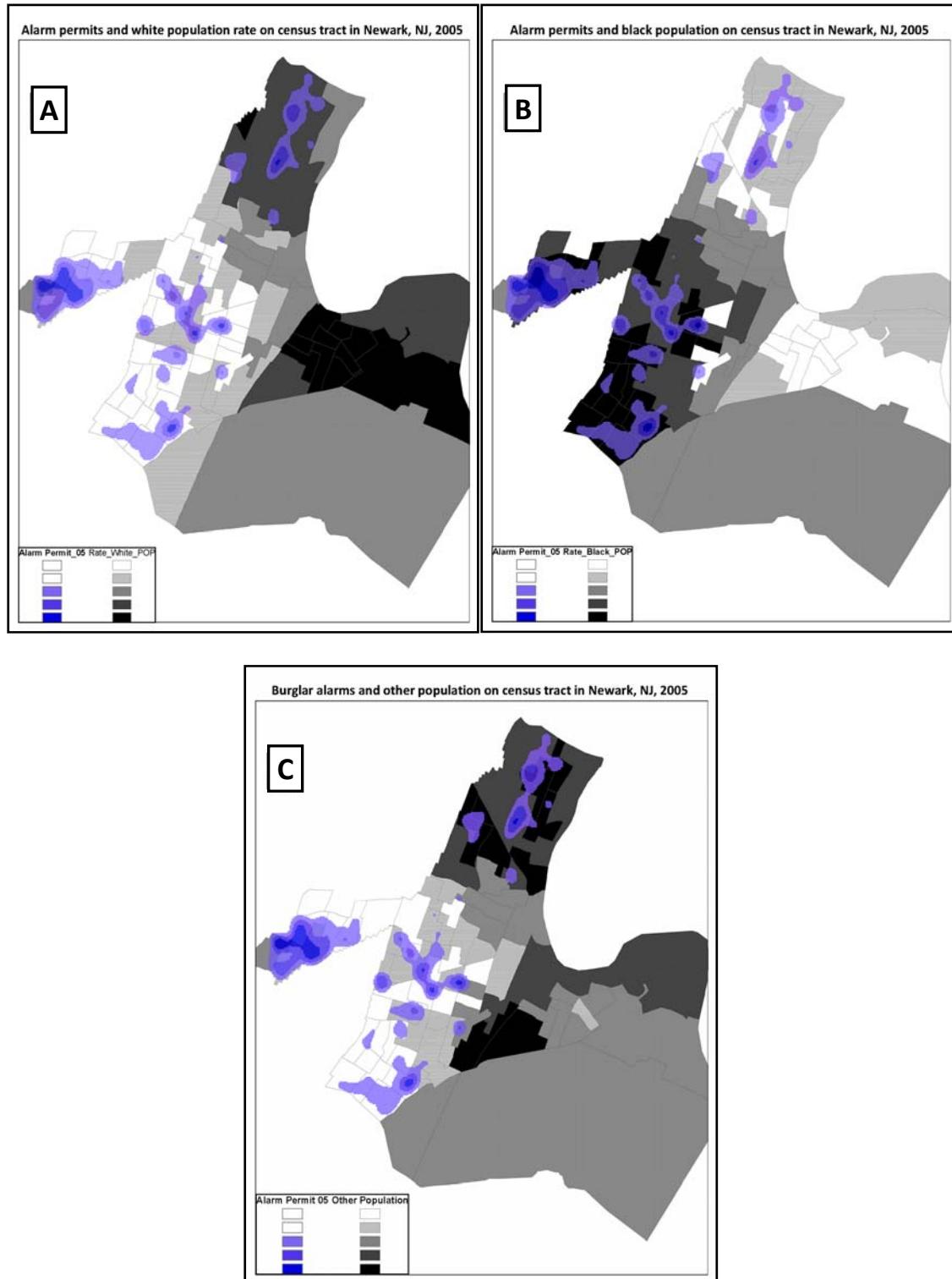
Figure 8.5 presents census-tract maps of general population rates by three race categories (e.g., white, black, and others²²) with residential burglar alarms (blue) being overlaid for the year 2005. For both cases, the darker colors represent higher rates. These maps show that these population races are not distributed equally throughout the city. White (map A) and others (map C) populations are concentrated in the northeastern and eastern parts of the city (darker black), whereas the black population (map B) as the largest population category clusters are in the western and southwestern neighborhoods. Furthermore, the highly concentrated areas of burglar alarms, as observed in Chapter 7, are located in the neighborhoods where the black population is dense. On the other hand, these spots are less likely to exist in areas with white and other populations. Such patterns are consistent from 2001 to 2005.

This observation implies that neighborhoods with a higher black population tend to have more burglar alarms being installed than neighborhoods with a higher

²²) “Others” category includes such races as American Indian and Alaska Native alone, Asian alone, Native Hawaiian and other Pacific Islander alone, Some other race alone, and two or more races (U.S. Census 2000).

number of people of other races. At the same time, it presents some critical questions. Does it indicate that the black population or black-dominant neighborhoods have a better socio-economic status to afford burglar alarm systems than other racial populations? Or do they have a worse burglary problem than the white and other population groups, so they have a greater need for burglar alarms to protect their properties?

[Figure 8.5] Census-tract maps of the general population by race with density maps of burglar alarms in Newark, NJ, 2005



It is not clear, however, whether—though an explicit spatial pattern of residential burglar alarms exists according to different population races—population race is the only factor to explain this pattern. There could be other factors to explain the pattern, and it is necessary to examine them. One approach to examine the spatial patterns of burglar alarms and population race with related variables is to overlay other census-tract information (e.g., rates of NAI burglary and unemployment) on the map.

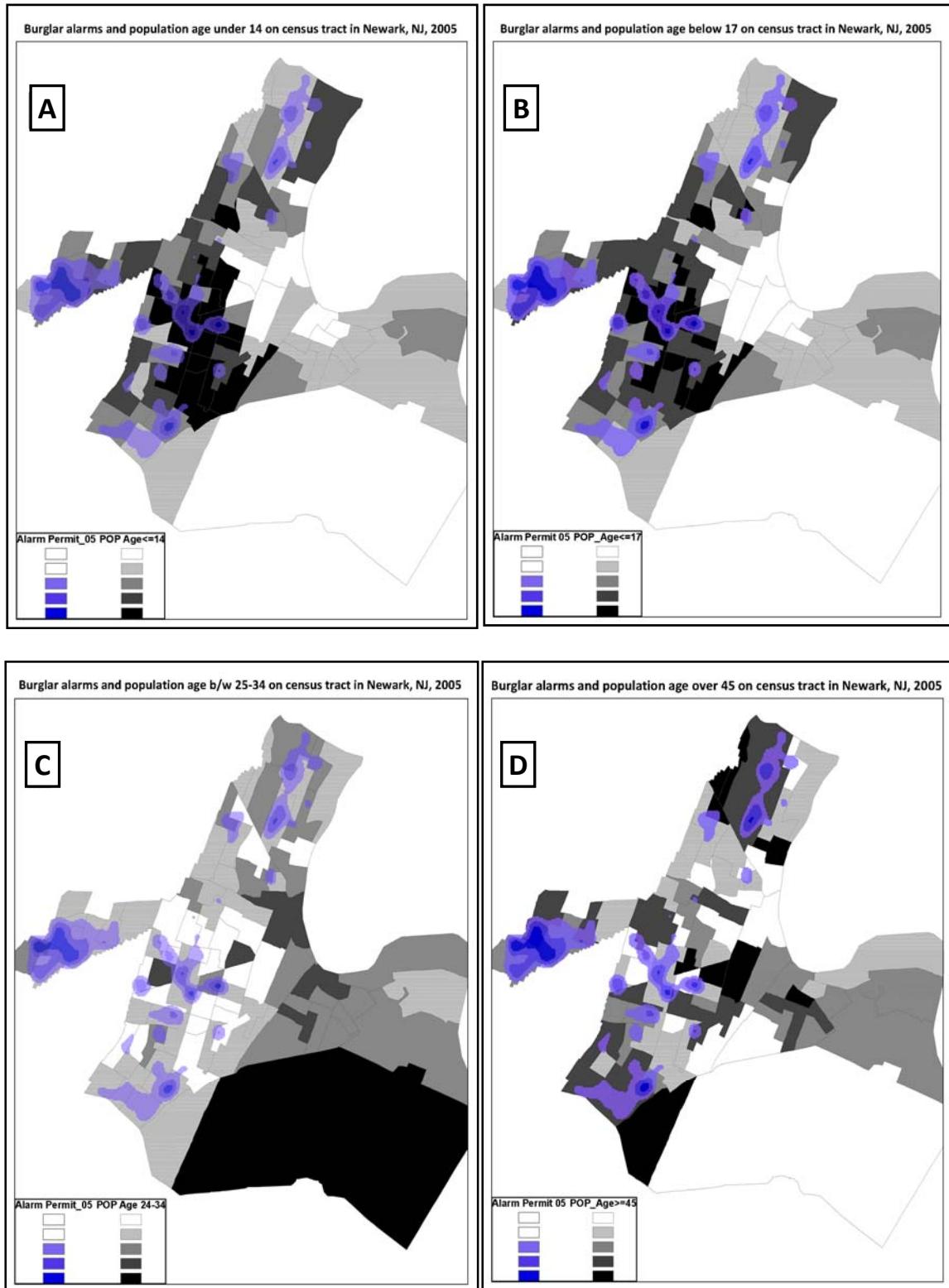
(2) Burglar alarms and general population age composition

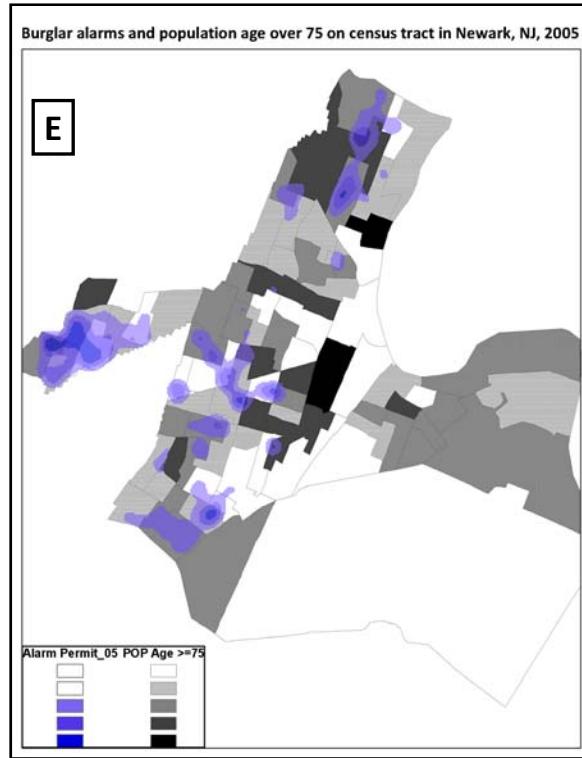
Within the population, 10 different groups and median age variables were created (see Appendix 3). Among them, only such three age groups—ages below 14, ages between 15 and 17, and ages over 75—show sporadic statistical relationships over the five-year period. It is possible to aggregate the first two age groups into one variable, ages below 17, because they share some statistical significance.

Figure 8.6 illustrates the census tract maps of several age groups. For ages below 14 years old (map A) and ages below 17 years old (map B), the census tracts in the western and central parts of the city have a higher number of these population groups. These tracts match with the highly concentrated areas of burglar alarm installations, implying that the neighborhoods with a higher proportion of the younger population—in particular, ages below 17 years old—are more likely to have burglar alarm systems installed, in line with the results from the correlation statistics (see Appendix 4). The regression statistics show that the overall relationship between burglar alarms and the population group under 14 years old is moderate and positive, indicating that as the installation rate of burglar

alarms increases, so does the number of the population under 14 years old. The results can be explained as parents of young children being concerned with safety and security issues in their neighborhoods and being willing to pay for burglar alarms to protect and secure the environment.

[Figure 8.6] Census-tract maps for the population age groups with density maps of burglar alarms in Newark, NJ, 2005





It also may be meaningful to examine the patterns of the population age groups from 25 to 34 (map C) and over 45 (map D). The assumption for two age groups is that because the population age group below 17 is closely related to burglar alarm installations, the age group of 25 to 34 may not be related to the pattern of alarm installation because, by and large, this particular population group tends to live independent from their parents and not have their own children. On the other hand, the population age group over 45 tends to form their own family with children and be more attached to the younger population age group. Thus, it might be assumed that burglar-alarm installation is linked to the neighborhoods with a lower density of the younger population group between 25 and 34 year old and a higher density for the middle-age population over 45. The third and fourth

maps in Figure 8.6 support this argument, showing that the pattern of alarm distribution in the neighborhoods is closely connected to the distribution of the different population age groups.

On the contrary, the map for the age group over 75 (map E) shows the opposite pattern of distribution to the age groups below 14 and between 15 and 17. The correlation coefficient and direction of the relationship for the population age group over 75 are relatively weak and negative, indicating that as the residents over 75 in a neighborhood increase, the installation rate of burglar alarms decreases.

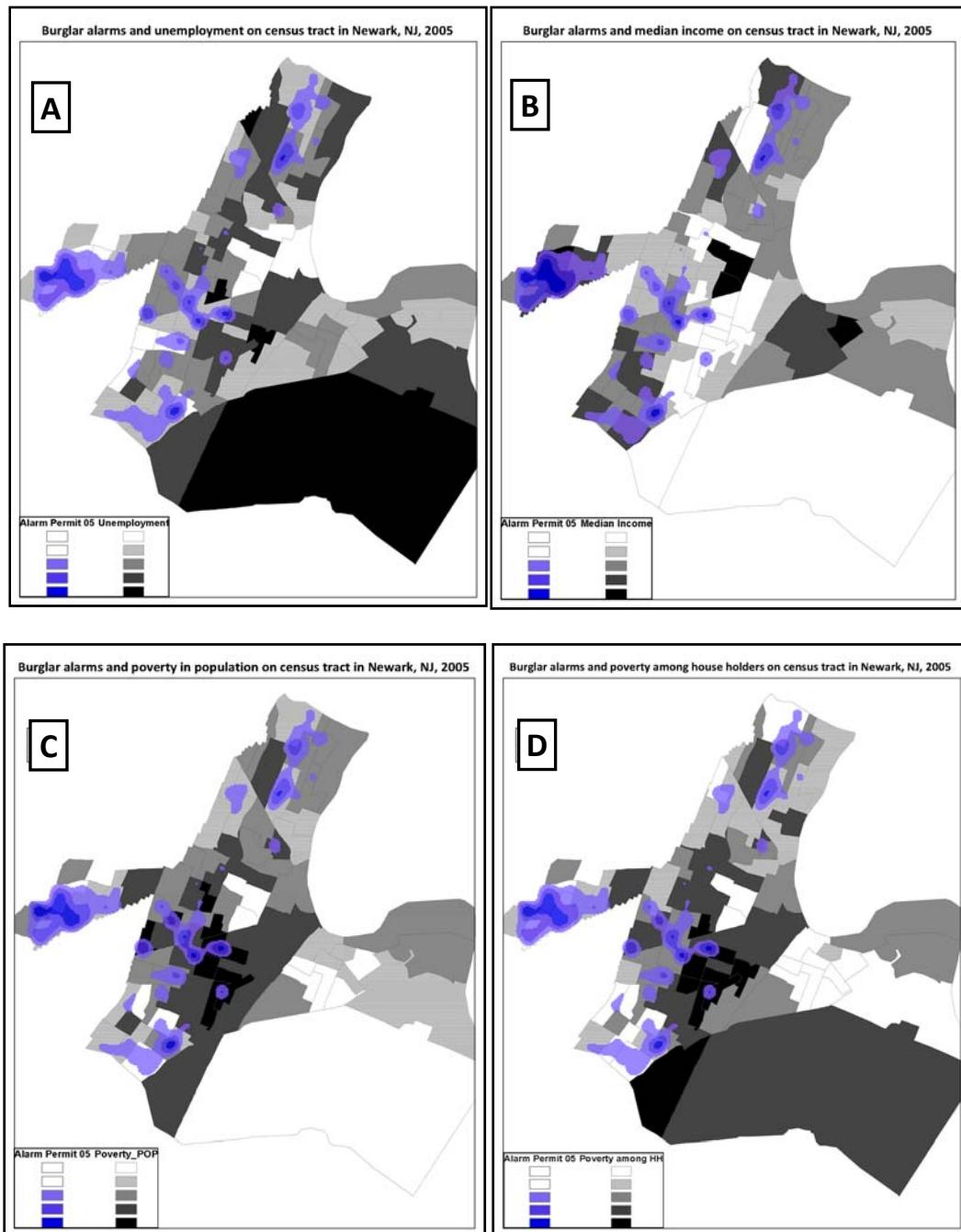
(3) Burglar alarms and socio-economic composition

Among the three variables in the socio-economic category (e.g., median income, unemployment, and poverty level), only unemployment demonstrates a sporadic statistical significance with burglar alarms in the correlation statistics (see Appendix 4). Though the other two variables do not have statistical relationships, it may be meaningful to examine their patterns in the census tracts.

Figure 8.7 presents census-tract maps for the socio-economic variables, including the variable poverty level in householders, with density maps of burglar alarms. Census tracts with higher unemployment rates (map A) are located in the northeastern and central parts of the city, whereas lower unemployment rates are in the western and central eastern parts of the city. A definitive pattern between the installation of burglar alarms and unemployment in census tracts cannot be determined, but the census tracts with higher rates of alarm installation do cluster in and around the census tracts with a relatively lower unemployment rate. A clearer pattern between median income (map B) in the population and alarm

installation exists, indicating that neighborhoods with a higher median income tend to have a higher rate of alarm installation, whereas a lower median income (e.g., in the central and northern parts of the city) has the lowest rate of alarm installation.

[Figure 8.7] Census tract maps of socio-economic characteristics with density maps of burglar alarms in Newark, NJ, 2005



Furthermore, Figure 8.7 displays spatial patterns between burglar alarms and poverty levels among the general population (map C) and householders (map D). The distribution patterns of the poverty levels of both the population and householders are similar with relatively higher levels in many of the central parts of the city. These maps show that the census tracts with comparatively higher population and number of householders living below the poverty level tend to have a higher rate of alarm installation. This is an unexpected observation because, first of all, the residents living in higher unemployment neighborhoods may not be able to afford to buy burglar alarm systems, and, second, unemployment conditions may keep adult family members in their houses longer, producing extended occupant hours for the houses. In short, this observation indicates that the neighborhoods with higher unemployment rates do not necessarily have fewer residential burglar alarms installed. More analyses with other socio-economic factors are needed to explain and verify these results.

(4) Burglar alarms and householders' race and age composition

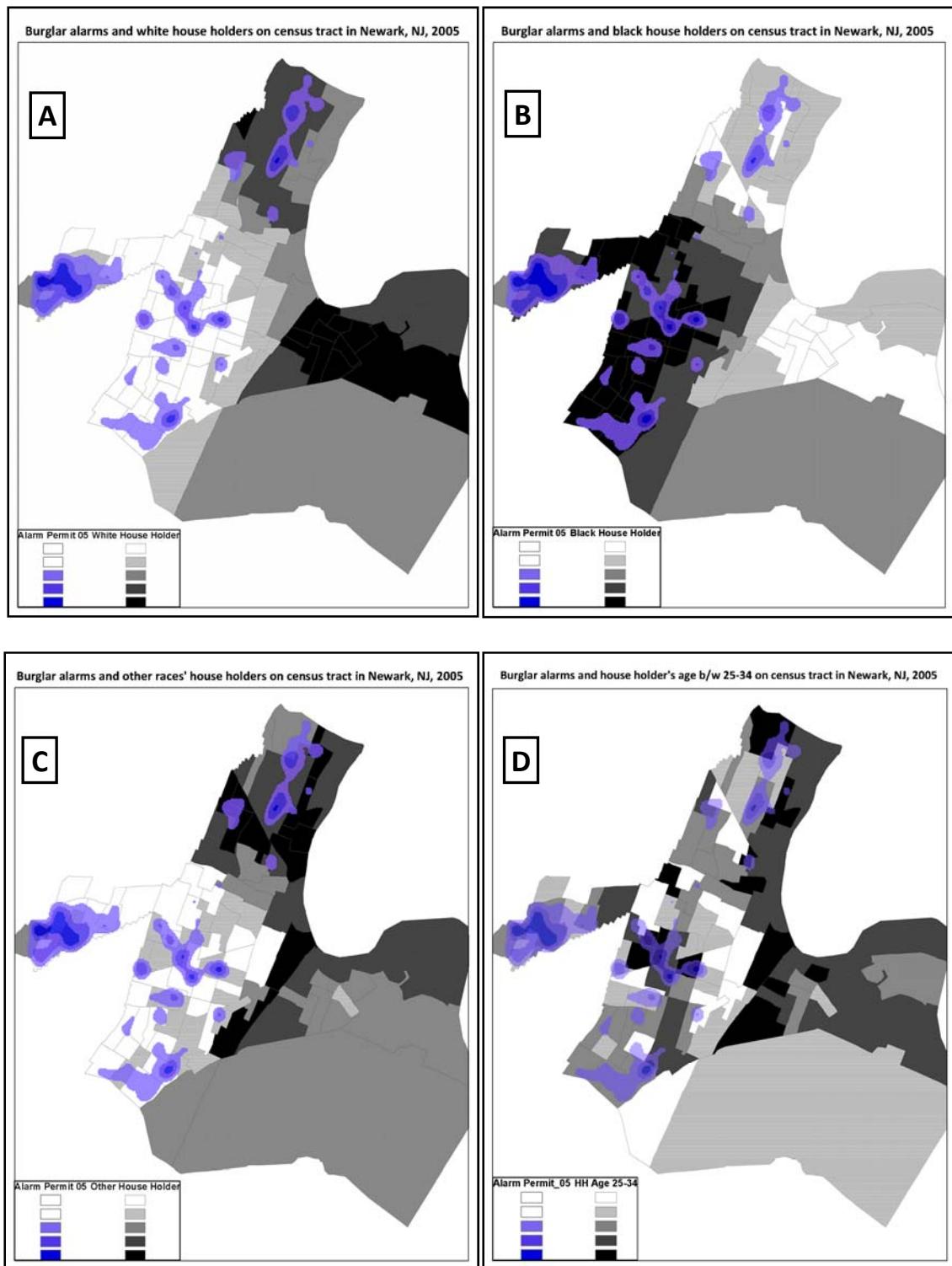
The variable householders by race is one of the housing characteristic categories with a statistically moderate and significant relationship with burglar alarms when using correlation statistics. But the direction of these statistical relationships is positive one for 'black' householder and negative for 'white' and 'others' householders.

Maps A, B, and C in Figure 8.8 display an explicit pattern between burglar alarms and householders by race on the census-tract level. The census tracts with white (map A) and others (map C) householders are predominantly located in the

northeastern and some eastern parts of the city, whereas black householders (map B) predominantly reside in the western central part of the city. The neighborhoods with higher proportions of white or others householders tend to have fewer residential burglar alarms than those of black householders. This pattern is intriguing because it becomes more concrete when compared with the census-tract maps between burglar alarms and the race of the general population in Figure 8.5, implying that black householders in the city tend to have more burglar alarms being installed in their houses.

In addition, map D in Figure 8.8 illustrates the census-tract map of householders in the age group from 25 to 34 with a density map of burglar alarms. Among the eight householder's age groups, only the ages 25 to 34 variable has intermittent significance depending on the year, but also significant in the overall time period from 2001 to 2005, with a moderate and positive relationship using correlation statistics (see Appendix 4). Compared with the map for the population age group from 25 to 34 in Table 8.6, which displays that the pattern of population distribution of this age group, the census map of the householders' age group from 25 to 34, except in the central part of the city, does not show a clear pattern. However, the census tracts with a relatively higher rate of householders in the age group from 25 to 34 reside in sections in the northeastern, central, eastern, and western parts of the city, corresponding to areas with higher rates of alarm installation. Thus, younger householders tend to have more burglar alarms being installed.

[Figure 8.8] Census-tract maps of householders by race and age with density maps of burglar alarms in Newark, NJ, 2005

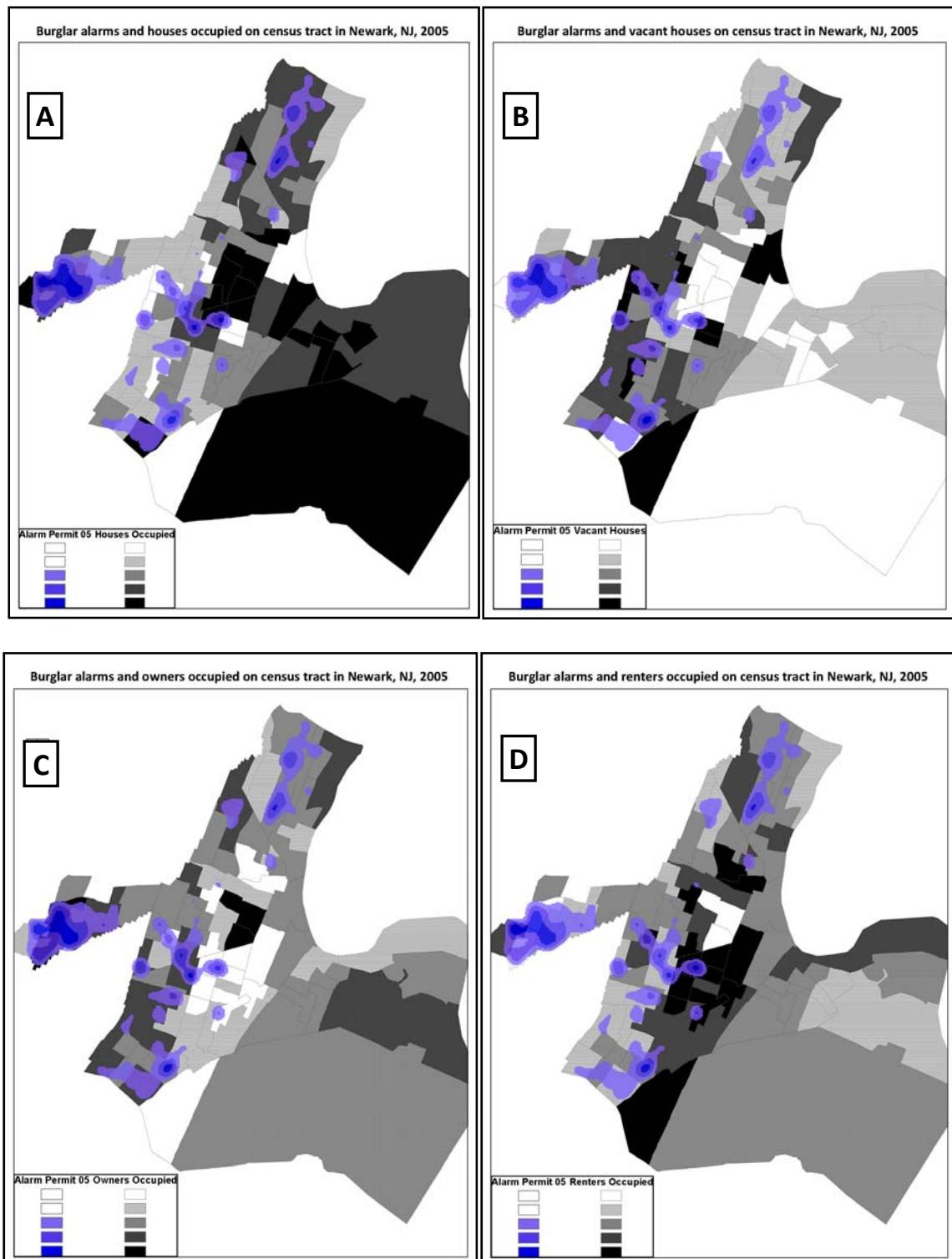


(5) Burglar alarms and housing characteristic composition

Two core variables in housing characteristic composition are house occupancy and owner occupancy. Maps A and B in Figure 8.9 display census-tract maps of house occupancy and vacancy. The western, northern, and eastern parts of the city maintain higher rates of housing occupancy than the central and southwestern parts. At first glance, in tracts where houses are occupied, it seems that the houses have fewer burglar alarms than in areas with more vacant houses. In addition, maps C and D show that the western, southwestern, and northern parts of the city have relatively higher rates of owner occupancy with more burglar alarms being installed.

However, these maps in Figure 8.9 do not illustrate a clear pattern between residential burglar alarms and the status of house occupancy and owner occupancy, indicating that these two variables are not substantial factors in deciding to install a burglar alarm. Other factors may be more plausible in explaining the installation pattern of residential burglar alarms.

[Figure 8.9] Census-tract maps of housing characteristics with density maps of burglar alarms in Newark, NJ, 2005



2. Spatial Characteristics of NAI Residential Burglary

(1) NAI residential burglary and demographic composition

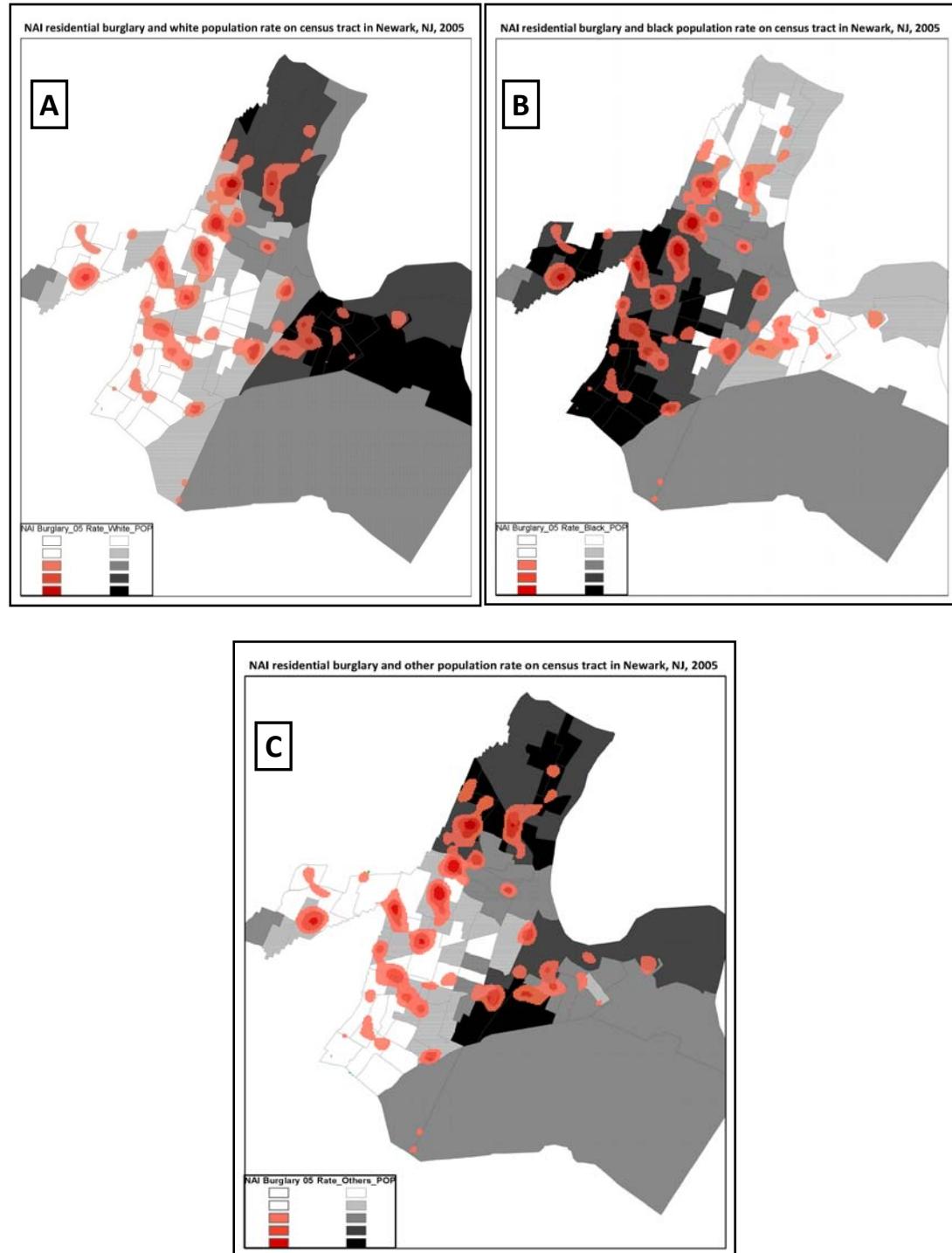
As discussed before, the dense areas of NAI burglary are spread across the city.

Figure 8.10 presents the map of those areas superimposed on census tracts of the population. The same census-tract maps are used as they were for the analyses of burglar alarms. A clear pattern is observed between two population groups: 'black (map B)' and 'white and others (maps A and C).' Census tracts with higher black population as the number one population category share a more highly concentrated rate of NAI burglary than those with white and others population. This observation is fairly similar to the pattern of burglar alarms, indicating that the distribution of burglar alarms and NAI burglary are closely linked to the distribution of race among the population.

Combining the information, black-dominant neighborhoods, comparatively, have more highly concentrated spots of burglar alarms and burglary, explaining a causal relationship between alarm installation and NAI burglary. As discussed in Chapter 7, the quantitative analyses could not explain which one of them might cause the other to happen, but spatial approaches show that census tracts dominated by black populations have more burglar alarms installed and NAI burglary. Under such circumstances, it could be assumed that the higher installation rate of burglar alarms might cause more NAI burglary incidents. However, it is more reasonable to presume that higher NAI burglary rate may urge residents in certain neighborhoods to install more burglar alarms. Thus, for a causal argument, a

higher NAI burglary rate may precede burglar-alarm installation. But further analyses are necessary to verify this argument.

[Figure 8.10] Census-tract maps of the general population by race with density maps of NAI burglary in Newark, NJ, 2005

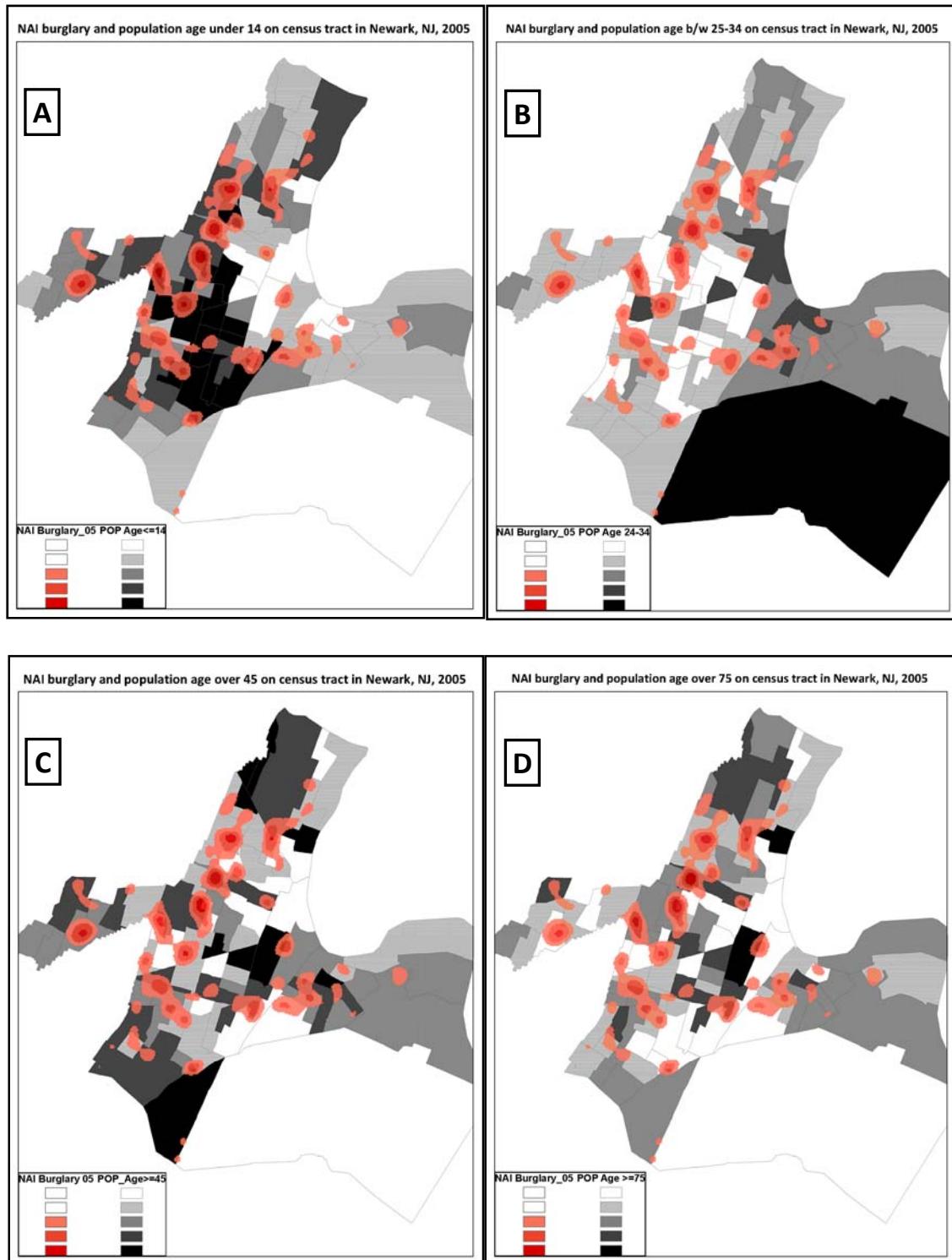


(2) NAI residential burglary and general population age composition

In the above section, residential burglar alarms showed a clear pattern in relationship to the general population age groups. As Figure 8.11 illustrates, an explicit pattern exists between NAI burglary and the distribution of the general population according to census tract. For example, map A shows that census tracts with a higher density of the population below 14 years old coincide with many highly concentrated areas of NAI burglary, though those spots are spread across the city. However, the remaining three maps B, C, and D do not have a clear pattern. Thus it can only be confidently argued that the population age group below 14 years old is strongly related to the distributions of NAI burglary.

However, scrutinizing the data leads to an interesting observation. One common pattern is found among the four maps in Figure 8.11; almost all census tracts with white colors, which represent the lowest degree of general population density, do not overlap the most highly concentrated spots of NAI burglary. For instance, the central eastern section in map A containing data from ages below 14, the central section in map B of ages 25 to 34, the upper eastern section in map C of ages over 45, and the upper eastern and southern sections in map D of ages over 75 do not share highly dense spots of NAI burglary.

[Figure 8.11] Census-tract maps of population age groups with density maps of NAI burglary in Newark, NJ, 2005



This observation implies two points. First, as discussed in Chapter 7 and shown in Figure 8.11, both NAI burglary and the age groups of the general population are not distributed evenly throughout the city, generating an obvious pattern of distribution, which relates to underlying socio-economic conditions in the neighborhoods. Second, the distributions of both NAI burglary and the age groups of the general population have a strongly linked pattern, suggesting that NAI burglary is more likely to be associated with younger population age groups, in particular below 14 years old, and that NAI burglary is definitely less likely to correlate with thinly populated neighborhoods beyond any distinctive age groups. Thus, connecting those arguments, the data demonstrate that residential burglary is, to a large extent, related to the distribution of the general population and associated with a younger population.

(3) NAI residential burglary and socio-economic composition

In the above section, the spatial pattern between burglar alarms and four socio-economic variables was discussed. The same variables are used to examine possible relationships with the spatial distribution for NAI burglary. Figure 8.12 illustrates census tract maps of socio-economic variables overlaid with NAI burglary. At first glance, no explicit patterns appear. For example, NAI burglary does not have an obvious pattern with the unemployment rate (maps A) on the census tract level—one of the reasons being that dense spots of NAI burglary are spread across the city. Unless independent variables (e.g., unemployment, median income, and poverty levels) maintain overt and consistent patterns in the spatial dimension, it is not easy to find and confidently argue that a spatial relationship between those variables

exists. However, Figure 8.12 shows some insight into this relationship. Regarding the unemployment rate in map A, several highly dense spots are superimposed with areas of NAI burglary, though it is not the case in the western section of the city.

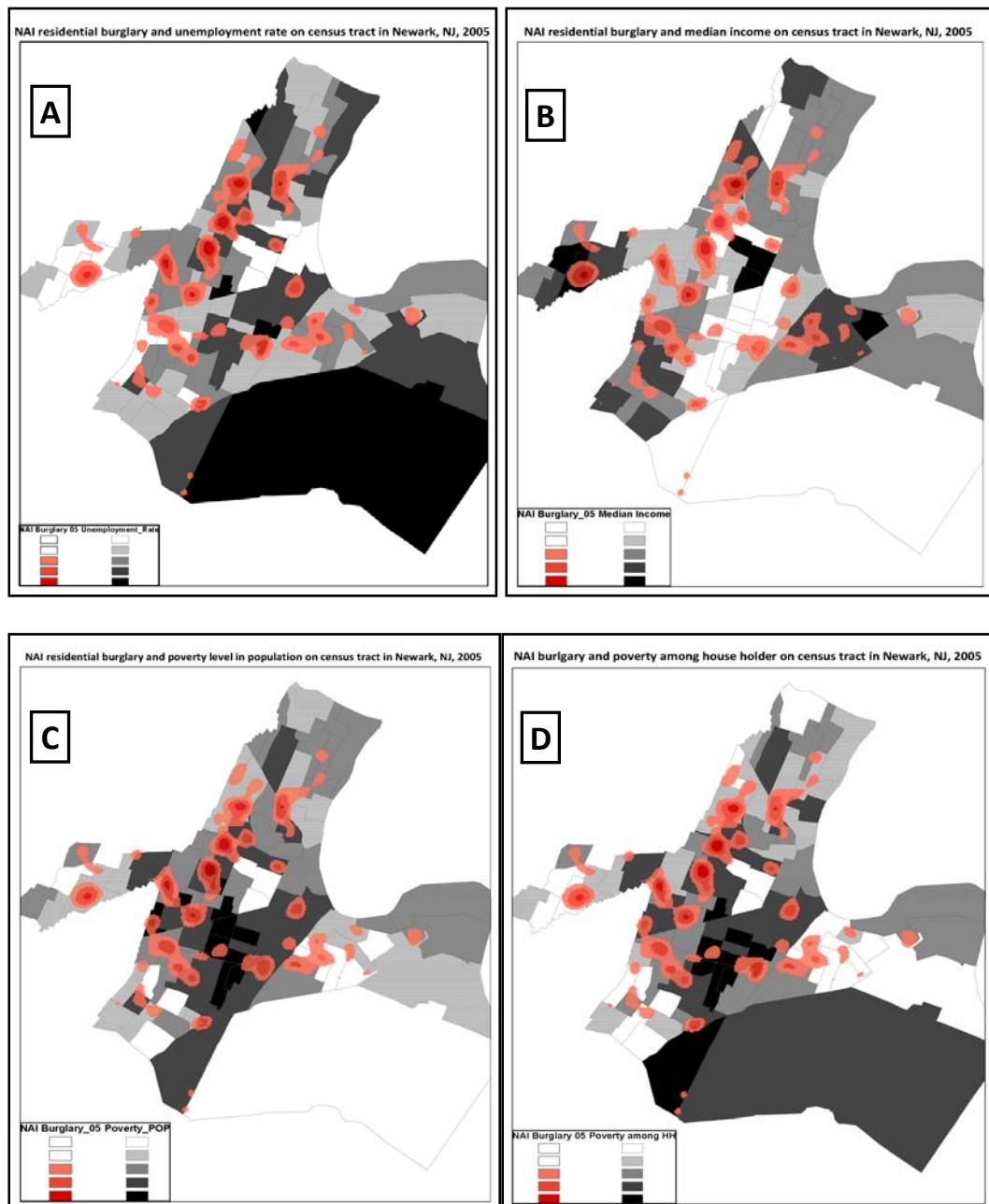
The median income in map B has an explicit pattern with the distribution of NAI burglary. The central section and some of the northern parts of the city have a lower-level median income, whereas most other parts of the city maintain a relatively higher-level median income. This observation is reliable when compared with map A because the levels of unemployment and median income are presupposed to be opposite, meaning that the higher the unemployment rate, the lower the median-income level. The western section of the city, in particular, illustrates this relationship. Thus, map B clearly shows that median-income is associated with NAI burglary in that the densest spots of NAI burglary reside in and around the census tracts with relatively higher median-income, whereas most census tracts with lower median-income in the central and northern parts of the city do not coincide with NAI burglary.

Poverty levels both in the general population (map C) and among householders (map D) have a similar pattern in that most of the central section maintains a comparatively higher level. Furthermore, census tracts in this area are closely associated with high levels of NAI burglary. On the other hand, lower levels of poverty in the population and among householders is less likely to be related to NAI burglary.

Linking these observations, socio-economic conditions demonstrate an explicit pattern that neighborhoods with higher levels of unemployment tend to

have a lower-level median income and higher levels of poverty in the population and among householders. The central section of the city illustrates this pattern on all four maps, indicating that NAI burglary is greatly affected by socio-economic conditions.

[Figure 8.12] Census-tract maps of socio-economic conditions with density maps of NAI burglary in Newark, NJ, 2005



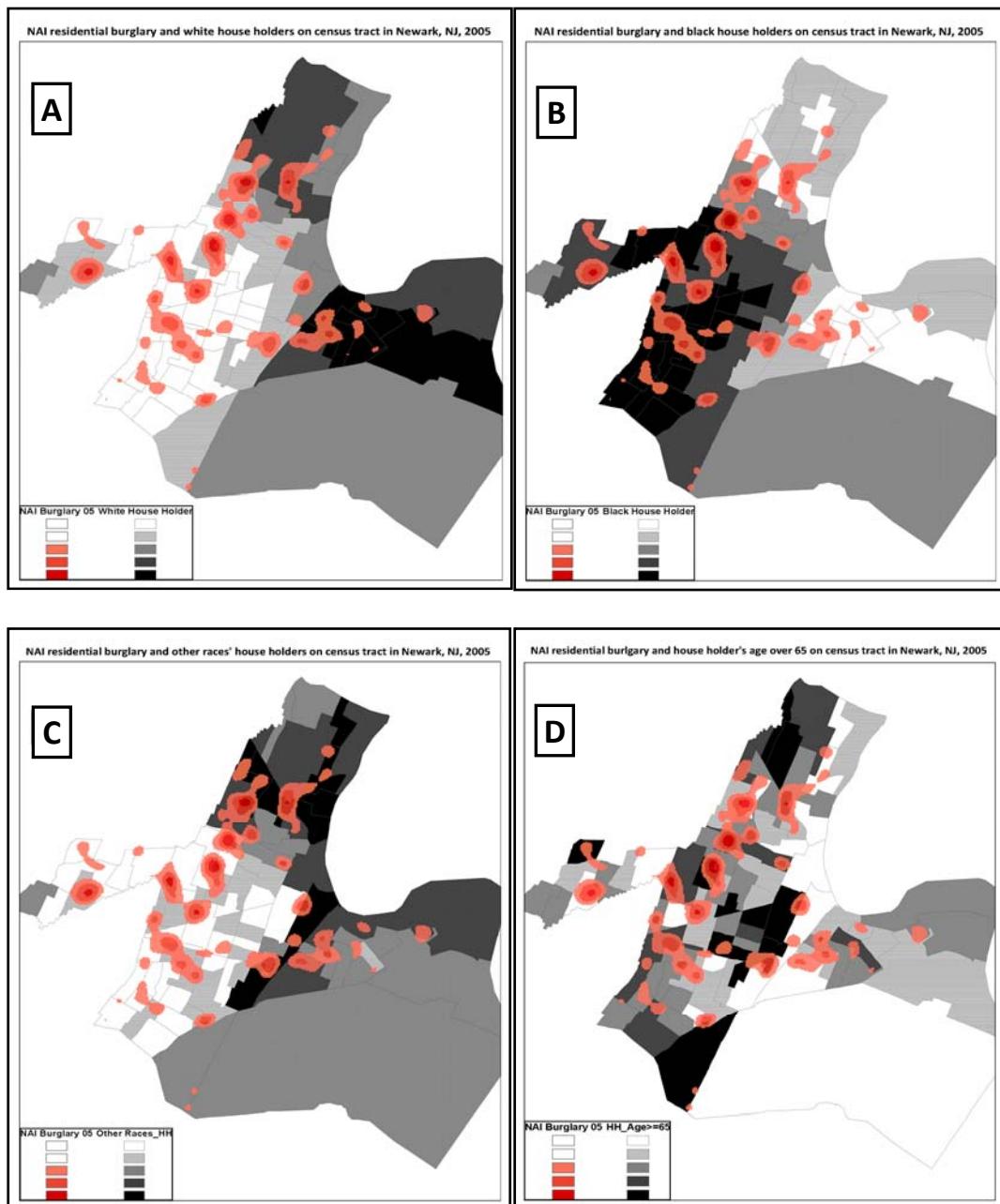
(4) NAI residential burglary and householders' race and age compositions

The distributions of householders by race in Figure 8.13 are similar to those of the general population in Figure 8.11, illustrating that census tracts with white (map A) and other race (map C) householders primarily reside in the eastern and northern sections of the city, whereas those with black householders (map B) are predominantly located in the western and central sections of the city. Some areas dominated by white and other have dense spots of NAI burglary, but most areas with high levels of NAI burglary overlap with neighborhoods with high concentrations of black. The pattern indicates that the neighborhoods dominated by black are more likely to be victimized by residential burglary than neighborhoods dominated by white and others.

This observation can link the causal relationship between burglar alarms and NAI burglary with the pattern of the general population by race. As discussed with quantitative statistics in Chapter 7, a statistically significant correlation between the increase of burglar alarms and the decrease of NAI burglary existed, but the order of causality was unclear. Spatial analyses can incorporate those observations to obtain a better explanation and understanding of this issue. The neighborhoods with dense NAI burglary also tend to have a higher rate of burglar alarms, but the number of NAI burglaries begins decreasing. Although the neighborhoods dominated by black population and householders enjoy declining residential burglary over the years along with the other neighborhoods, those neighborhoods still have comparatively higher rates of residential burglary. Consequently, they are more likely to install burglar alarms than neighborhoods with the population and

householders dominated by white and others. On the other hand, neighborhoods with white and others population and householders have relatively lower rates of NAI burglary, which may directly connect to the lower rate of installation of burglar alarms. But, the results are not conclusive.

[Figure 8.13] Census-tract maps of householders by race and age with density maps of NAI burglary in Newark, NJ, 2005



(5) NAI residential burglary and housing characteristic composition

Maps A and B in Figure 8.14 present the distribution of house occupancy with NAI burglary. The western, eastern, and northern parts of the city have dense rates of housing occupancy (map A), whereas the central west and southwestern sections show relatively dense rates of housing vacancy (map B). A clear pattern is not conclusive, but many of the densest spots of NAI burglary existing along the central west line of the city in map B share the same spatial dimensions with tracts having higher vacancy rates.

In addition, maps C and D illustrate that the neighborhoods with relatively higher rates of house occupancy by owners, in particular in the western and southwestern sections of the city, tend to have more NAI burglary than other neighborhoods. The existence of an explicit pattern cannot be conclusively argued.

[Figure 8.14] Census-tract maps of housing characteristics composition with density maps of NAI burglary in Newark, NJ, 2005



IV. Chapter Conclusion

Spatially descriptive analyses were conducted to examine Research Question 4 with two primary focuses: (1) to examine the spatial distributions and patterns of both burglar alarms and residential burglaries; and (2) to verify the findings based on quantitative analyses presented in Chapter 7. All addresses of burglar alarms and residential burglaries were geocoded for the purpose of map projection on a street-line city map using GIS computer program. Several spatial statistical techniques (e.g., point maps, density maps, and overlaying maps with independent variables) were used to examine the spatial relationships of burglar alarms and residential burglaries with other selective demographic, socio-economic, and housing characteristic variables by incorporating with and overlaying over the census tract-based maps.

First, point and density mapping methods were used as a macro-level approach. The point mapping approach by pinpointing all events onto a city map illustrated some indication of isolated patterns between burglar alarms and residential burglaries, but did not demonstrate clear spatial pattern over the years. On the other hand, the density mapping approach by creating a smooth continuous surface to represent the density or volume of the events distributed across the city clearly visualized several gradually concentrated areas of both burglar alarms and NAI residential burglary, showing that the patterns of burglar alarms installations and residential burglary incidents were not evenly distributed throughout the city. Though many of streets and city blocks had burglar alarms installed and were affected by residential burglaries, certain areas or neighborhoods obviously existed

with either more burglar alarms or more burglary incidents. Such patterns occurred dependent upon neighborhoods' conditions, such as demographic, socio-economic, and housing characteristics.

In addition, superimposed density maps between burglar alarms and NAI burglary plainly demonstrated that in most parts of the city, the heavily dense spots of both burglar alarms and NAI burglary did not overlap, showing that street blocks or small sectors of the city with high installation rates of burglar alarms had less NAI burglary incidents, whereas street segments or some sectors with higher residential incidents had less burglar alarms installed. These mapping analyses indicated that the installation pattern of residential burglar alarms showed some positive impact on residential burglary by pushing away potential burglar(s) from the highly concentrated areas of burglar alarms.

An overlaying mapping method was used: (1) to examine spatial characteristics of both burglar alarms and residential burglaries with some independent variables (e.g., population race and age group, unemployment, median income, householders' race and age group, house occupancy, and owner occupancy); and (2) to examine the consistency and reliability of the early quantitative observations by linking them to census-tract mapping analyses. Regarding the spatial installation pattern of residential burglar alarms, neighborhoods with a higher black population had more burglar alarms had more burglar alarms being installed than neighborhoods with a higher number of people of other races. Neighborhoods with a higher proportion of the younger population—ages below 17—had more burglar alarms installed because of its parent's concern of safety.

Neighborhoods with greater burglar alarms did cluster in and around the neighborhoods with a relatively lower unemployment rate, while neighborhoods with a higher median income level had more burglar alarms than those of a lower median income. Furthermore, neighborhoods with higher proportion of white or others householders had less burglar alarms installed than those of black householders.

With regard to the pattern of NAI burglary, neighborhoods with a relatively higher black population shared a more highly concentrated rate of NAI burglary than those with a white and others population. In short, black-dominant neighborhoods had more highly concentrated spots of burglar alarms and residential burglary. Neighborhoods with a highly density of the population below 14 years old coincided with many highly concentrated areas of NAI burglary, showing that NAI burglary was, though not a personal crime, to a large extent, related to the distribution of the general population and associated with a younger population. Neighborhoods with higher levels of unemployment had a lower-level median income and higher levels of poverty in the general population and among householders, showing that NAI burglary was greatly affected by socio-economic conditions in the neighborhoods. In short, these descriptive spatial analyses generally confirmed most of the earlier findings based on quantitative statistics in Chapter 7.

In the next chapter, spatial impact analyses of both burglar alarms and residential burglaries will be conducted and discussed to answer Research Question 5, which primarily focuses on spatial impact. Using GIS program, some simple

spatial statistics (e.g., spatial centrality and spatial dispersion analyses) and advanced spatial statistics (e.g., spatial autocorrelation analyses and spatial clustering analyses) for burglar alarms and residential burglaries will be employed.

CHAPTER 9. SPATIAL ANALYSES OF THE IMPACT OF BURGLAR ALARMS ON RESIDENTIAL BURGLARIES

I. Introduction

In Chapter 7, the analyses and discussions focused on quantitative statistics to examine the relationship between burglar alarms and residential burglaries. In Chapter 8, the descriptive spatial analyses examined the distribution and pattern of burglar alarms and residential burglaries in conjunction with quantitative analyses. In particular, the combined descriptive-spatial approach with quantitative statistics in the present study is an advanced method in the sense that research on burglary previously has lacked a unified analysis using both these methods.

As discussed and observed in Chapter 8, in many cases producing and presenting a map portraying the relevant variables can be enough to get the answers to the research questions. But examining a series of maps and trying to draw conclusions from those maps are not always easy, particularly when they are based on a descriptive approach. One shortcoming of such descriptive spatial analyses is that they do not provide statistical scrutiny. Thus, conducting a geographic analysis using spatial statistics is imperative. This statistical approach on a spatial dimension can produce more reliable and valid conclusions. Research Question 5 with the emphasis on spatial impact analyses of both burglar alarms and residential burglaries is directly related to this chapter.

With this in mind, this chapter focuses on geographic analysis using spatially statistical approaches to determine the impact of residential burglar alarms on residential burglary and vice versa. The two primary questions related to this

analysis are: (1) How are the features of residential burglar alarms and burglaries distributed in a spatial dimension; and (2) Where are the clusters? Answering these questions involves finding clusters of burglar alarms and residential burglaries to examine the cause of clusters, to determine whether those features occur together and to measure the strength of the relationship. By identifying a relationship, it may be possible to predict where these features will occur. Several spatially analytical tools are employed.

II. Spatial Centrographic Analyses for Burglar Alarms and Residential Burglaries

Geographic statistics can unveil the distribution and characteristics of features (e.g., burglar alarms, non-alarm-installed (NAI) residential burglary, and alarm-installed (AI) residential burglary), such as their geographic centers, the extent to which the features are clustered or dispersed around the center, or whether the features trend in a particular direction. The primary purpose of using this spatial centrographic approach is to examine a graphic representation and dispersion of both burglar alarms and NAI/AI burglaries.

1. Measures of Spatial Centrality for Burglar Alarms and Residential Burglaries

Finding the geographic center of a group of features is useful for tracking change in the distribution. Three measures of such a center are used: mean center, median center, and central feature. The underlying concepts and assumptions of these features are quite similar to those in quantitative statistics (e.g., mean, mode, and median). For example, the mean center is the average x-coordinate and y-

coordinate of all the features in the region this study covers. The median center is the location that has the shortest total distance to all features in the study area, being calculated using the straight-line distance from the x-coordinate and y-coordinate. The central feature is the feature that is the shortest total distance from all other features (Mitchell, 2005). Among these three, the mean center, which represents the most centrally located feature, is primarily used.

As observed and discussed in the previous chapter, the distribution of residential burglar alarms and NAI burglary were spread throughout the city, though many highly concentrated spots existed, and were unevenly located, in the city. In addition to these concentrated areas, it also is worthwhile to map the spatial points of representation of all spots for burglar alarms and NAI/AI burglaries.

Figure 9.1 shows the geographic mean centers of burglar alarms and NAI/AI burglaries. Maps A and B illustrate that the mean centers of residential burglar alarms are located to the left of the mean centers of NAI burglary, which reside in the center of the city. Map C puts these mean centers together, showing that each spatial mean center for both burglar alarms and residential burglary is closely clustered in one proximate geographic area within two distinctive parts of the city. The mean center for AI burglary is near the mean centers of residential burglar alarms.

[Figure 9.1] Mean centers of burglar alarms and residential burglaries annually in Newark, NJ



The distribution of mean centers is a reflection of the overall distribution of burglar alarms and NAI/AI burglaries. As discussed in Chapter 8, the areas with more burglar alarms were more likely to be located in the western and central sections of the city, whereas those of NAI burglary resided in the same sections of the city, as well as in the eastern section of the city (see Figure 8.3). This pattern pushes the mean centers for NAI burglary toward the eastern boundary of the city, away from those of burglar alarms, indicating that the distributive pattern of burglar alarms tends to be clustered more geographically than that of NAI burglary, which is less clustered, or more spatially dispersed, throughout the city. In other words, the city itself is, to a large extent, affected by residential burglary, while some certain sections of the city are influenced by burglar alarms. In particular, some eastern parts of the city definitely have fewer burglar alarms installed than other sections of the city with similar levels of NAI burglary (see Figure 8.3).

It should be noted that, like with any quantitative statistic, one or more outliers can skew the mean center or median center. An outlier may be a feature that is located incorrectly—especially if the street address was incorrectly geocoded. Furthermore, multiple events at a single location are stored as individual features in the geographic information system (GIS) database.

2. Measures of Spatial Dispersion for Burglar Alarms and Residential Burglaries

Measuring the compactness of distribution provides a single value representing the dispersion of features around a geographic center. There are two measures for spatial compactness of any distribution: standard distance deviation and standard deviational ellipse. Standard distance deviation is the spatial equivalent of the

standard deviation, a statistic mainly employed to describe the dispersal of values around the mean. The difference lies in that the standard distance deviation is a distance, so the compactness can be represented on a map by drawing a circle with the radius equal to the value. The value can be used to compare two or more distributions or to compare the same type of feature over different time periods (e.g., daytime and nighttime burglaries). The standard distance deviation value is expressed in the units in which the features are represented. The greater the standard distance value, the greater the distance varies from the average, and the more widely dispersed the features are around the center (Chainey and Ratcliffe, 2005; Mitchell, 2005).

On the other hand, the standard deviational ellipse measures the orientation and direction of spatial compactness. It can be thought of as a directional equivalent of the standard distance. The ellipse measures the standard deviation of the features from the mean center on the x-coordinates and the y-coordinates individually. An ellipse can be drawn using two, or more, standard deviations. An ellipse calculated using one standard deviation shows where features are concentrated. An ellipse calculated using two or more standard deviations shows where most of the features occur (Mitchell, 2005).

Thus, the standard deviational ellipse provides an accurate examination if the distribution of features is elongated, and hence has a particular orientation. It gives a more accurate picture than using the standard distance circle because the result is based on a statistical calculation rather than a visual interpretation of map output. The information also can be used in comparing the distributions of

categories of features and for comparing a single feature at different times (Chainey and Ratcliffe, 2005). These two analytical tools can be incorporated in conjunction with the mean centers.

Maps A and B in Figure 9.2 present the standard distance deviations and standard deviational ellipse of burglar alarms (red) and NAI burglary (blue), together with the mean centers. Both the standard distances and ellipses share the same spatial point as mean centers and use one standard deviation distance from the mean, which contains about 68 percent of the addresses of both burglar alarms and NAI burglary. The standard distance deviation circle of burglar alarms is larger than that of NAI burglary, showing that the distribution of burglar alarms tends to be more dispersed from the mean center than residential burglary and indicating that an equal measure of the standard distance from the mean center for all burglar alarm points is longer and less concentrated than NAI burglary, despite the fact that the overall geographic area covered by the densest distributions of burglar alarms is smaller than that of NAI burglary (see Figure 8.1 and Figure 8.3). On the other hand, the distribution of NAI burglary seems to be more clustered around the mean center in comparison with the wider distribution of burglar alarms, implying that the measure of the standard distance for NAI burglary is shorter than that of burglar alarms.

Regarding the standard deviational ellipse in Figure 9.2, both ellipses for burglar alarms and NAI burglary (map C) show an explicit orientation, both being inclining toward the east because both distributions for burglar alarms and NAI burglary in the city have dense areas toward the upper northeastern and lower

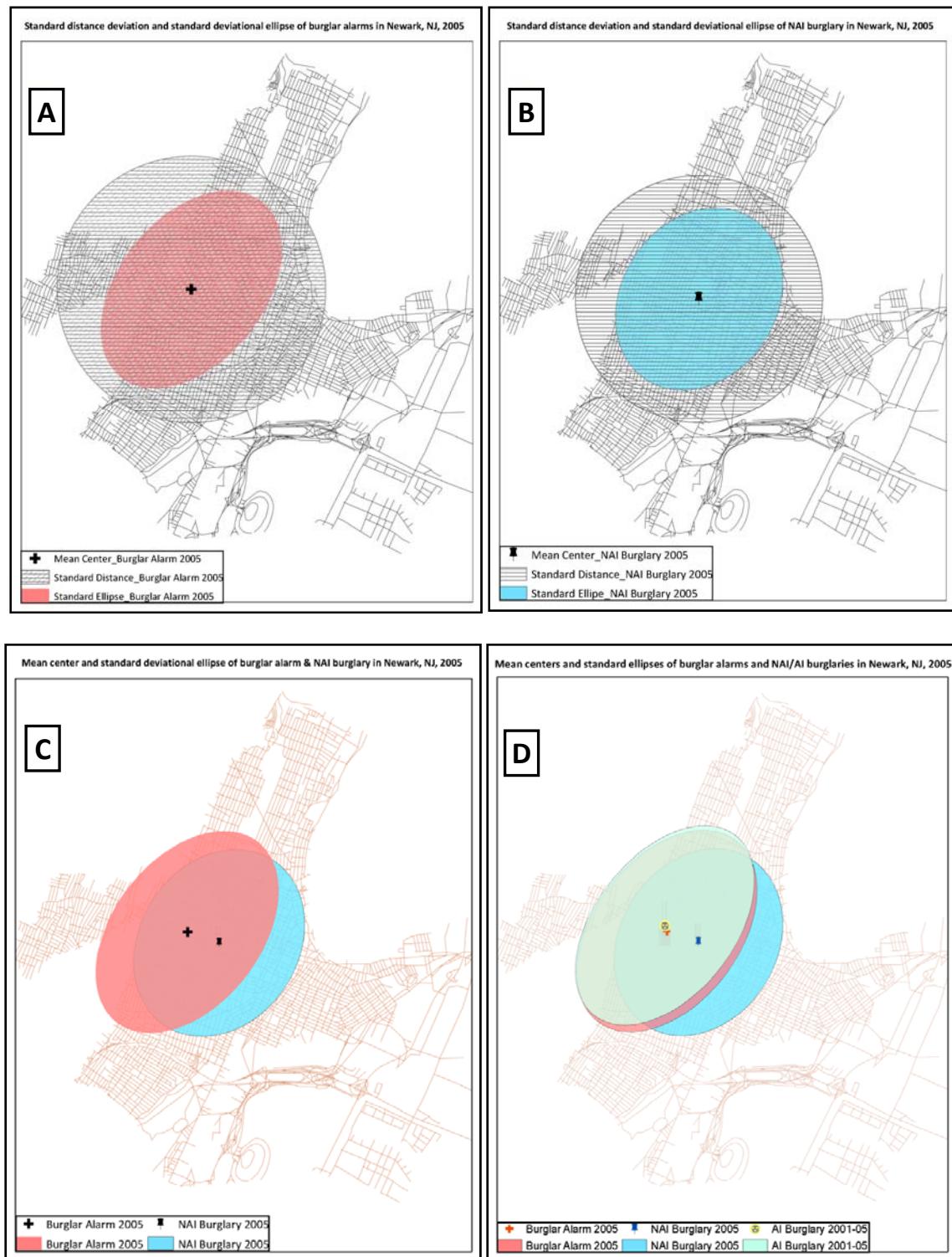
southwestern sections (see Figure 8.3), which elongate the standard deviation distances into the current shapes.

But though the ellipses have the same orientation, the sizes are different. For example, map C, which overlays burglar alarms and NAI burglary data from Figure 9.2, illustrates that the ellipse shape for burglar alarms (red) is a thinner oval than that of NAI burglary (blue). This observation indicates that while many dense areas of burglar alarms reside in the western section of the city, NAI burglary has dense areas of distributions in the same western section, but also in the eastern section of the city (see Figure 8.3). In other words, the distribution of NAI burglary is wider spread than that of burglar alarms. It stretches the oval shape of the standard deviational ellipse for NAI burglary wider toward the western and eastern boundaries of the city than burglar alarms.

Map D overlays the standard deviational ellipse for AI burglary on the ellipses for burglar alarms and NAI burglary, together with the mean centers. The orientation of the three features is fairly similar, and the size for AI burglary is matches the other two features. The similar pattern can be explained mainly by the distribution of AI burglary being based upon those of NAI burglary.

Figure 9.2 clearly demonstrates that the standard deviational ellipse is more sensitive to the geographic distributions of burglar alarms and residential burglaries than the standard distance deviation. Thus, its measures provide better information and understanding about geographic distributions and patterns of these features.

[Figure 9.2] Standard distance deviation, standard deviational ellipse, and mean center of burglar alarms and NAI/AI burglaries in Newark, NJ, 2005



But some of these observations contradict the factual observations from the previous chapter (see Figure 8.3). The number of dense areas of burglar alarms in the city are fewer than that of NAI burglary and cover smaller geographic sections of the city, in particular, in the western section of the city. At the same time, the areas of NAI burglary are spread more widely throughout the city because, it can be assumed, a smaller geographic area covered by the features should have a smaller standard deviation distance. Thus, the size of the standard distance deviation for burglar alarms should be smaller than that of NAI burglary. But the actual maps above show the opposite.

This phenomenon is closely associated with the assumption that the standard distance deviation is an equal measure in every direction from the mean. As observed in Figure 9.2, the geographic area covered by both the dense spots and the overall distribution of burglar alarms is smaller than that of NAI burglary, but this does not mean that the size of the standard distance also coincides with the geographic area of burglar alarms and, thus, is smaller in size in comparison to NAI burglary. The same assumption for the standard deviation in quantitative statistic explains this phenomenon in the sense that though distributions of burglar alarms cover a smaller geographic area, the standard deviational distance can be larger when all points of those features are clustered near each other but located farther from the mean center, because both the standard deviation and standard deviational distance are solely based on the mean and mean center. Thus, both the standard deviational distances and standard deviational ellipses, in conjunction with the points and density maps in Chapter 8, indicate that the distribution of

residential burglar alarms covers a relatively smaller geographic area than NAI burglary, but burglar alarms are much clustered than NAI burglary.

In addition, two issues should be mentioned. First, the standard distance deviation lacks directional focus (Chainey and Ratcliffe, 2005). Irrespective of the spread of the points in a particular direction, the standard distance is an equal measure in every direction. A more useful type of global dispersal measure is the standard deviational ellipse. Second, both the standard distance deviational and the standard distance ellipse are affected by outliers. In particular, regarding the orientation or size of the ellipse, the latter can be skewed by a few outlying features and, thus, not provide an accurate picture of the distribution.

Furthermore, though those analyses are useful and necessary to examine spatial patterns and characteristics for burglar alarms and residential burglaries, they have been analyzed and discussed without statistical tests. In other words, without a statistical approach for the spatial data, the geographic observations presented and discussed previously cannot be confirmed and, the null hypotheses for the spatial pattern analysis cannot be tested. Thus, it is imperative to conduct spatially statistical tests. But even with these limitations and issues, standard deviational ellipses are an improvement over standard distance deviations in terms of indicating point dispersion and direction of that dispersion.

III. Spatial Autocorrelation Analyses for Burglar Alarms and Residential Burglary at the Macro-Level

In the above section, the geographic representation and dispersion of the features for burglar alarms and NAI burglary at the city level were presented and discussed.

But spatial statistics measuring patterns is more accurate than identifying patterns by examining maps. For spatial statistic measures, the concepts of global and local statistics are used. Global statistics focus on whether the features form a pattern across the study area and the type of pattern that exists, whereas local statistics focus on individual features and their relationship to nearby features (Mitchell, 2005). In other words, the global method calculates a single statistic that summarizes a geographic pattern for the study area, while the local method calculates a statistic for each feature based on its similarity to its neighbors.

For example, the spatial impact of residential burglar alarms on residential burglary can be examined on the city level as a single unit of analysis, rather than on the neighborhood level or by sections within the city. This approach can be a global statistic in order to identify and measure overall geographic patterns. If the approach focuses on local or neighborhood variations for the impact of burglar alarms on residential burglary within the city, it would be considered local statistic.

This section uses the first approach, a global statistic to identify a clustered pattern in the city at different times looking for the geographic distribution impact between burglar alarms and residential burglary. Any distribution of features or values within a defined area can create a pattern. Geographic patterns range from completely clustered at one extreme to completely dispersed at the other. A pattern that falls at a point between these extremes is said to be random. Thus, knowing if there is a pattern in the data is useful to have a better understanding of a geographic phenomenon, monitor conditions on the ground, compare patterns, or track changes.

One way of identifying patterns in geographic data is to use statistics to measure the extent to which features or values are clustered, dispersed, or random. With that measure, it can be possible to compare the patterns for different sets of features or compare patterns over time. Using statistics to measure patterns is more accurate than identifying patterns by looking at a map. Global statistics are used to determine whether the features form a pattern across the study area and on what type of pattern exists.

For instance, as seen and discussed in the previous chapter (see Figure 8.3), many heavily dense spots exist across the whole city for the distribution of both burglar alarms and NAI burglary. One observation from the data is that all the points of burglar alarms and NAI burglary are not randomly distributed but have explicit patterns, which implies that residential burglar alarms have some positive impact on residential burglary by pushing away NAI burglary. If a spatial statistical test confirms this observation as being statistically significant, the spatial relationship between burglar alarms and NAI burglary is more reliable and supportive of the positive impact of burglar alarms on residential burglary.

Two primary approaches can be applied for spatial autocorrelation at the global statistic level: (1) measurement of the spatial pattern by discrete features²³ (e.g., points, lines, or noncontiguous areas), using quadrant analysis, nearest neighbor index (NNI), and k-function; and (2) measurement by attribute values

²³⁾ Discrete features can be points, lines, or areas. Points are used to represent either stationary features or events that occur at a specific place and time. Lines can be disjunctive or connected in a network. Discrete areas are usually distinct and separate, but may share a border or even overlap as fire boundaries often do (Mitchell, 2005).

associated with the features (e.g., census tracts or census blocks), using join count, Geary's C and global Moran's *I*, and general G (Chainey and Ratcliffe, 2005; Mitchell, 2005). Among these measures, NNI and global Moran's *I* approaches are most commonly applied to crime data.

1. Measure of the Nearest Neighbor Index (NNI) for Burglar Alarms and Residential Burglaries

As observed in Chapter 8, several dense areas of burglar alarms and residential burglaries exist across the city. A critical question about those areas is whether the distribution of the points within each area is clustered or dispersed with statistical significance, which can explain the spatial impact of residential burglar alarms on residential burglaries.

The NNI is a distance statistic for point pattern data sets that gives an indication of the degree of clustering of the points. The simple assumption for the NNI analysis is based on the comparison of the actual (or observed) distribution of features to a hypothetical random (or expected) distribution of the same number of features over the same study area, which enables the null hypothesis test for spatial data. Thus, the analysis compares the characteristics of an observed set of distances between pairs of closest points with distances that would be expected if points were randomly placed. It finds the distance between each feature and its closest neighbor, then calculates the average (or mean) of these distances. The results of NNI values are used for statistical significance (Chainey and Ratcliffe, 2005).

There are three general types of geographic pattern (see Table 9.1). A clustered pattern is often the most common form of spatial pattern seen with crime

data because neither opportunities nor the routine activities of offenders and victims are randomly distributed. If a pattern is more widespread, it is possible that it exhibits the second type of spatial pattern: a random distribution. In this type of pattern, although there may be some local clusters, the overall pattern of the crime series is spread across the study area without any apparent pattern—an event has an equal chance to appear anywhere in the study area. The third type of pattern is a dispersed distribution. This occurs where points are spaced roughly the same distance apart (Chainey and Ratcliffe, 2005; Mitchell, 2005).

[Table 9.1] Nearest Neighbor Index (NNI) ratios and results

NNI Ratio	Pattern
Ratio = 1	Random (no apparent pattern)
Ratio < 1	Clustered (similar values are found together)
Ratio > 1	Dispersed (high and low values are interspersed)

(Source: Mitchell, 2005)

NNI ratios can range from 0.0, for the distribution of features (e.g., burglar alarms and NAI/AI burglaries) that have all the points at the same geographic location, through 1.0, for a random distribution of points, up to a maximum value of 2.15. Values less than 1.0 indicate a clustered pattern (Chainey and Ratcliffe, 2005). Thus, if the NNI value is less than 1.0 and the *p*-value is less than 0.05, the probability that the distribution of the features is clustered due to random variation is less than 5 percent, which is a statistically significant finding.

Table 9.2 displays the values of NNI ratio and z-scores with the statistical significance level for burglar alarms and NAI/AI burglaries. Figure 9.3 demonstrates two positioning continua of NNI ratio values and z-scores: one at the

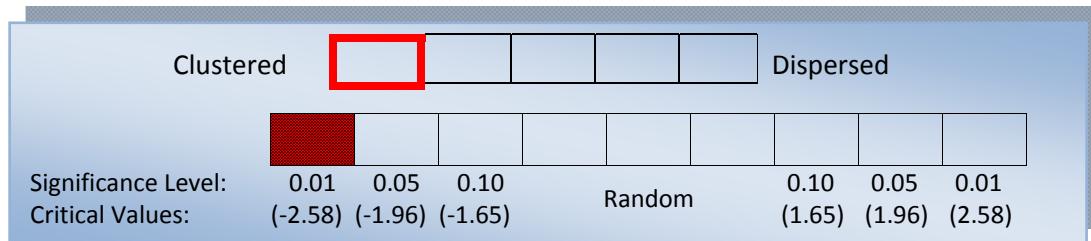
five-class continuum between clustered and dispersed, and the other at the nine-class continuum for the position of z-scores between plus (+) and minus (-) three standard deviations.²⁴ The null hypothesis is that the features (e.g., burglar alarms and NAI/AI burglaries) are randomly distributed in the city.

[Table 9.2] NNI ratios and z-scores for burglar alarms and NAI/AI burglaries annually in Newark, NJ

Type	Residential Burglar Alarms						NAI Residential Burglary						AI
Year	2001	2002	2003	2004	2005	overall	2001	2002	2003	2004	2005	overall	overall
NNI Ratio	0.39	0.42	0.38	0.37	0.37	0.13	0.38	0.39	0.37	0.40	0.44	0.24	0.49
Z-score	-39.3 **	-34.5 **	-45.1 **	-49.8 **	-53.8 **	-142.5 **	-58.9 **	-57.6 **	-55.9 **	-52.3 **	-40.9 **	-150.4 **	-18.6 **

** Statistically significant at the .01 level

[Figure 9.3] The results of NNI analyses



Regarding the NNI ratio for residential burglar alarms, the values are around 0.4, on average, with a statistical significance at the 0.01 level, rejecting the null hypothesis that burglar alarms are randomly distributed in the city and indicating that the distribution of burglar alarms is not randomly scattered but heavily clustered at certain geographic spots being affected by socio-economic conditions.

²⁴⁾ These two positioning continua are a typical, visual output for geographic statistical analysis in the ArcGIS computer software.

The results clearly support earlier observations and discussions in Chapter 8 about the pattern of burglar alarms.

The NNI ratios for both NAI/AI burglaries also are around 0.4, on average, with a statistical significance at the 0.01 level, which implies that NAI/AI burglaries are not evenly scattered across the city, but clustered within certain areas or neighborhoods. This finding also supports the earlier observations about the distribution of NAI/AI burglaries in Chapter 8. A substantially spatial relationship between burglar alarms and residential burglaries exists. Thus, for both burglar alarms and NAI burglary, the null hypotheses that the features are randomly distributed throughout the city are rejected.

Furthermore, combining Table 9.2 and Figure 9.3, this observation proposes that the distributions of both burglar alarms and NAI/AI burglaries are influenced by neighboring locations. This phenomenon is called a “spatial autocorrelation (or spatial dependency),” which means that, in general, places closer together are more likely to have a similar value (Chainey and Ratcliffe, 2005).

This can explain the installation pattern of residential burglar alarms by residents in certain neighborhoods. For example, when the NNI ratio for burglar alarms shows a clustered pattern with statistical significance, an installation of a alarm system at one geographic point directly affects the proximate or nearest location causing the installation of burglar alarms, and from the next nearest location to the surrounding area, and so forth. Then, after a certain time period, a relatively dense, but limited, geographic area for residential burglar alarms can be created. Once such a specific spot is created, it becomes self-sustaining and growing.

Such a process and phenomenon can occur in many small geographic areas in the city simultaneously or according to different timelines.

Thus, these dense spots of residential burglar alarms throughout the city tend to be clustered together in a geographic dimension, to provide protective seals over these particular areas and to keep residential crime rates comparatively lower than the areas without enough burglar alarms by pushing away residential burglar(s). One burglar alarm system at a house creeps into the next house. Such a spatial phenomenon demonstrates the positive impact of burglar alarms on residential burglaries. The descriptive geographic analyses in Chapter 8 visualize such spatial distributions (see Figure 8.1 and Figure 8.3). In particular, most of the heavily dense spots of burglar alarms are isolated from those areas of NAI burglary. More importantly, this is the basic concept of the “diffusion of benefits” of crime prevention schemes, which will be discussed in greater detail in the following chapter. Nonetheless, residential burglar alarms can be self-sustainable and can spread the diffusion of benefits of crime prevention to the neighborhood.

By the same token, the victimization pattern of residential burglary can be explained by a similar process and phenomenon using the pattern for residential burglar alarms. In other words, two crucial questions can be answered based on the values of the NNI ratios and z-scores with statistical significance: (1) Why is NAI burglary not spread evenly throughout the city?; and (2) Why do many heavily dense areas of NAI burglary exist across the city? The same spatial effect may occur for the pattern of crime victimization by residential burglary.

2. Measure of the Global Moran's *I* for Burglar Alarms and Residential Burglaries

Moran's *I* is a classic measure of global spatial autocorrelation and is commonly applied to crime data. The advantage of Moran's *I* over NNI analysis is that while NNI measures the clustering in points, Moran's *I* can show if there is significant clustering in a variable (Chainey and Ratcliffe, 2005). This means, for example, that the process is able to determine whether there is clustering in the patterns for burglar alarms or residential burglaries, even if those patterns are aggregated to the same set of polygons. Thus, global Moran's *I* can determine whether the dense areas of both burglar alarms and residential burglaries also are surrounded by other dense areas of burglar alarms and residential burglaries, and whether less dense areas are surrounded by other less dense areas. If so, then the patterns of burglar alarms and residential burglaries are said to display positive spatial autocorrelation. If, however, less dense areas are surrounded by dense areas of burglar alarms and residential burglary, and dense areas are surrounded with less dense areas, the series would display negative spatial autocorrelation. If there is no pattern to the distribution of dense and less-dense areas, then the series would have zero spatial autocorrelation (Mitchell, 2005).

Table 9.3 shows the range of possible values of Moran's *I* index from - 1 to 1. If all neighboring features have close to the same value, the index value will be near 1 with a positive z-score, indicating complete clustering of values. Conversely, if the values are completely dispersed, the value of the index is near - 1 with a negative z-score.

[Table 9.3] Global Moran's *I* Index values and results

Moran's <i>I</i> Index	Pattern
Ratio = 0	Random (zero spatial autocorrelation)
Ratio < 1	Clustered (positive spatial autocorrelation)
Ratio > -1	Dispersed (negative spatial autocorrelation)

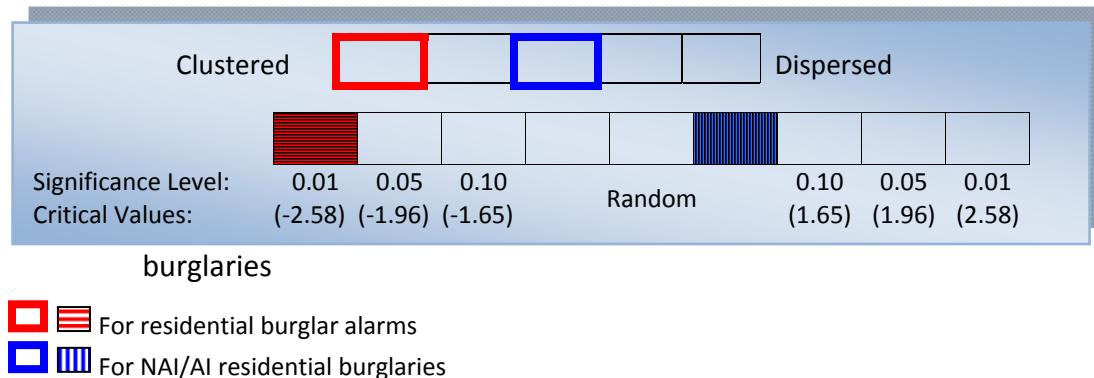
(Source: Mitchell, 2005)

Table 9.4 displays index values of Moran's *I* for burglar alarms and NAI/AI burglaries to examine the spatial relationships. Figure 9.4 demonstrates the position of Moran's *I* indexes in the continuum between clustered and dispersed and the position of z-scores in the continuum between plus (+) and minus (-) three standard deviations.

[Table 9.4] Global Moran's *I* values for burglar alarms and NAI/AI burglaries annually in Newark, NJ

Type	Residential Burglar Alarms					NAI Residential Burglary					AI	
Year	2001	2002	2003	2004	2005	overall	2001	2002	2003	2004	2005	overall
Moran's Index	0.04	0.04	0.09	0.09	0.05	0.08	0.00	-0.01	0.00	0.00	0.00	0.00
Z-score	3.7 **	3.9 **	7.4 **	7.6 **	5.0 **	6.5 **	1.4	0.9	1.4	1.4	1.2	1.3

** Statistically significant at the .01 level

[Figure 9.4] The results of Global Moran's *I* analysis for burglar alarms and NAI/AI

For residential burglar alarms, the average value of Moran's *I* Index is about 0.06 with a statistical significance at the 0.01 level. Figure 9.4 shows that the spatial pattern of residential burglar alarms is clustered, confirming the previous finding with the NNI analysis and demonstrating that features near each other are more alike than features far apart. Many dense areas of burglar alarms in the city exist because, as discussed in the previous section, the distribution of burglar alarms in a certain dense area is not isolated from other dense areas, but surrounded by dense areas of distribution of burglar alarms, which consequently creates a heavily dense spot in the city. Furthermore, the dense areas of burglar alarms themselves are not isolated from other spots but surrounded by them, which enables all these dense areas to be clustered.

Thus, not only do heavily dense spots of burglar alarms exist in the city, but also these spots reside in considerable proximity, being bound by the mutual gravitation of surrounding dense spots. This observation supports the positive impact of residential burglar alarms to neighboring geographic areas. In other words, the effect of diffusion of benefits of burglar alarms delivers a comparatively high level of diffusion of benefits to the neighborhoods where burglar alarms have been installed.

NAI residential burglary, however, the average value of Moran's *I* index is 0.00 with no statistical significances (but the z-scores are not close to 0.0), which indicates that unlike burglar alarms, statistical analysis does not support spatial clustering for NAI burglary. The results do not mean that spatial clustering completely does not exist throughout the city. It does show that although the

individual distribution of points within individual spots is clustered and many dense spots of NAI burglary exist, the distribution of these dense spots at the city level is not clustered, but rather dispersed, because those spots are not distributed closely to each other, but are instead randomly spread throughout the city.

Three issues for the above observations of the Moran's *I* value should be noted. First, unlike burglar alarms with a statistical significance at the 0.01 level, NAI burglary has almost 0 spatial autocorrelation with no statistical significance. However, by and large, this finding may coincide with the distribution of burglar alarms and NAI burglary because the positive spatial autocorrelation for burglar alarms is associated with the most heavily dense spots, located in the western, central, and southwestern sections of the city, whereas the 0 spatial autocorrelation for NAI burglary is related with many heavily dense spots spread throughout the city. In other words, the former is concentrated in smaller geographic sections of the city, while the latter is scattered around the city, which global Moran's *I* test does not show a statistical significance.

Second, the different observations between burglar alarms and NAI burglary according to the Moran's *I* are closely related to the geographic density map discussed in the previous chapter (see Chapter 8). The average number of burglar alarms and NAI burglary over the five years are 2,138 and 2,269, respectively (see Table 5.1), though each year has discrepancies. Thus, the total number of burglar alarms and NAI burglary per year is similar, but the geographic distribution of them shows a quite different pattern. The distribution of dense spots for burglar alarms is concentrated in the western, central, and southwestern areas of the city, whereas

the distribution of NAI burglary is spread across the city. The overall size of the geographic area for burglar alarms is definitely smaller than that of NAI burglary. It produces a higher geographic compactness for burglar alarms and a lower compactness for NAI burglary. Therefore, global Moran's *I* shows the positive spatial autocorrelation for burglar alarms and the zero spatial autocorrelation for NAI burglary.

Third, such global spatial statistics as NNI ratio and Moran's *I* may provide little insight into the location, relative scale, size, shape, and extent of hotspots. Those spatial association statistics examine whether the number of point events in an area is similar to the number of point events in neighboring areas. In general, they explore the spatial autocorrelation between data variables and can determine if positive spatial autocorrelation is said to exist. But these global statistical measures often tend to summarize an enormous number of possible disparate spatial relationships in crime data (Chainey and Ratcliffe, 2005). It is imperative to examine the spatial impact of burglar alarms on residential burglaries at the micro-level with local spatial statistics. Nevertheless, the critical point here is that this observation from the Moran's *I* analysis is not contradictory to the positive impact of burglar alarms on residential burglary.

IV. Spatial Clustering Analyses for Burglar Alarms and Residential Burglaries at the Micro-Level

In the above section, the spatial pattern and impact for both residential burglar alarms and burglaries were presented and discussed on a city level with the overall features of all distributions of burglar alarms and residential burglaries, using global

geographic statistics. Local spatial statistics also can be used to focus on individual features and their relationship to nearby features.

Local spatial statistics are useful to identify the spatial association between a single value and its neighbors. Using a local statistic can help find hotspots when a global statistic indicates that there is a clustered pattern. In other words, if a global statistic indicates there is spatial autocorrelation, the measure of local variation can help pinpoint which feature or features are contributing to it. For example, the clearly clustered pattern for both burglar alarms and NAI residential burglaries are identified at the entire city level in the previous section. Are those observations consistent even at the local level within the city? Local indicators of spatial association statistics (Chainey and Ratcliffe, 2005) can be used to provide a better understanding and insight of the geographic patterns and impact between burglar alarms and residential burglaries.

Unlike the spatial autocorrelation statistics with the whole city as a unit of analysis, census tract of the city are used as a unit of analysis for local indicators of spatial association statistics. Thus, local spatial statistics can show consistency and validity of the earlier observations and discussions regarding the spatial relationship and impact for burglar alarms and residential burglaries, and provide better insight into the spatial patterns and relationships at the micro-level.

Three measures of spatial local statistics are available: local Geary's *C*, local Moran's *I*, and General *Gi**. They are calculated and used in different ways each with its strengths and weaknesses. For example, local Geary's *C* compares the values of neighboring features by calculating the difference between them. It emphasizes

how features differ from their immediate neighbors because it compares the values of neighboring features directly with each other. On the other hand, Local Moran's *I* compares each value in the pair to the mean value for all the features in the study area. Thus, it emphasizes how features differ from the values in the study area as a whole because it compares the value of each feature in a pair to the mean value for all features in the study area. Gi^* compares neighboring features within an area that a researcher specifies. It is useful to find hotspots or coolspots because the results indicate the extent to which each feature is surrounded by similarly high or low values (Mitchell, 2005). Among them, local Moran's *I* and Gi^* are employed here for spatial clustering analyses.

1. Geographic Clustering Analyses

To measure the impact of burglar alarms on residential burglaries, two approaches will be used: macro-level and micro-level. As observed and discussed previously, the macro-level analysis could be employed to examine the impact of alarm systems on crimes at a city level. For this approach, the density function was used to identify the dense spots of residential burglar alarms and NAI/AI burglaries. This method is useful in analyzing the pattern between burglar alarms and residential burglaries, as well as for visually examining whether the dense spots of burglar alarms and residential burglaries overlap.

Further global statistical measures with the NNI ratio and Moran's *I* index are used to test spatially statistical significance for the geographic pattern. Those analyses presented the macro-level impact and directionality (e.g., positive or negative impact) of alarm systems on residential burglaries. One shortcoming of the

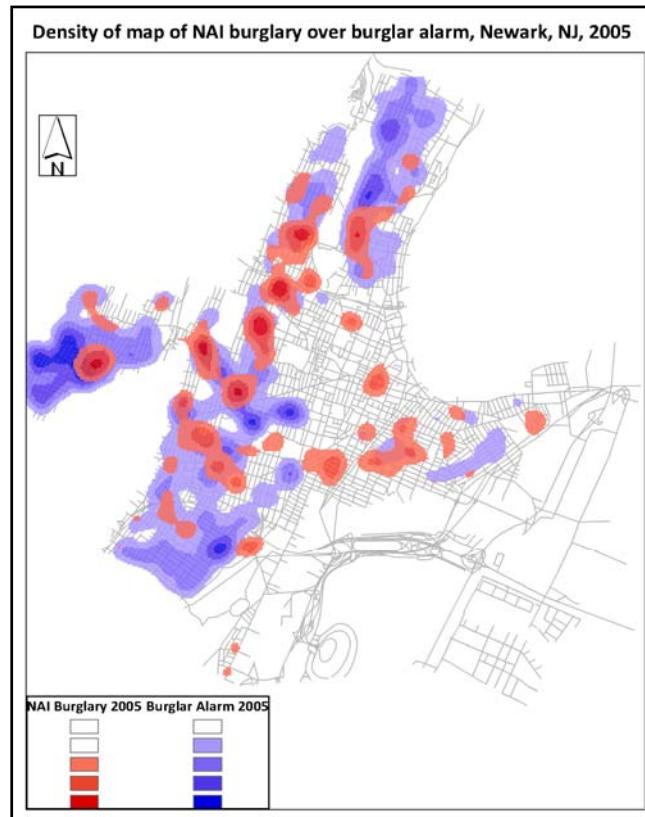
macro-level approach with aggregated data is that it lacks a micro-level analysis at the level of the single house, census block, or census tract. It is necessary to have more sensitive spatial analyses with disaggregated data at a micro-level in order to examine the impact of burglar alarm systems on residential burglaries.

The fundamental concept for this level's approach is cluster. Clusters occur in a geographic distribution either when features are found in close proximity or when groups of features with similarly high or low values are found together (Mitchell, 2005). In the context of crime analysis, the concept of a hotspot is similar to that of a cluster of features. For example, when similarly high values of features are found closely clustered, it can be identified as a hotspot. The method can be applied to both burglar alarms and residential burglaries.

Clustering at the macro-level is used to examine the impact of burglar alarms on crime at a city-level and can be done by using the density function (or smoothing-out) in ArcGIS. With this method, the individual data points depicting the addresses of either residential burglaries or burglar alarms are "smoothed out" to create an image that shows the areas with the highest density or concentration. Two comparison density estimations for burglar alarms and NAI burglary are produced. The outcome is two separate images of hotspots. An examination of distinctive distribution patterns can determine if they overlap, and statistical tests can show their relationship. Thus, seeing the impact of alarm systems on residential burglaries can be useful. Figure 9.5 is one example of a density map of NAI burglary overlaid with information for burglar alarms in the city in 2005. The map visually

displays multiple hotspots for both burglar alarms (blue) and NAI burglary (red). In both cases, darker colors show higher numbers.

[Figure 9.5] Overlaid density map of burglar alarms and NAI burglary in Newark, NJ, 2005



One drawback of the macro-level approach with a larger study area is that it lacks a micro-level analysis at levels of a single house, census block, or census tract. For example, as presented in Figure 9.5, the overlapping hotspots between burglar alarms and NAI burglary exist, in particular, in the western and central sections of the city. Such a spatial observation may lead to misinterpreting the impact of alarm system on residential burglaries. In other words, because of those overlapping hotspots, the issues of displacement and diffusion of benefits are questionable.

Furthermore, it can be argued that the spatial relationship between burglar alarms and residential burglary does not exist. Therefore, more sensitive spatial analyses with disaggregated data at the micro-level are required in order to examine the impact of alarm systems on crime.

2. Local Moran's *I* Analyses for Burglar Alarms and Residential Burglaries

Local Moran's *I* cluster is used to identify the locations of statistically significant hotspots. In particular, it identifies those clusters of points with values similar in magnitude and those clusters of points with heterogeneous values. The cluster analysis output is a Local Moran's *I* value with an associated z-score for each feature. The z-score represents the statistical significance of the index value. It, in effect, indicates whether the apparent similarity or dissimilarity in values between the feature and its neighbors is greater than would be expected by chance.

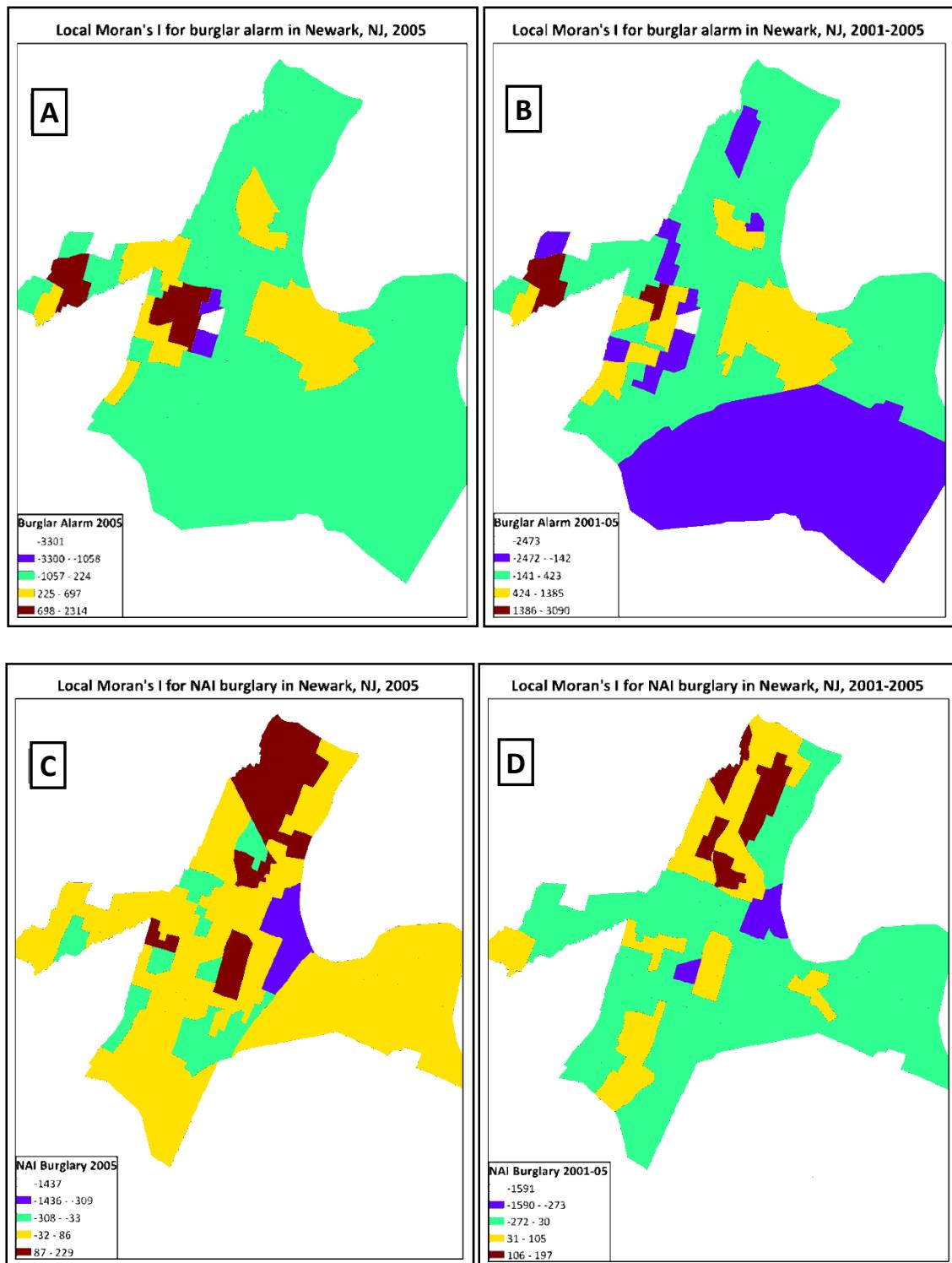
A high positive z-score for a feature indicates that the surrounding features have similar values, either high or low. A group of adjacent features having high z-score indicates a cluster of similarly high or low values. A low negative z-score for a feature indicates that the feature is surrounded by dissimilar values—that is, if a feature has a negative z-score, its value is different than its neighbors (i.e., a high value relative to a neighborhood that has low values or a low value relative to a neighborhood that has high values) (Mitchell, 2005).

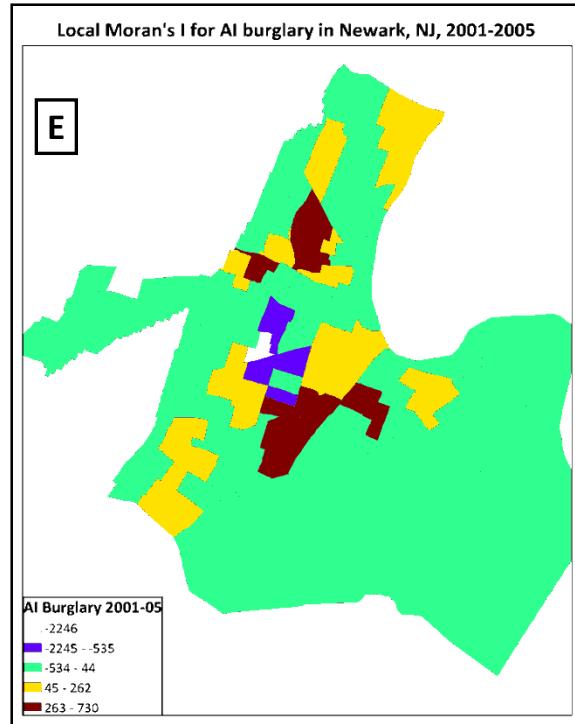
This approach can determine the degree to which each feature is similar or dissimilar to its neighbors—where high values are surrounded by high values or low values are surrounded by low values. This method calculates a statistic for each feature and maps the features based on this value to find the locations of features

with similar values. It also can locate hotspots and coolspots as this approach looks at values of adjacent features or features within a specified distance and compares the average value for the neighborhood to the average value for the study area. The method also indicates whether clusters are composed of high or low values. Thus, Local Moran's *I* shows local variation, that is what is occurring immediately surrounding each feature. For this approach, 90 census tracts in the city were used as a unit of analysis. Census-tract maps based on Local Moran's *I* analysis illustrate geographic clustering for the attributes (e.g., burglar alarms and NAI/AI burglaries) among the features (e.g., census tract).

Figure 9.6 presents the census maps of Local Moran's *I* for burglar alarms and NAI/AI burglaries for 2005 and the overall. For this analysis, all counts of both burglar alarms and residential burglaries were regrouped and geocoded according to the 90 census tracts. The best way to view and interpret these maps is to examine whether the same color census tract appear next to each other or share the same tract boundaries. The greater the number of areas with the same color gather, the more tracts that are similar. Maps A and B for burglar alarms in Figure 9.6 present the same level of burglar alarms neighboring each other. For example, yellow-colored census tracts with high rates of burglar alarms gather together in the central, eastern, and central northern sections of the city, whereas brown-colored census tracts with the highest rates of burglar alarms are next to each other in the western and central parts of the city.

[Figure 9.6] Local Moran's I for burglar alarms and NAI/AI burglaries in Newark, NJ, 2005 and overall





The similar patterns of spatial clustering for NAI and AI burglaries are identified in the remaining maps of C, D, and E in Figure 9.6, showing that census tracts with NAI/AI burglaries are surrounded by neighboring census tracts with substantially similar rates of residential burglaries at several geographic sections within the city.

Several indications are observed from these maps based on Local Moran's *I* analysis. First, as discussed in the previous section and chapters, the distributions of both burglar alarms and residential burglaries on the census-tract level are not evenly scattered across the city. The same geographic observation was found on the city level. Thus, not only on the city level, but also on the census level, the distribution of burglar alarms and residential burglaries are spatially clustered, meaning that the local variations of the levels of alarm installation and NAI burglary exist and those local variations are strongly linked to each other by forming spatial

closeness. Therefore, geographic clustering of both burglar alarms and NAI burglary based on the Global and Local Moran's *I* analyses are consistent over the years. In other words, these observations do not occur by random chance, but are closely linked to neighborhoods' socio-economic factors.

Second, some of the densest spots of both burglar alarms and NAI burglary, in dark brown, are scattered across the city because the same levels of burglar alarms and NAI burglary tend to gather next to each other on the census-tract level, with the result being relatively large geographic areas occupied with the same color. This observation confirms the earlier findings and discussions based on the NNI ratio and Global Moran's *I* index regarding the spatial clustering of the distributions of burglar alarms and NAI burglary, which are spread evenly throughout the city but spatially clustered in neighborhoods with dense spots forming across the city. These spatial observations from Local Moran's *I* are moderately consistent over the years (see Appendixes 13 and 14).

Third, these geographic observations confirm that the effect of diffusion of benefits can explain the installation pattern of burglar alarms and NAI burglary in Newark, N.J. The densest census tract, shown with a dark brown color, of burglar alarms can affect the neighboring tract and create both yellow and green colors, which eventually creates a group of census tracts. Its group, thus, produces one geographic boundary with the densest rate of alarm installation. The same process can be used to explain NAI burglary. However, the diffusion of benefits of burglar alarms (maps A and B in Figure 9.6) is more apparent and visual than that of NAI burglary.

3. Local Hotspots (Gi^*) Analysis for Burglar Alarms and Residential Burglaries

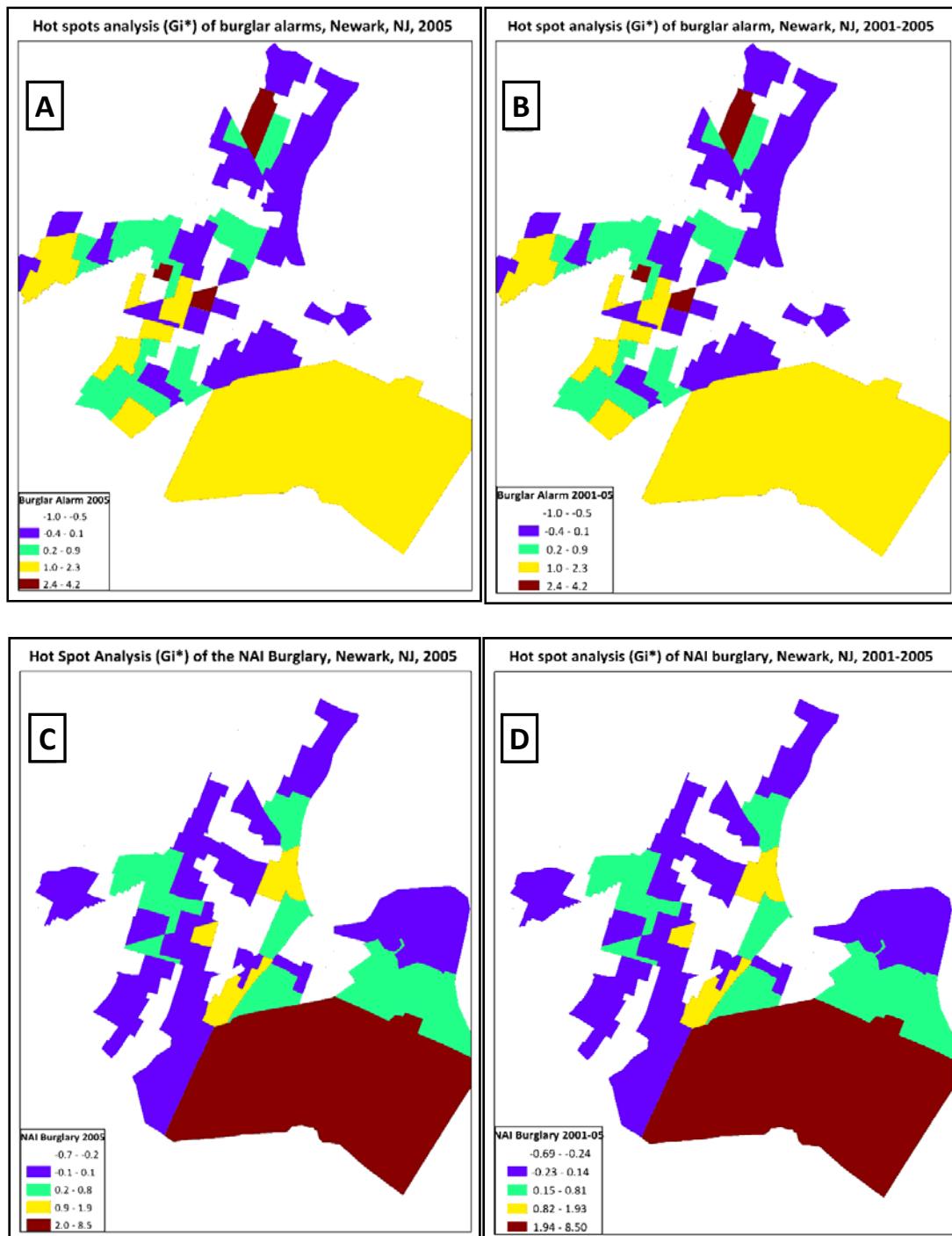
The local Gi^* analysis describes where geographic clusters of high or low values are located. Gi^* statistics identify the extent to which each feature is surrounded by similarly high or low values in an effort to find hotspots or coolspots. A group of features with high Gi^* values indicates a cluster or concentration of features with high attribute values. Conversely, a group of features with low Gi^* values indicates a coolspot. Thus, a Gi^* value near 0 indicates there is no concentration of either high or low values surrounding the target feature (Mitchell, 2005).

Figure 9.7 presents the census-tract maps of Gi^* for burglar alarms and NAI burglaries. Like the Local Moran's I , the best way to observe and interpret these maps is to examine whether census tracts of similar colors gather together or share boundaries with other similar tracts. The higher the number of same-color clusters, the more each tract in a group is similar. In addition, a census tract with the densest color (brown) can be identified as a hotspot, and the census tract with the lightest color (white) can be recognized as a coolspot. Yellow-colored census tracts with a relatively higher level of both burglar alarms and NAI burglary also can be identified as hotspots.

Maps A and B for burglar alarms by census tract in Figure 9.7 show that most of the same-colored tracts, depending on different levels of the Gi^* values, are clearly neighboring each other, forming a group of census tracts with the same level. For example, the first level of several hotspots (brown-colored census tracts) of burglar alarms is seen in the central and northern sections of the city. In addition, the second level of hotspots (yellow-colored census tracts) for burglar alarms is

located in the western and southwestern neighborhoods in the city. But the coolspots for burglar alarms are found in some central sections, most of the eastern section, and the central northern section of the city.

[Figure 9.7] Gi^* for burglar alarms and NAI burglary in Newark, NJ, 2005 and overall



A similar pattern of spatial clustering for NAI burglary is identified in maps C and D in Figure 9.7, showing that most of census tracts for NAI burglary are surrounded by the neighboring census tracts with a substantially similar rate of residential burglaries at several geographic sections in the city. In particular, the first and second levels of hotspots (brown- and yellow-colored tracts) for NAI burglary are found in the southern and central eastern sections of the city, while the coolspots are observed throughout the city.

As discussed earlier, the Gi* approach can be used to identify both hotspots and coolspots of distribution of burglar alarms and NAI burglary. The maps in Figure 9.7 illustrate that the hotspots and coolspots for both features exist throughout the city. This observation is consistent with the earlier findings in Chapters 7 and 8. For example, in Chapter 7, it was argued that the distribution of both burglar alarms and residential burglaries was not evenly spread throughout the city, indicating that the variation was due to several key variables of the neighborhoods' characteristics (e.g., burglar alarms, NAI burglary, black population, owner's occupancy, unemployment, population age group over 45 years old, and householder age group of 60 to 64 years old). In Chapter 8 with a series of geographic mapping approaches, those descriptive mapping analyses supported most of the findings from quantitative approaches in Chapter 7. In particular, those maps indicated that the installation pattern of residential burglar alarms had some positive impact on residential burglaries. Furthermore, several statistically geographic analyses confirmed those earlier findings and the existence of the effect of diffusion of benefits of burglar alarms.

V. Chapter Conclusion

Research Question 5 was related to the spatial impact analyses of both burglar alarms and residential burglaries. Using GIS program, some simple spatial statistics (e.g., spatial centrality and spatial dispersion analyses) and advanced spatial statistics (e.g., spatial autocorrelation and spatial clustering analyses) were employed for burglar alarms and residential burglaries.

With regard to spatial centrographic analyses with the focus on spatial distributions of burglar alarms and residential burglaries, three geographic centers were used: mean center, median center, and central feature (which are quite similar to those in quantitative statistics, such as mean, mode, and median). The distribution of mean centers reflected the overall distributions of burglar alarms and NAI/AI burglaries. For example, as seen in Chapter 8, the areas with more burglar alarms were more likely to be located in the western and central sections of city, whereas those of NAI burglary resided in the same sections of the city, as well as in the eastern section of the city. This pattern pushed the mean centers for NAI burglary toward the eastern boundary of the city, away from those of burglar alarms. It showed that the distributive pattern of burglar alarms tended to be clustered more spatially than that of NAI burglary throughout the city. In other words, the city itself was, to a large extent, affected by residential burglary, while some certain sections of city are influenced by burglar alarms.

Spatial dispersion analyses showed that the distribution of burglar alarms was more dispersed from the mean center than residential burglary and that the oval shape of the standard deviational ellipse for NAI burglary stretched wider

toward the western and eastern boundaries of the city than burglar alarms, because many dense areas of burglar alarms resided in the western section of the city, whereas NAI burglary had dense areas in the same western section, as well as in the eastern section of the city.

With regard to spatial autocorrelation analyses, both the NNI ratio and global Moran's *I* for burglar alarms and residential burglaries showed that the distribution of them was not randomly scattered but heavily clustered at certain geographic spots across the city being affected by socio-economic conditions. Both findings clearly supported earlier observations about the distributions of burglar alarms and residential burglaries that a substantially spatial relationship between them with other variables existed.

More importantly, the distributions of both burglar alarms and residential burglaries were influenced by neighboring locations, meaning that places closer together were more likely to have a similar value, which is called a spatial autocorrelation. In other words, an installation of a burglar alarm at one geographic point directly affected the proximate or nearest location causing the installation of burglar alarms, and from the next nearest location to the surrounding area, and so forth. Then, after a certain time period, a relatively dense, but limited, geographic area for burglar alarms can be created. Once such a specific spot is created, it becomes self-sustaining and growing. Thus, these dense spots of burglar alarms throughout the city were clustered together in a geographic dimension, provided protective seals over these particular areas, and kept residential crime rates comparatively lower than the areas without enough burglar alarms installed by

pushing away residential burglar(s). As a result, most of the heavily dense spots of burglar alarms, as visualized in Chapter 8, were isolated from those areas of NAI burglary. Thus, not only do heavily dense spots of burglar alarms existed in the city, but also these spots resided in considerable proximity, being bound by the mutual gravitation of surrounding dense spots. Such a spatial observation is the basic concept of the “diffusion of benefits” of crime prevention schemes, supporting that burglar alarms had the positive impact on the decrease of residential burglary incidents to neighboring geographic areas.

Regarding spatial clustering analyses, local Moran's *I* for burglar alarms and residential burglaries showed that, on both the city level but also the census level, the distribution of burglar alarms and residential burglaries were spatially clustered, demonstrating that the local variations of the levels of alarm installation and NAI burglary existed and those local variations were strongly linked to each other by forming spatial closeness. In other words, these spatial distributions did not occur by random chance, but were closely link to neighborhoods' socio-economic factors.

Furthermore, local hotspots (Gi^*) analysis for burglar alarms and NAI burglary showed that either hotspots or coolspots was clearly neighboring each other by forming a group of census tracts with the same level, indicating that the installation pattern of burglar alarms had some positive impact on the decrease of residential burglaries.

In the following chapter, Research Question 6 will be examined and discussed, which focuses on the spatial displacement and diffusion of benefits of burglar alarms on residential burglaries. Acknowledging the absence of a

standardized study design for the measurement of spatial displacement and diffusion of benefits of criminal prevention programs, nonequivalent-group quasi-experimental research design will be discussed. In addition, the theoretical approach of the weighted displacement quotient (WDQ) will be discussed and utilized with nested buffer and control zones approach at the individual household level to devise the research design to measure the spatial displacement and diffusion of benefits. A land parcel map using GIS program also will be used.

CHAPTER 10. DISPLACEMENT/DIFFUSION OF BENEFITS OF BURGLAR ALARMS ON RESIDENTIAL BURGLARIES

I. Introduction

This chapter is directly related to Research Question 6, which examines the spatial displacement and diffusion of benefits of burglar alarms on residential burglaries.

In the previous chapters, spatial analyses were conducted to scrutinize the relationship between burglar alarms and residential burglaries. Those analytical approaches used datasets from two primary agency data sources (e.g., police department and city hall) to create new sub-datasets by grouping, regrouping, recounting by topic, and analyzing. Units of analysis were the addresses of both burglar alarms and non-alarm-installed (NAI)/alarm-installed (AI) residential burglaries for quantitative analyses and the entire city and the census tracts for spatial analyses. Those approaches produced insightful and useful knowledge to understand the relationship between burglar alarms and residential burglaries by answering Research Questions 1 through 5. In addition, no specified research design was used for the previous analyses. The primary research method was a secondary data analysis, which, by and large, uses agency data (e.g., federal, state, and local criminal justice agencies) (Maxfield and Babbie, 2008).

However, in order to answer Research Question 6, it is necessary to devise a customized research design at the street and/or single household level. The question requires a whole different approach for research design, measurement, and analysis. It should fit to the theoretical background, and its analytical process should be reasonable and clear to obtain an accurate answer to Research Question 6.

Nonequivalent-groups quasi-experimental research design with buffer function at the individual household level can be employed to examine the spatial displacement and diffusion of benefits of burglar alarms on residential burglaries.

II. Nonequivalent-Groups Research Design for the Measurement of Displacement and Diffusion of Benefits

1. Measurement Issues

One of the most potentially negative consequences of crime prevention programs is that of crime displacement, whether such programs are aimed at well-defined geographic locations or specific population groups. The idea of preventing crime through the manipulation of environmental factors has been plagued with the issue of whether or not crimes prevented are simply displaced to other types of crime, times, places, or tactics (Bowers and Johnson, 2003).

In an effort to understand the extent to which displacement occurs, some researchers have compiled information from a number of studies that have examined crime displacement in general. For instance, Hesselink's (1994) review found that reported cases of spatial and other forms of displacement were in the minority. Eck's (1993) review also found that spatial and other forms of displacement in crime prevention programs were minor. Reppetto (1974) argues that displacement, whether geographic or functional, looms as one of the major obstacles to any strategy for the control of residential crime.

Though literature review shows that spatial displacement is generally not a common phenomenon, rigor for scrutinizing such an observation in crime prevention research has been required. As Bowers and Johnson (2003) noted, the

measurement of displacement is notoriously difficult, and different researchers have used a variety of techniques to quantify the phenomenon. Several relevant issues are worth discussing.

One of the problems of the lack of rigorous studies is the absence of a standardized method. As Weisburd and Green (1995) argued, finding the right size for a buffer zone is an important issue in displacement and diffusion of benefit analysis. It should not be so large that any increase in crime due to displacement will be imperceptible, but large enough to ensure that any change is detectable.

2. Measurement at the Individual and Household Levels

In particular, the household-level approach is imperative to examining spatial displacement and diffusion of benefits of burglar alarms on residential burglaries. A number of studies have examined the displacement and diffusion of benefits of crime-prevention initiatives targeting burglaries. The units of analysis for those studies were relatively large geographic areas, such as a census tract and police district (Bowers, Johnson, and Hirschfield, 2003; Ratcliffe, 2005) or street block (Weisburd et al., 2006). In addition, a few studies used the time-series approach to study a burglary-reduction program in Australia (Ratcliffe, 2004). This approach incorporated geographic boundaries (e.g., hotspots).

The previous chapters of this study employed similar approaches and demonstrated that residential burglar alarms maintained a positive impact on residential burglary, showing an effect of diffusion of benefits by creating an invisible protective seal over the dense spots of burglar alarms. However, these methods lack any examination of the displacement and diffusion of benefits of

crime-prevention schemes at a household-level in their research design and analysis. Though burglar alarms positively impact residential burglary at the city level or in a relatively large geographic area (e.g., census tract and police district), a household-level analysis may produce similar or quite different spatial analyses.

Thus, it is necessary to examine the displacement and diffusion of benefits of residential burglar alarms on residential burglaries. In the context of studying the impact of burglar alarms on residential burglaries, it is imperative to examine the nature of crime displacement caused by alarm systems in the targeted area and to investigate the potential for diffusion of benefits from alarm security measures, which have been given little attention in the research literature. This approach has several benefits. First, unlike other studies that used a large geographic unit to test this issue, this approach is a first attempt to use the single house as a unit of analysis to closely investigate the spatial displacement and diffusion of benefits of residential burglar alarms on crime.

Second, this examination may or may not confirm the previous observations and findings in Chapters 7 through 9, which indicate that there is a statistically significant relationship between burglar alarm systems and residential burglaries and identifies a spatially positive impact of burglar alarms on residential burglaries. If this analysis shows the same outcome, it proves that alarm systems have a positive impact on reducing or preventing residential burglaries. On the other hand, if this spatial approach reveals the opposite result, it contradicts the previous observations and arguments, meaning that it is not conclusive that burglar alarm systems act as a deterrent in preventing residential burglaries.

As Barnes (1995) argued, however, the measurement of displacement is notoriously difficult, and in the absence of a standardized approach, several researchers have used a variety of techniques to quantify the phenomenon. For this measurement, the buffer function as a micro-level spatial analysis at the single-house level will be used. The buffer and control zones approach will be generated to detect the displacement and diffusion of benefits of alarm systems on crime over time. The nested buffer and control zones have three rings (the inner target area [e.g., house with burglar alarm], middle buffer area, and outer control area). To measure the extent to which alarm systems have an impact on residential burglary, the Weighted Displacement Quotient (WDQ) will be modified and applied. The WDQ examines the rates of burglar alarms and NAI burglaries in the buffer and control zones in a particular year and compares them with the previous year's rate. WDQ values will show the size (e.g., net effect, no effect, or no benefit) and directionality (e.g., positive, negative, or no effect) of the impact of alarm systems on residential burglary.

3. Nonequivalent-Groups Quasi-Experimental Research Design

Quasi-experimental research design (Maxfield and Babbie, 2008; Shadish, Cook, and Campbell, 2002) can be used when randomization²⁵ is not possible. In most cases,

²⁵⁾ The classical experiment has several requirements and components. The most conventional type of experiment in the natural and the social sciences involves three major pairs of components: (1) independent and dependent variables; (2) pretesting and posttesting; and (3) experimental and control groups. But before beginning any experiment, two crucial decisions must be made: (1) who will participate; and (2) how particular members of the target population will be selected for the experiment. Ideally, these processes must meet the scientific norm of generalizability. For that purpose,

quasi-experiments do not randomly assign subjects to treatment and comparison groups and, therefore, may suffer from the internal validity threats that are well controlled in true experiments. Maxfield and Babbie (2008) regroup quasi-experimental research designs into two categories: (1) nonequivalent-groups designs and (2) time-series designs.

One of the assumptions of random assignment is the equivalence in experimental and control groups. But if a nonrandom procedure is used to construct groups, the design uses nonequivalent-groups. On the other hand, a time-series design involves examining a series of observations of variables over time. In particular, an interrupted time series is a special type of time-series design that can be used in cause-and-effect studies (Maxfield and Babbie, 2008).

It should be noted that there are no simple formulas for designing an experimental or quasi-experimental study. Each category has several modified approaches, depending on the nature of research topic and subject. For the present study, a time-series design is not appropriate because one of the requirements of it is to have a specific time order in the datasets. In other words, a series of observations is compared before and after some form of intervention is introduced. The unit of analysis in this study is the address of burglar alarm permits and NAI/AI burglaries. If the current dataset of burglar alarms had the date of alarm installation, the time-series design would have been a better method. But such information is

randomization is required. Thus, randomization is a central feature of the classical experiment. The important characteristic of randomization is that it produces experimental and control groups that are statistically equivalent. However, in most criminal justice research, randomization is not easy to execute (Maxfield and Babbie, 2008).

not available, even though the date of NAI/AI burglaries is available. Thus, no proper comparison groups exist for burglar alarms and NAI/AI burglaries if comparing exact dates. As a consequence, the nonequivalent-groups research design is more feasible to adopt for the present analysis. Maxfield and Babbie (2008) suggest three different nonequivalent-groups design examples. Table 10.1 illustrates a diagram of them, using the X (intervention program), O (data measurement) and t (time order) notation.

[Table 10.1] Three examples of nonequivalent-groups quasi-experimental designs

Widom (1989)		Clarke (1997)			Gill and Spriggs (2005)		
Treatment group	$\underline{X} \quad O$	Treatment group	$O \quad X \quad O$	Target area 1	$O \quad X_1 \quad O$	Target area 1	$O \quad X_1 \quad O$
Comparison group	O	Comparison group	$O \quad O$	Comparison area 1	$O \quad O$	Comparison area 1	$O \quad O$
	$t_1 \quad t_2$		$t_1 \quad t_2 \quad t_3$	Target area 2	$\underline{O} \quad X_2 \quad O$	Target area 2	$\underline{O} \quad X_2 \quad O$
				Comparison area 2	$O \quad O$	Comparison area 2	$O \quad O$
				---	---	---	---
				Target area 13	$O \quad X_i \quad O$	Target area 13	$O \quad X_i \quad O$
				Comparison area 13	$O \quad O$	Comparison area 13	$O \quad O$
X=official record of child abuse	X=caller identification and call tracing O=customer complaints of obscene calls			$t_1 \quad t_2 \quad t_3$	X_i =CCTV installation in area i O=police crime data, survey data on fear of crime		
O=counts of juvenile or adult arrest							

Source: Maxfield and Babbie (2008)

As Maxfield and Babbie (2008) argue, the first example used by Widom (1989) for the study of the relationship between child abuse and later arrest was produced using experimental and comparison groups matching individual subjects without having a before-and-after research design. The second example was used for the study of deterring obscene phone calls by Clarke (1997a) and employed the before-and-after design because the study has data on the treatment and comparison groups with pre- and post-intervention measures. The third example, used for the evaluation study of CCTV and crime prevention by Gill and Spriggs

(2005), was designed to evaluate 13 CCTV projects installed in a variety of residential and commercial settings. It employed the before-and-after design by creating two types of comparison areas: (1) comparison areas with similar socio-demographic and geographic characteristics and crime problems, and (2) buffer zones as in the area within a 1-mile radius of the edge of the target area where CCTV cameras were installed.

These quasi-experimental design examples above reflect the nature of the research topic and data collected. For example, in the child abuse study (Widom, 1989), it was not possible to assign children randomly to groups in which some were abused and others were not. Thus, a research design was developed without pre- and post-intervention measures. The second example, the study of the effectiveness of newly introduced caller-identification (ID) and call-tracing programs against obscene or threatening phone calls (Clarke, 1997b), was designed based on two criteria: (1) the new telephone services were available (the treatment group); and (2) the services were not (the comparison group). The records of formal customer complaints about annoying phone calls in these two groups were compared to examine whether the number of formal complaints in the treatment group dropped. This design employed pre- and post-intervention measures with the treatment and comparison groups.

The third example, the evaluation study of CCTV on crime (Gill and Spriggs, 2005), is similar to the second example of research design using both the treatment and comparison groups and pre- and post-intervention measures. The unique feature of the study's design is that it uses the concept of buffer zones as a

comparison area. The buffer zones have been divided into three concentric rings around a target area. The rationale for buffer zones as comparison areas is that if CCTV is effective in reducing crime, either crime should decline in target areas but not in buffer areas, or any reduction in crime should be greatest in the target areas and the degree of the reduction should decline moving away from the target areas.

As seen in Table 10.2, for the current study, a modified research design from the second and third examples of nonequivalent-groups design is devised and employed by borrowing the assumptions of treatment and comparison groups, pre- and post-intervention measures, and buffer zones. It is not possible to use the same treatment and comparison groups, but instead the two nonequivalent groups of residential burglar alarms and NAI burglary are used. However, as discussed briefly in the previous section, a clear time order for the installation date of all residential burglar alarms is not available. Only aggregate installation data by year (from 2001 to 2005) is available. It would be better to use the year as a unit of intervention time order. Detailed dates of all residential burglaries are on hand, but they also should be aggregated by year for comparison purposes with burglar alarms.

[Table 10.2] Nonequivalent-groups quasi-experimental design for the current study

The Impact of Burglar Alarms on Residential Burglaries					
Burglar alarms 2001	O	X_1	O		
NAI residential burglary 2001	O	Y_1	O		
Burglar alarms 2002	O	X_2	O	X_i =Residential burglar alarm permits by year i	
NAI residential burglary 2002	O	Y_2	O	Y_i =Number of instances of NAI residential burglary by year i	
---		---		O_a =Police incident report data on NAI residential burglary	
Burglar alarms 2005	O_a	X_i	O_a	O_b =City Hall data on residential burglar-alarm permit record	
NAI residential burglary 2005	O_b	Y_i	O_b	t_1 and t_2 =Consecutive two years	
	t_1		t_2		

The buffer zone approach will be incorporated with the WDQ approach, which calculates WDQ ratios to interpret spatial displacement and diffusion of benefits of the crime prevention scheme. Thus, together with this buffer zone approach, the concept of WDQ is utilized to develop a flexible and usable nonequivalent-groups quasi-experimental research design for this study in the following section.

4. Weighted Displacement Quotient (WDQ)

The nested buffer and control zone approach is based on a statistical technique, the WDQ (Bowers and Johnson, 2003), which aims to measure spatial displacement of crime prevention programs. The rationale is that the displacement and diffusion of benefits can only be attributed to crime prevention schemes if crime is reduced in the target area. Thus, the WDQ not only measures what occurs in the buffer zone, but also relates changes in the buffer zone to those in the target area over the years. WDQ values will show the size and directionality of the impact of alarm systems on residential burglary.

As seen in Figure 10.1, the conceptual approach of the WDQ has three concentric zones nested within each other. The target zone (A) is the area in which a crime prevention scheme is applied. Surrounding the target zone is a buffer zone (B), which may have been influenced by the operation of the crime prevention in the target zone and represents the displacement or diffusion of benefits zone. Surrounding the buffer zone is a wider control zone (C), which is unlikely to be affected by changes within the target or buffer zone. In addition, it is equally possible to have one, or several, control zones that do not surround the buffer and

target zones. Bowers and Johnson (2003) argued that since it was possible to define more than one control zones in this way, the reliability of any analysis conducted could be increased using this procedure.

[Figure 10.1] Nested buffer and control zones

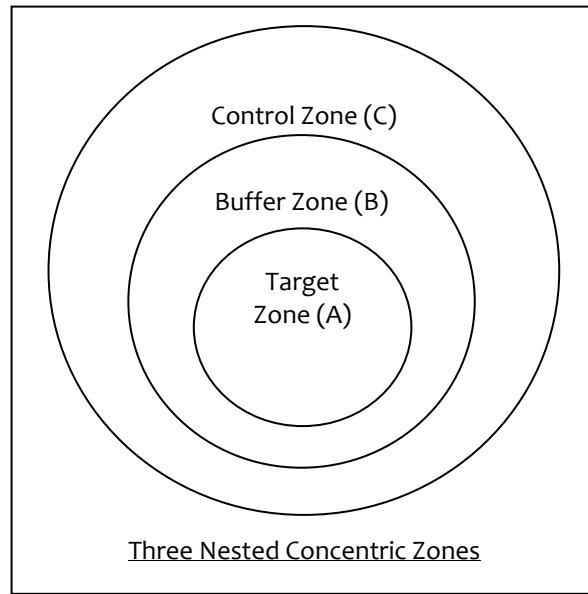
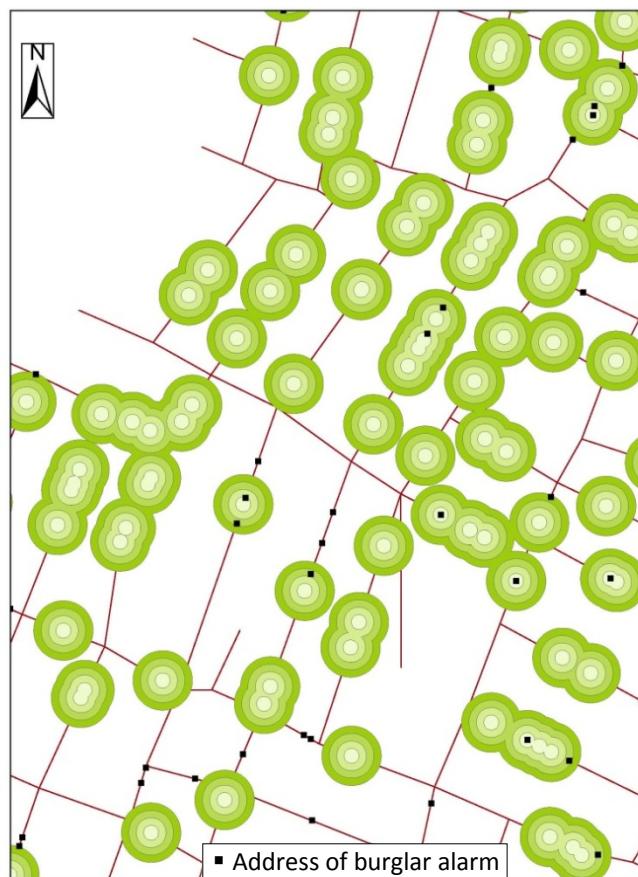


Figure 10.1 is based on a theoretical approach. However, it is limited in its explanation and application to a real-life situation. For example, in Figure 10.2 the four buffer rings can be used as a universal and consistent method to view all residential alarm permits in the city. Black dots represent the addresses of houses with residential burglar alarms installed. Thus, the program can produce four same-size buffer rings with the same radii throughout the city because this pin-map application is based on a theoretical assumption, and not on the real size of houses or the distance between houses. Though most urban neighborhoods have well-planned street blocks and housing arrangements, some parts of neighborhoods have different structures. It is necessary to apply the WDQ conceptual approach into a

real situation. Doing so may produce different-shaped buffer zones (B) and control zones (C).

[Figure 10.2] Four-ring buffering maps of burglar alarms and NAI burglary in the western and northeastern parts of Newark, NJ, 2005

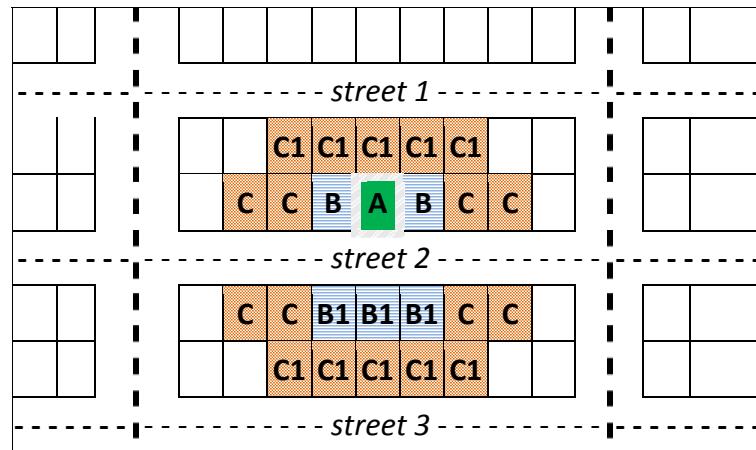


5. Application of the Nonequivalent-Groups Design and WDQ

Figure 10.3 shows a typical street block and housing arrangement. The entrances of each house face the streets. For example, houses A, Bs, B1s and Cs have the same entrances facing Street 2. On the other hand, all C1s face either Street 1 or Street 3. The target zone with a burglar alarm (A – green color) is surrounded by the five buffer houses (B and B1 – blue color), which, then, border the outer control zone

with 18 houses (C and C1 – red color). The reason the C1 houses, which are located directly behind house A, are not included among the buffer houses is that their entrances face Street 1, meaning that even though they are located next to each other, in order to check whether the C1 houses have burglar alarms, an offender must use Street 1 or Street 3, rather than Street 2. More time is needed to check and enter the house Bs on Street 2 because the offender must walk the entire street block. As a consequence, C1 houses directly behind house A may be less likely targets of crime than the house Bs, which are next to house A on both sides of Street 2.

[Figure 10.3] Application of the nested buffer and control zones in a typical housing layout



Also, the four C houses next to the house Bs are included to the control zone with all C1 houses. The rationale for this assignment is that, first, according to the literature on displacement and diffusion of benefits of crime prevention programs (Bowers and Johnson, 2003; Bowers, Johnson, and Hirschfield, 2003; Johnson, Bowers, Young, and Hirschfield, 2001), the buffer area directly neighbors the target

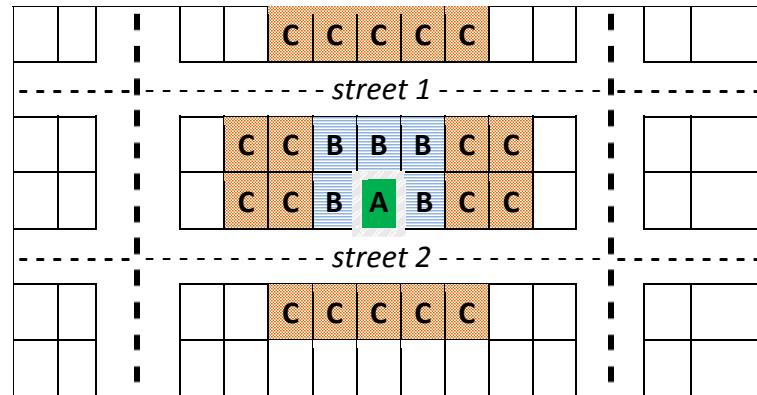
area, while the control area covers a relatively wider area beyond the buffer area. Secondly, assuming that an offender spends 5 to 10 minutes on one street to check for a house with a burglar alarm, and then, finds house A, the offender may spend the remaining time carefully seeking other possible targets around house A. The offender would not spend a longer period of time to spy out crime targets, but use as short a period as possible. Thus, the time period would be less than 5 minutes, and the four house Cs can be vulnerable alternative targets to house A.

In addition, the three B1 houses across Street 2 are included in the buffer area, the assumption being that if an offender finds that house A has a burglar alarm installed, the offender may seek a nearby target for crime. Even though these houses are on the other side of the street, due to their close proximity and the alarm-system yard signs for house A, they would be included in the buffer zone houses to examine the impact of displacement and diffusion of benefits of burglar-alarm systems on residential burglaries. Thus, each target house with a burglar alarm has five buffer houses and 18 control houses.

Figure 10.3 shows a typical layout of single-family housing units in urban neighborhoods. However, some parts of the city display different layouts and do not conform to the pattern in Figure 10.3. Thus, the selection process should be flexible and adaptable based on the layout of the housing units or street blocks, even though the same principle of the nested buffer and control zones applies in the selection of buffer and control areas. Accordingly, the shape of buffer and control areas may be different from that of Figure 10.3. Figure 10.4 is one example of a slightly different shape of buffer and control zones. But the concept and assumptions of the nested

buffer and control zones will still apply. It should be noted that the simple street map of a city is inappropriate for this detailed approach. The city parcel map, which is based on the real size and location of houses, is necessary for this analysis.

[Figure 10.4] Application of the nested buffer and control zones



6. Measuring Process of Applied Nonequivalent-Groups Design and WDQ Analysis

The assumption of this WDQ approach is that over any given time period, the buffer zone (Bs and B1s) would account for a particular proportion of the crime committed within a control area (Cs and C1s). If a burglar alarm has some positive impact on residential burglary, the diffusion of benefits should spread from the target zone into the buffer zone that surrounds it with the crime rate in the buffer zone decreasing. The unit of analysis for this method is a single address of homes with burglar alarms.

The selection process of the three distinct areas follows as:

- ① To select the addresses of repeated alarm permits from 2001 to 2005.

These addresses will be the target zones (A in Figure 10.3).

- ② To select the buffer houses (B and B1 in Figure 10.3) surrounding the target zone, each target zone with a burglar alarm installed may have five neighboring houses without burglar alarms. If the neighboring houses have burglar alarms installed, they each can be one target zone with five buffer houses.
- ③ To select the control houses without burglar alarms (C and C1 in Figure 10.3) surrounding the buffer zone. The control area will include 18 houses in a typical housing layout.
- ④ To count the number of crimes in the three areas over the five-year period and calculate the changes in the burglary rate in the buffer zone (expressed as a proportion of that in the control area) for different times. Then this figure is weighted by an index that measures crime rate in the target area by the control area.

The equation is:

$$\frac{B}{\frac{C}{A}} \quad [Equation 10.1]$$

where B = crime rate in buffer zone, C = crime rate in control area, and A = crime rate in target area. This index only examines the differing proportions in the various areas at one point of time. Thus, it is necessary to examine the changes over years. The modified equation for the WDQ above is:

$$WDQ = \frac{\frac{Bt_1 - Bt_0}{Ct_1 - Ct_0}}{\frac{At_1 - At_0}{Ct_1 - Ct_0}} \quad [Equation 10.2]$$

Equation 11.2 takes into account the changes observed in the control area over time by comparing the situation after implementation (t_1) with the situation before implementation (t_0). Instead of the before-after time frame, a five-year time frame can be applied for this study.

There are two possible outcomes for the numerator. If it is positive, this is indicative of possible displacement. But if it is negative, it may suggest that there may have been a diffusion of benefits because the buffer zone (B) suffered proportionally less crime in comparison with the control area (C) over the years examined. There are also two possible outcomes for the denominator. If it is negative, it shows that a burglar alarm was successful in reducing burglary relative to the control area (C). If it is positive, then this means that a burglar alarm has been unsuccessful, and thus, it is difficult to relate any change in the buffer zone (B) to the target area (A).

Then, as Table 10.3 shows, the WDQ can be interpreted in several ways (Bowers and Johnson, 2003; Chainey and Ratcliffe, 2005). Positive WDQ values indicate diffusion of benefits to the buffer zone, and negative WDQ values indicate geographic displacement of crime. With the WDQ values, a figure of + 1 shows a diffusion of benefits where the burglary reduction in the buffer zone is equal to that in the target area. In other words, there is a positive net impact of burglar alarms on residential burglaries. A value of - 1 indicates a displacement where a burglary reduction is offset entirely by an increase in the buffer zone. A WDQ of 0 represents a scenario where there was apparently no change in the buffer zone, or where this change could not be attributed to changes in the control area.

[Table 10.3] Interpretation guide for WDQ ratios

WDQ Ratios	Displacement/Diffusion	Overall Intervention Effect
WDQ>1	Diffusion greater than direct effect	Positive net effect of the intervention
WDQ near 1	Diffusion about equal to direct effect	
1>WDQ>0	Diffusion, but less than direct effect	
WDQ=0	No displacement or diffusion	
0>WDQ>-1	Displacement, but less than direct effect	
WDQ near -1	Displacement about equal to direct effect	No net benefit to intervention
WDQ <-1	Displacement greater than direct effect	Intervention worse than doing nothing

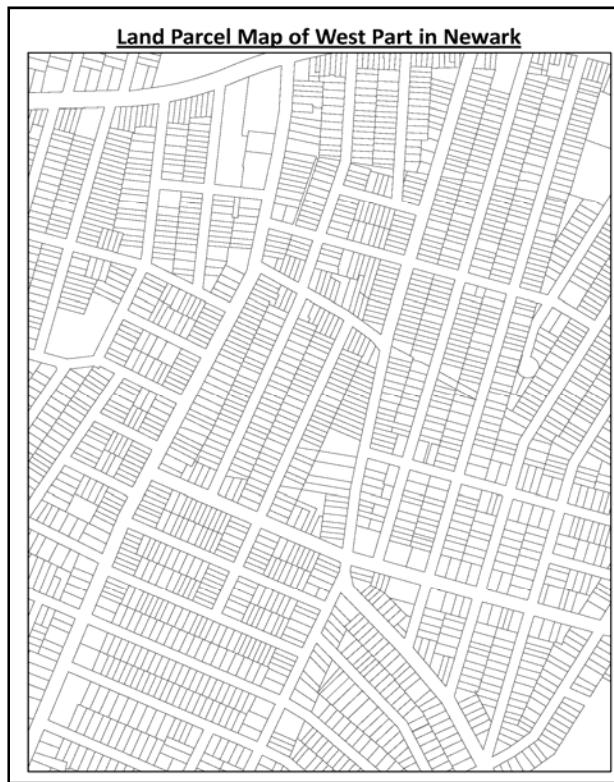
Source: Chainey and Ratcliffe (2005)

III. Applied WDQ Analysis of Burglar Alarms on Residential Burglaries

1. A Land Parcel Map

The previous analyses used a regular street map of the city of Newark, N.J. But for applied WDQ analysis, a parcel map is necessary. The parcel map is based on a polygon feature, a multisided figure represented by a closed set of lines. Examples of polygon features are census tracks, police beats, and land parcels (Boba, 2001). This valuable tool, unlike regular street maps, allows for detailed spatial analyses of a small area. It also is more specific and precise than a centerline map in indicating the exact location of a feature, such as an incident of residential burglary or a permit record of a burglar alarm. Figure 10.5 shows one example of the land parcel map in the western part of the city. The land parcel map of Newark identifies 48,249 parcels. Each rectangle shape lot is an exact land parcel and identified as a single polygon. When an address of an alarm permit is geocoded, the point is placed in the exact middle of the polygon.

[Figure 10.5] Example of the land parcel map of the western part in Newark, NJ



2. The Selection Process of Buffer and Control Zones

The WDQ analysis for the study of displacement of crime and/or the diffusion of benefits of burglar alarms on residential burglaries involves several sequential selection processes with a parcel map of the city.

The first step is to identify all polygons of residential burglar alarm permits on the city's land parcel map by overlaying the addresses of each year's alarm permit records. This step can be accomplished using the join function in the ArcMap computer software. The address-level point data (e.g., each year's addresses of alarm permit records) are joining to the polygon data (e.g., a land parcel map of the city). This produces a new layer that includes a new variable, called count, on the

original land parcel map. The count variable has the number of points occurring in each polygon annually. The second row in Table 10.4 shows the number of residential burglar alarm records annually after being joined with the polygon data on the city's parcel map.

The second step is to identify the spatial target zone (*A*) on the joined land parcel map. The process starts by using the selection function in the ArcMap software. After uploading the new joined land parcel map, all addresses of NAI burglaries are selected by location. Several selection features²⁶ are available in the ArcMap. This study used the “Are Completely Within” selection feature, which selects features in one layer that fall completely inside the polygons of another without applying any buffer distance. The same method is repeated five times using each year’s NAI burglaries’ data. Thus, this approach produces five new layers of the number of NAI burglaries upon the joined land parcel map. The third row in Table 10.4 presents the numbers in the target zone (*A*).

The third step is to create the spatial buffer zone (*B*) on the joined land parcel map and to count the number of NAI burglaries in these zones. This method starts by creating the first zone (*B*) using the buffer function in the ArcMap. The buffer distance for this zone is 9 meters (approximately 29.53 feet), which almost completely covers at least the surrounding three land parcels (see Figure 10.6 with red-color rims). After creating the buffer zones surrounding the target zones, all

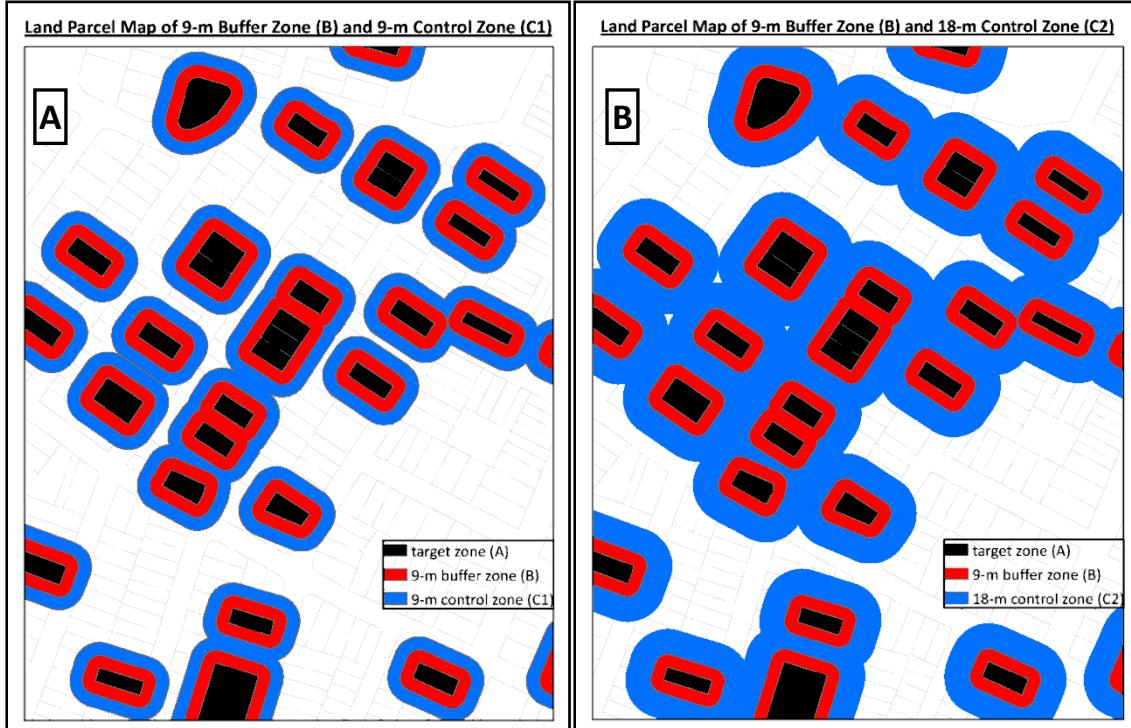
²⁶) Examples of available selection features are “Are Crossed By The Outline Of,” “Intersect,” “Are Within Distance Of,” “Have Their Center In,” “Are Completely Within,” “Completely Contain,” “Share A Line Segment With,” “Tough The Boundary Of,” “Are Identical To,” “Contain,” and “Are Contained By” (CMAP, 2007).

addresses of NAI burglaries are selected by location by using the selection function in the ArcMap with the “Are Completely Within” selection feature. These steps produce a new layer with the number of NAI burglaries within the 9-meter buffer zone parcel map. The fourth row in Table 10.4 shows the number of NAI burglaries in buffer zones (B_s) throughout the years.

The fourth step is to create the spatial control zone (C_1) on the joined parcel map by using the buffer function in ArcMap and to count the number of NAI burglaries in these zones with the selection function (see map A in Figure 10.6 with blue-color rims). The procedure is the same as the third step. But the buffer distance for the control zone is another 9 meters from the boundary of each of the 9-meter buffer zones (B_s). The fifth row in Table 10.4 shows the number of NAI burglaries in the control zones (C_{1s}).

In addition, one more spatial control zone (C_{2s}) is created and identified with an 18-meter (approximately 59.06 feet) buffer distance (see map B in Figure 10.6 with blue-color rims). The last row in Table 10.4 shows the numbers of control zone (C_{2s}). The primary purpose of having another control zone surrounding the target and buffer zones is that two control zones allows for the calculation and comparison of WDQ values to examine where the values are consistent or discrepant. The assumption is that when WDQ values from two control zones show a similar pattern (e.g., increase or decrease together over the years), the argument over the displacement and/or diffusion of benefits of burglar alarms on residential burglaries is stronger and more reliable.

[Figure 10.6] Land parcel maps of 9-meter control zone (C_1) and 18-meter control zone (C_2) with 9-meter buffer zone (B)



[Table 10.4] Number of parcel-mapped residential alarm records annually, Newark, NJ

ZONES	YEAR				
	2001	2002	2003	2004	2005
Parcel-mapped alarm permits	670	601	921	1,020	1,188
Target zone (A)	124	132	149	183	101
Buffer zone (B)	77	72	69	109	65
Control zone (C_1) w/ 9 meters	61	54	105	79	75
Control zone (C_2) w/ 18 meters	117	128	171	150	137

3. The Values of Applied WDQ Analysis

After creating the three spatial zones based on the joined land-parcel map (e.g., target, buffer, and control zones) and counting the number of NAI burglary on each

of these different zones, WDQ values are calculated by using Equation 10.2 to scrutinize geographic displacement and/or diffusion of benefits of burglar alarms.

Table 10.5 presents the values of the applied WDQ analysis based on the above spatial approaches and numbers. At first glance, all values are positive, showing, according to the interpretation guide for WDQ ratios in Table 10.3, the phenomenon of spatial diffusion of benefits from burglar alarms against residential burglaries. There is no indication of any spatial displacement of residential burglaries due to burglar alarms.

[Table 10.5] Values of applied WDQ analysis in Newark, NJ

Control Zones	2001-2002	2002-2003	2003-2004	2004-2005
Control Zone C_1	0.17	0.66	0.81	0.53
Control Zone C_2	3.28	0.99	0.93	0.53

WDQ values in the control zone C_1 are less than 1, indicating that the diffusion of benefits is no greater than the direct effect. In other words, the positive net effect of burglar alarms against residential burglaries does not exist. However, the “less than direct effort,” but “close to direct effect,” of burglar alarms is found. For example, the WDQ value of 2003-2004 is 0.81, indicating that there is a positive and substantial impact of burglar alarms on residential burglaries. WDQ values for 2002-2003 and 2004-2005 also indicate that there is no direct effect of burglar alarms, but a sizable impact on the continual decrease of residential burglaries exists over the years. The WDQ value for 2001-2002 is 0.17, which is relatively lower than the other values. Still its value indicates that some geographically positive effect of burglar alarms exists against residential burglaries.

In addition, WDQ values in the control zone C_2 show a similar pattern to those in control zone C_1 , except the value from 2001-2002. In general, the values are higher than those in the control zone C_1 . In particular, the values for 2002-2003 and 2003-2004 are close to 1, which can be interpreted as the direct effect of diffusion of benefits by burglar alarms on residential burglaries. It is mainly because control zone C_2 s cover a wider geographic area and consequently include a larger number of NAI burglaries with 65.8 more burglaries, a 93 percent increase on average.

The WDQ value for 2001-2002 is 3.28. According to the interpretation guide for WDQ ratios in Table 10.3, this unexpected value indicates that there is a far greater than direct effect of diffusion of benefits. In other words, the positive net effect of burglar alarms against residential burglaries is observed. However, concluding that this high WDQ value reflects the true effect of burglar alarms on residential burglaries should be done cautiously because, as discussed in the previous chapters, there also are several other independent variables that could explain the decrease of NAI burglaries over the years. Thus, although the WDQ value is far greater than 1, showing that there is a greater diffusion of benefits, the discussion of the diffusion of benefits of burglar alarms on residential burglaries should be presented in context with other variables.

Nevertheless, it is conclusive that WDQ values in control zone C_2 s show the geographic diffusion of benefits of burglar alarms on residential burglaries and that the geographic displacement of residential burglaries due to burglar alarms is not

found. Thus, these observations and arguments are consistent with those in control zone C_1 s.

Several points are worthy of further discussion. First, the applied WDQ values clearly do not show the geographic displacement of NAI burglaries due to the installation of burglar alarms throughout the years. Instead, the substantial and consistent geographic diffusion of benefits of residential burglar alarms against residential burglaries is found.

Second, although the above findings explain the diffusion of benefits of burglar alarms against residential burglaries, it should be cautiously concluded that such diffusion of benefits is the net effect or absolute benefit. Rather, burglar alarms have a sizeable, direct, and considerable impact on the constant decrease of residential burglaries over the years. There are other factors that could explain the same trend in residential burglaries, such as population composition, householders' age composition, and housing characteristics. However, the above analyses reveal that residential burglar alarm systems do not negatively impact the spatial displacement of residential burglaries, but they maintain a persistent diffusion of benefits on residential burglaries.

Third, an unexpected observation was found in that, according to WDQ values in Table 10.5, residential burglar alarms not only have a short geographic ambit of diffusion of benefits (control zone C_1), but also a wider geographic range of diffusion against residential burglaries based on the higher WDQ values in the control zone C_2 , which are higher than those in the control zone C_1 . This finding is consistent over the years.

This observation is linked to the current literature on the argument of displacement in crime prevention circles. In particular, it has been argued that with geographic displacement, there is likely to be a displacement gradient, meaning that displacement is most likely to occur within close proximity to a target area where a crime prevention program is introduced and that it will decrease as the distance from the target area increases. This assumption is based on the notion of familiarity decay (Eck, 1993). The alternative to familiarity decay or distance decay effects (Bowers and Johnson, 2003) is that as the effect of geographic displacement weakens with distance from the target zone, the effect of diffusion of benefits of a crime prevention intervention can strengthen. In other words, the distance decay effect of the geographic displacement of crime can be explained by the distance strength effect of the geographic diffusion of benefits. As discussed above, WDQ values in control zone C_{2S} , with wider geographic areas, are greater than those in control zone C_{1S} . Though the spatial displacement of NAI burglary due to burglar alarms is not found in two control zones, WDQ values indicate that the geographic diffusion of benefits of alarm systems from target zone A_S gets stronger in control zone C_{2S} than control zone C_{1S} .

4. The Diffusion of Benefits of Burglar Alarms on Residential Burglaries

As discussed in the previous chapters with quantitative analyses, a relationship between burglar alarms and residential burglaries exists, in that the decrease of the total number of NAI burglaries and the increase of the total number of alarm permits over the five-year period maintained a statistically significant relationship. When other independent indicators (e.g., demographic, socio-economic, and housing

characteristic variables) were added in advanced statistical analyses, the relationship between these two primary variables (e.g., burglar alarm permits and NAI burglary) still showed a statistically consistent and significant relationship. Based on such observations, the causal relationship between the two variables can be recognized in that the steady decrease of the number of NAI burglary over the years was directly or indirectly impacted by the steady increase in the total number of residential burglar alarms. At the same time, advanced multiple regression models showed that both burglar alarms and NAI burglary, when used as an independent variable, was a strong predictor of the other, when used as a dependent variable. However, any arguments were made cautiously as to the direct and positive impact of the increase of burglar alarms on NAI burglary, pending verification by further spatial analyses.

In addition to the quantitative approach, most spatial analyses confirmed the earlier observations and findings of the quantitative analyses. Furthermore, such analyses strongly suggested that residential burglar alarms had a positive impact on the steady decrease of NAI burglary due to the effect of diffusion of benefits, an invisible protective seal being spread from a house with a burglar alarm installed to the nearest neighboring houses in a relatively small geographic area. The argument is interrelated with the hotspot approach. Such an analysis was done at the macro-level with both the entire city and census tract.

Moreover, a micro-level approach at single-house level was completed in this chapter, utilizing the city's land-parcel map and the applied WDQ method. As discussed above, a geographic displacement of NAI burglary over the years was not

observed, but the diffusion of benefits of burglar alarms against NAI burglary was found.

Therefore, it is conclusive that there is not only a statistically significant relationship and causal relationship between the increase of residential burglar alarms and the decrease of residential burglaries, but also a geographic diffusion of benefits of burglar alarms on residential burglaries. The houses with residential burglar alarms installed are less victimized and better protected than the houses without burglar alarms. Houses located next to a house with a burglar alarm installed are also less likely to be victimized and are better protected. These relatively small geographic protected hotspots are spread across the entire city. Such a phenomenon can be explained as the result of the spatial diffusion of benefits of a house with a burglar alarm over the immediate and surrounding houses. Furthermore, this spatial effect also directly links to the distance strength effect of the spatial diffusion of benefits of burglar alarms on residential burglaries.

Having a burglar alarm system at a home definitely brings a positive impact in protecting the home and preventing residential burglaries. A home burglar alarm can be used as an effective and powerful deterrent against residential burglaries.

IV. Chapter Conclusion

Research Question 6 focused on the examination of spatial displacement and diffusion of benefits of burglar alarms on residential burglaries. Unlike the previous analyses with no specified research design, a customized, flexible, and usable measuring design was devised. Acknowledging the absence of a standardized study

design for the measurement at the individual household level, the nonequivalent-groups quasi-experimental research design was discussed, borrowing and modifying the assumptions of treatment and comparison groups, pre- and post-intervention measures, and buffer zones. The buffer zone approach was incorporated with the WDQ concept, which aimed to measure geographic displacement of crime prevention programs. The WDQ not only measured what occurred in the buffer zone, but also related changes in the buffer zone to those in the target area over the years. Its values showed the size and directionality of the impact of burglar alarms on residential burglary. For this application to the measurement, the city land parcel map, which is based on the real size and location of house buildings, was utilized.

After creating the three spatial zones based on the joined land parcel map (e.g., target, buffer, and control zones) with burglar alarm permits and counting the number of NAI residential burglary on each of these different zones, WDQ values were calculated. The applied WDQ analyses clearly showed that there was no indication of any spatial displacement of residential burglaries due to the increase of burglar alarm installations and that there was a positive and substantial impact of burglar alarms on the decrease of residential burglaries over the years. Furthermore, WDQ analyses showed that a distance strength effect of the spatial diffusion of benefits of burglar alarms on residential burglaries was observed.

In conclusion, having a burglar alarm system at a home definitely brought a positive impact in protecting the home and preventing residential burglaries. A

home burglar alarm can be used as a powerful deterrent against residential burglaries.

In the following chapter, a summary of the previous study findings and policy implications will be presented. Limitations of the present study and further research agenda, focusing on the effect of burglar alarms systems on crime also will be discussed.

CHAPTER 11. DISCUSSION AND CONCLUSION

I. Introduction

This study questioned, analyzed, and examined the impact of home burglar alarms on residential burglaries, using multiple variables. Quantitative and spatial analyses were primarily employed for the present study. This chapter discusses the significance of the findings presented and discussed in Chapters 6 through 10 and offers explanations for these results. Implications for policy and crime prevention, limitations of the present study, and suggestions for further research, focusing on the impact of burglar alarm systems on crime also are discussed.

II. Finding Explanations and Policy Implications

1. Results Summary

The general trend analyses according to the data from police department and city hall showed that residential burglar alarms in use had steadily increased over the five-year period, while both NAI and AI residential burglaries also had progressively decreased. This crossing observation became the deep-seated research question penetrating throughout the present study in order to scrutinize the deterrent effect of burglar alarms on residential burglaries. Of the hypotheses proposed in Chapter 4, most are supported by either the quantitative analyses in Chapter 7 or the spatial analyses presented in Chapters 8 through 10.

The first research question and hypothesis concerned the overall relationship between burglar alarms and residential burglaries over the years. The continual decrease of the number of residential burglaries was closely and

statistically associated with the consistent increase of burglar alarm installations in Newark, N.J. Chi-square and changed proportion statistics supported the crossing relation was statistically significant and persistent over the years, which indicated that burglar alarms impacted on the decrease of residential burglary incidents.

Followed by rudimentary quantitative inquiries, correlation and regression statistics not only confirmed the crossing relationship between the increase of burglar alarms in use and the decease of residential burglary incident but also identified key variables with statistical significance to explain about and link to the patterns of burglar alarm installations and residential burglary incidents. Both patterns were dependent on such variables as population race (white, black, and others), population age groups (ages under 17, 25 to 34, and 60 to 64), unemployment rate, householder race and age groups, and house occupied by owner.

For example, regarding increased installation trends of residential burglar alarms, neighborhoods with greater black populations, population ages 12 to 17, black householders, householders within the 25 to 34 age group, and houses occupied by owner were more likely to have burglar alarms installed because of safety issue in their houses. The installation pattern of burglar alarms also was closely related to employment status, showing that neighborhoods with lower unemployment rates were more likely to have burglar alarms installed than neighborhoods with higher unemployment rates.

With regard to the pattern of residential burglaries, neighborhoods with greater population groups of ages under 14, ages 15 to 17, and ages over 45,

householder age group over 65 years old were less likely to be victimized by residential burglary. The interrelation between this finding and the installation pattern of burglar alarms clearly revealed that the increase of burglar alarms in use had positive impact on the decrease of residential burglary incidents due to the fact that neighborhoods with greater population ages 12 to 17 were more likely to have burglar alarms installed and less likely to be victimized by residential burglary. The elderly population over 65 years old was less likely to be victimized. But the most vulnerable target for residential burglary was within the 60 to 64 householder age group. Furthermore, neighborhoods with higher unemployment rates tended to have higher number of residential burglary. The unemployment rate was one substantial indicator to explain the patterns of both burglar alarm installations and residential burglaries. In short, both patterns of burglar alarm installations and residential burglaries were dependent upon, and explained by, those key indicators.

The further advanced multiple regression statistics enabled to suggest a group of powerful predictors, rather than to single out the most influential variable on the dependent variable, to both burglar alarms and residential burglaries. The forward selection multiple regression showed that among the group of indicators were black population, owner occupancy, householder ages 25 to 34, NAI burglary, and general population ages under 14 to best explain and predict the installation pattern of residential burglar alarms. On the other hand, the hierarchical selection multiple regression showed that such variables as burglar alarms, unemployment, population ages over 45, and householder ages 60 to 64 were the best indicators,

though not necessarily in that order of degree of predictability, to explain and predict the pattern of NAI burglary.

A series of spatial analyses was an eye-popping visualization to examine the spatial distributions and patterns of both burglar alarms and residential burglary and to verify the findings based on quantitative analyses presented in Chapter 7. An overlaying mapping method demonstrated consistent quantitative findings even on a spatial dimension and identified spatial relationships with key indicators which were used in correlation and regression statistics. For example, neighborhoods with the dense spots of higher black population and younger population ages under 17 shared the same or neighboring dense spots of higher installation of burglar alarms.

Point and density mapping methods showed that distribution patterns of both burglar alarm installations and residential burglaries were not evenly distributed throughout the city. Though many of streets and city blocks had burglar alarms installed and were affected by residential burglaries, certain areas or neighborhoods obviously had heavily dense spots cross the city with either more burglar or more burglary incidents. Such a spatial pattern occurred dependent upon neighborhoods' conditions (e.g., demographic, socio-economic, and housing characteristics). More importantly, those dense spots of burglar alarms and residential burglaries did not overlap, showing that street blocks or small geographic sections of the city with high installation rate of burglar alarms had less residential burglary incidents and visa versa. Further spatial statistics and analyses (e.g., spatial autocorrelation and clustering analyses) confirmed this spatial

observation that hotspots and coolspots of both burglar alarms and residential burglaries existed and that the distribution of those spots were not randomly scattered but heavily clustered at certain geographic areas across the city, being affected by demographic, socio-economic, and housing conditions. In short, those spatial patterns demonstrated that the increased installation of residential burglar alarms had some positive impact on the decreased number of residential burglary incidents over the years by creating a protective seal around the hotspots of burglar alarm installations and pushing away potential burglar(s) from these hotspots.

Finally, the applied WDQ analysis revealed that no indication of spatial displacement of residential burglary due to the increase of burglar alarm installations was observed and that there was a positive and substantial impact of burglar alarms on the progressive decrease of residential burglaries over the years. Such an analysis explicitly supported spatial diffusion of benefits of burglar alarms on residential crime. In short, all the quantitative and spatial findings were consistent and explained the impact of burglar alarms on residential burglaries.

2. Policy Implications

The research outcomes presented and discussed in Chapters 7 through 10 support prior findings showing that residential burglar alarms have a deterrent effect in reducing incidents of residential burglaries. In addition, this study finds that the geographic displacement of residential burglaries by burglar alarms is not observed, but that the diffusion of benefits of burglar alarms is shown. The study's results throughout the various analyses are reliably consistent and predictable with several key variables. Attached to those findings are some promising implications for policy

and practice. The policy implications presented below address the key variables shown to be the strongest predictors of patterns of burglar-alarm installation and residential burglaries in the current study. These policy implications will be directed to the security industry and potential buyers of alarms, as well as the local police departments, governments, insurance industry that are able to address crime problems in our neighborhoods to build safer and more secure communities.

The discussion of policy implications here is directly related to the theoretical background presented in Chapter 3. The theoretical background for studying burglary and the offender's perspective has been built upon well-established theories, such as routine activities theory and rational choice theory. Those theoretical arguments have become the basis for the development of crime prevention approaches for situational crime prevention. One similarity of those theories is that crime is a normal, commonplace aspect of modern society. Burglary also is regarded as a routinely produced form of behavior by the normal patterns of social and economic life, rather than as a deviation from normal civilized conduct. Thus, crime prevention strategies based on those theories identify recurring criminal opportunities and seek to govern them by developing situational controls. Criminogenic situations, hot products, and hotspots are the new objects of control (Garland, 2001).

The key variables in the present study explaining the impact of burglar alarms and residential burglaries are situational indicators. To be effective, crime prevention strategies targeting residential burglaries address these situational variables. The spatial analyses in the current study supported that a burglar is more

likely to respond to a residential burglar alarm at the neighborhood, block, or individual residence level. As Cromwell, Olson, and Avary (1991) and Wright and Decker (1994) argued, crime prevention strategies at the macro-level, such as increased levels of prosecution, increasing statutory penalties, and large-scale social change, or at the middle-level, such as neighborhood watch programs, may not be perceived as being effective, except under certain circumstances. Of course, the potential benefits for crime prevention of these macro- and middle-level crime prevention strategies should not be dismissed.

For instance, as discussed in Chapter 7, a powerful predictor of residential burglaries was unemployment. Thus, job creation would seem to be one of the more promising means to keeping both active burglars and would-be burglars away from engaging in criminal activities because the assumption is that burglars also need a stable financial source and would quit offending if they have a good job. However, creating such jobs is a daunting, long-term task. Even if this were accomplished, it is not clear that the offenders actually would be willing or able to take advantage of the new employment opportunities. The persuasive argument is that not only are the majority of them poorly educated and unskilled, but many are unreliable, having drug or alcohol problems. These circumstances may suggest that expanded employment opportunities can be effective in reducing residential burglaries, but it is dubious that a job creation program will impact those already heavily involved in crime (Wright and Decker, 1994).

Rather, micro-level approaches, such as installing a lock on windows and doors or installing a burglar alarm, instituted by the residents of a potential

burglary target, are perceived to be more effective because a burglar is more concerned with the possibility of immediate detection and immediate rewards (Felson and Clarke, 1998). Even though burglars cannot be completely kept out through target-hardening means, such as locks, bolts, and alarms, still such means of prevention can delay, frustrate, and deter attempted entries. In other words, they can slow down the burglar by making the burglary difficult for those critical seconds, which may either make the burglar give up or enable him to be observed in the act of residential burglary. Thus, a residential burglar alarm is one such means of an effective micro-level strategy to respond to residential burglaries.

Analyses of the changes in residential burglary in the buffer and control zones throughout the years indicated that geographic displacement was not found, but instead geographic diffusion of benefits of burglar alarms was observed, with houses within these zones experiencing a reduction in the risk of burglary. This important finding suggests that the preventive effects of situational crime reduction measures may extend to unprotected houses within close proximity of a scheme. Thus, the possibility exists that the effectiveness of many situational crime reduction interventions may be increased by adopting targeting strategies that give the illusion of a greater area of coverage (Bowers, Johnson, and Hirschfield, 2003).

One of the most substantial results in this study is that burglar alarms are indeed effective in deterring residential burglar(s) in AI houses and in diffusing the positive benefits of burglar alarms to houses in close proximity and the surrounding geographic area. Spatial density analyses in Chapter 8 and NNI, Moran's *Is*, and Hot Spot (*Gi**) analyses in Chapter 9 showed that hotspots of NAI burglary in the city

were surrounded by many NAI houses, whereas coolspots of NAI burglary were surrounded by many AI houses. These patterns and relationships between burglar alarms and residential burglaries were continual over the years. Understanding those relationships can help homeowners considering alarm systems for better protection of their residences.

Even when motivated offenders know that a dwelling is unoccupied, situational measures remain that can discourage them from attempting to burglarize it. Foremost among these are occupancy proxies, such as burglar alarms. Few of the offenders were prepared to tackle burglar alarms, and most made a concerted effort to avoid them (Gillham, 1992; Wright and Decker, 1994). Spatial analyses in Chapter 8 supported that neighborhoods in which burglar alarms were heavily installed have fewer incidents of residential burglaries than the neighborhoods with fewer burglar alarms. Thus, the installation of burglar alarms makes dwellings less attractive to the would-be and active burglars.

Technology advances and market competition over the years have brought down the costs of the first-time installation and monthly maintenance. In most cases homeowners can obtain alarm systems for less than the monthly cost of a cell phone, though the initial cost of system installation is relatively pricey to low-income neighborhoods in particular. The alarm industry and insurers should offer discounts in premiums for alarm ownership. Residential burglar alarms indeed have some positive impact on residential burglaries by having a lower number of incidents, being compared with NAI houses, and having diffusion of benefits of alarm systems to surrounding houses. In order to justify awarding discounts to

alarm owners, the discount must be considered in the alarm-purchase decision process because burglar alarms can yield financial benefits to insurers even after paying for discounts. Though the initial cost and maintenance costs of burglar-alarm systems have lowered due to market competition and better technology, still this suggestion is recommended. Some affluent communities can afford alarm systems, but many households in the city of Newark, N.J. may be not. The median income was \$26,926, with a wide range of variation among neighborhoods in the city, and the black population variable as the largest population category over other population categories was the most important predictor in explaining the pattern of alarm installations. In other words, the neighborhoods with a larger black population tended to have more alarm systems installed than any other population group. But those who live in lower-income neighborhoods and have an alerted concern for safety and security may not be able to afford to buy and install a burglar alarm. Thus, offering discounts in premiums for alarm ownership from both the alarm industry and insurance company is strongly recommended in order to encourage the residents in black population neighborhoods to buy and install alarm systems.

In addition, as discussed in Chapters 7 and 8, house ownership was directly related to the installation pattern of residential burglar alarms. As proposed, more discounts in premiums for alarm ownership for homeowners are recommended. In particular, this suggestion links two critical predictors: householder age group 25 to 34 and general population age group under 14 years old. As discussed in Chapter 7, these younger householders had more burglar alarms installed than other

householder age groups. Of course, it is dubious to think that most of them owned their houses. It is more reasonable to assume that most those younger householders were renters rather than homeowners. The data show that the rate of renter-occupied houses in the city is substantially high (76 percent). However, both homeowners and renters are concerned with the safety and security for either owner-occupied or renter-occupied houses. In the case of renter-occupied houses, the original homeowner had installed a burglar alarm. At the same time, this younger householder age group from 25 to 34 years old generally had more babies, toddlers, or children at their houses than older householders with more attention paid to their children's safety. Thus, from a policy-oriented view, it is recommended to offer substantial and persistent discounts in premiums for alarm ownership for targeted homeowners based on demographic, socio-economic, and housing indicators by both the alarm industry and insurance companies. Such a policy will encourage them to buy and install burglar alarms to better protect their homes.

Also, with the insurance industry looking to enhance alarm sales, cooperation between the two industries will be beneficial to both. The insurance industry could cooperate by working toward standardizing discounts and stressing the merits and effectiveness of burglar alarms to clients. These suggestions would require more aggressive activity by the alarm associations. They also propose increased cooperation with police and the insurance industry to increase the credibility and visibility of the industry and to improve service.

Finally, as discussed in Chapters 8 and 9, distinctive spatial hotspots and coolspots of residential burglaries supported that the crime is not spread evenly

across the city. These distributions were formed by embedded key indicators in the neighborhoods in the city, such as demographic, socio-economic, and housing characteristics. The existence of such indicators informs the police of hotspots that routinely need patrolled. But a hotspots-oriented police patrol should not be a stand-alone consideration to develop a patrol program or crime prevention strategy. It should be incorporated with the temporal analysis of residential burglaries, which is discussed in Chapter 6. Together, they can guide local police departments to develop an analytical and targeted patrol strategy, utilizing scant police resources in fighting residential burglaries.

III. Limitations of the Present Study

As discussed in Chapter 4, this study resolved several serious methodological issues stemming from the previous studies on the research topic for a better understanding and insight into the relationship between burglar alarms and residential burglaries. But this one study cannot disentangle all possible methodological problems. In other words, several limits inevitably subsist in the current study. It should be noted that though several study limitations exist, they supply further research topics on the broader spectrum for the impact of burglar alarm systems on crime. The following is suggestions for future research.

1. Nonequivalent-Groups Quasi-Experimental Design

As discussed and proposed in Chapter 10, the current study used a nonequivalent-groups quasi-experimental research design. Randomization was not possible because this study utilized the secondary data from the local police department and

City Hall. Then, by definition, experimental and control groups were not equivalent because the experimental and control groups were defined and identified according to spatial proximity to AI houses with a burglar alarm as a crime prevention stimulus. The WDQ approach was modified and applied to examine the spatial impact of burglar alarms on residential burglaries.

Though the nonequivalent-groups quasi-experimental design in the current study was grounded in a theoretical understanding, as Maxfield and Babbie (2008) argued, this study may suffer from a possible threat to validity. Either a more rigorous and theoretically grounded quasi-experimental research design or randomized experimental design should be developed and used to study this topic.

2. The Potential Drawbacks of Recorded Crime Data

The primary data source for this study is “data from agency records.” The methodological limitations of the official police record data is well-known among criminologists, especially in regard to the data’s failure to capture crimes unreported to authorities. Relying on such a secondary data source presents the problem of the dark figure of crime, or crimes that go unreported to police.

For the current study, the data for NAI and AI burglaries were collected from the police-incident reports database. Due to the proportion of unreported crimes to the police, it is not possible to know the actual number of crimes in the city. This disadvantage underestimates the total number of NAI burglary, and skews the rate of residential burglary, which is calculated by dividing the total number of crimes with the total number of households in the city. Thus, the size of crime rates based on secondary data would be smaller than the size of crime rates based on the true

number of crime. Consequently, the ratio of residential alarm permits to NAI burglary would be biased.

3. Some Proportion of In-Use, but Non-Registered, Burglar Alarms Exists

The residential alarm-permit records from City Hall include the total number of applications in a given year. But this record does not present the true total number of burglar alarms in use in the city. According to the Alarm Section in the police department, there are three categories of residential burglar alarm users: (1) the legitimate burglar-alarm user with a city permit; (2) the expired alarm user, who once applied for the city permit but did not renew it; and (3) the unlicensed burglar-alarm user who has installed alarm systems but has never applied for a city permit. The second and third categories are non-registered alarms. Table 11.1 shows the total number of burglar alarms according to different types of residential alarm users from 2001 to 2005.

[Table 11.1] Numbers of three different residential burglar alarms annually in Newark, NJ

Type	Year					Average (%)
	2001	2002	2003	2004	2005	
Legitimate alarm permit	1,261 (0.80)	1,081 (0.74)	1,649 (0.76)	1,887 (0.69)	2,205 (0.75)	0.75
Expired alarm	88 (0.06)	120 (0.08)	124 (0.06)	44 (0.01)	90 (0.03)	0.05
Unlicensed alarm	211 (0.14)	266 (0.18)	391 (0.18)	770 (0.30)	642 (0.22)	0.20
TOTAL	1,560	1,467	2,164	2,701	2,937	1.00

(Source: Newark City Hall and Police Department)

The total number of expired and unlicensed alarms are based on the number of summons issued by the police department. Table 11.1 shows that the number of

summons issued to those who have an unlicensed alarm system is higher than that of an expired alarm system. Even though these numbers are substantial, the police department and City Hall cannot estimate even the approximate total number of unlicensed alarm users in the city. It is not known why many homeowners have installed and used burglar-alarm systems without city permits. It also is unclear why some homeowners would not renew their current alarm systems and use them. These issues need to be further studied.

The problem of the number of nonregistered burglar alarm users may overestimate the total number of AI residential burglary. The current dataset of AI burglary does not identify which incidents involved alarm systems. When comparing the rate of AI burglary by total alarm systems, the outcome may be biased toward a lower rate. For example, in 2004 there were 1,887 total registered alarm permits, 814 nonregistered (44 expired alarms and 770 unlicensed alarms), and 54 AI burglary. The rate of AI burglary by total alarm systems without nonregistered alarms is 2.86, while the rate with the nonregistered alarms is 2.0. The combined number of the three types of residential alarm systems in use is treated as the total number for this project.

4. A Sudden Increase in Residential Alarm Permit Records

In 2005, 2,205 residential alarm permits were issued. Table 12.2 shows the percentage change of residential alarm permits over the years. During the five years, the alarm permits increased each year. In particular, when compared with 2001 and 2002 records, the number of permits in 2005 increased by 75 percent and 104

percent, respectively. The change occurred within three years, a relatively short period of time.

[Table 11.2] Number of residential burglar alarm permits annually in Newark, NJ, 2001-2005

	Year					Average (\bar{X})
	2001	2002	2003	2004	2005	
Number of permits	1,261	1,081	1,649	1,887	2,205	1,617
Change (%)		-14.3	+52.5	+14.4	+16.9	+17.4

(Source: Newark City Hall)

Such sudden increases are, to some extent, unusual among general social phenomenon. Several factors may produce this increase, such as a sudden social change, sharp increase of the crime rate, new internal policy, or new laws regulating the alarm industry. When the researcher asked a City Hall public officer, who was in charge of the licensing business, whether there had been any significant policy change or new regulations relating to the alarm-installation businesses or residential alarm permits during the last five years, the officer answered that there were no such changes. At this time, the direct factor(s) for the sudden increase is not clear. This issue could be included in a future research agenda.

This issue may have a bias toward the impact of alarm systems on residential burglaries. For example, in calculating the rate of alarm permits in 2005, a sudden increase in the total number of alarm permits produces an unusual high value compared with the previous year. It can, all other things being consistent (i.e., the decrease of residential burglary was consistent), demonstrate a significantly positive impact of alarm systems on residential burglaries.

5. Some Proportion of Unmatched Geocoding Addresses

In the course of data transformation, all addresses of residential alarm permits, NAI burglary, and AI burglary were geocoded for descriptive and statistical spatial analyses. This process was done by using a GIS software function (e.g., geocode address). But there was some proportion of unmatched addresses from the three different datasets, with the average being 9 percent. The threshold of percent matching in criminal justice research is 85 percent. The current study shows a 93 percent matching point, and thus, is higher than the acceptable threshold in criminal justice research. Several factors may cause this problem, such as problems with handling abbreviations, incorrect spellings, incomplete addresses, addresses of an area of open space, and non-existent addresses.

This issue may cause problems with the spatial analysis processes. For example, in identifying hotspots for both alarm permits and NAI burglary, the unmatched addresses are excluded, and, thus, underestimate the total numbers of hotspots of alarm permits and NAI burglary, producing biased outcomes for macro-level spatial analyses.

6. Lack of a Multiple Factor Approach in Examining the Impact of Alarm Systems on Crime

This study primarily focuses on examining the impact of residential burglar alarms on levels of NAI burglary. But the reality is that other initiatives (e.g., secured lock systems on doors and windows, security yard sign without an actual alarm system, dog, and street lights) by residents also may have an effect at this level. These initiatives can be a confounding factor in investigating the impact of alarm systems

on crime. Because the datasets from City Hall and the police department did not have such information with residential burglar-alarm systems, it is not possible to include the information in the various datasets used for this study. This sort of information can be obtained through questionnaire, telephone, or door-to-door surveys. Without such information included, the outcome of analyses in this study can be questionable and biased toward the discussion of the impact of the alarm system on crime. Thus, for a better understanding of the effect of the alarm system on crime, it is necessary for the study to incorporate other research methods (e.g., ethnographic approach and field observation), including more variables which have a possible effect on the levels of residential burglary.

7. The Generalization of the Study Is in Issue

The site for this study is an urban neighborhood close to a metropolitan city. According to the U.S. Census data for 2000, the population of the city was close to 270,000, and the total number of households was approximately 100,000. Even though the population and household numbers remain static, Newark also has diverse ethnicities. Such conditions may not be similar to other urban cities in the United States. Crime patterns and alarm-permit distributions may be different from other urban neighborhoods.

In addition, suburban neighborhoods and metropolitan cities will show different patterns of residential burglaries and distribution of residential burglar alarms than other urban areas. Thus, even if the same research design may be used in other urban and sub-urban neighborhoods or metropolitan cities, the research findings could be different. Originally, two more cities were included as research

sites, but due to problems with databases and a lack of cooperation from local police departments, only one city was included in this study. It remains necessary to study the impact of alarm systems on residential burglaries in different cities.

IV. Further Research Agenda

This study focuses on the relationship and impact between burglar alarms and residential burglaries. As discussed in Chapters 6 through 10, some consistent and reliable research findings were observed to argue that burglar alarms have a substantially positive impact on the continuous decrease of residential burglaries over the years and that burglar alarms have a strong spatial diffusion of benefits against residential burglaries at a single-house level.

However, this one approach with three different secondary data sources cannot be the best research method to understand and explain the relationship and impact between burglar alarms and burglaries. For a comprehensive and better understanding of this relationship, it is imperative to expand the current research with available research methods.

The first research agenda should be related to the generalizability issue discussed above. The study area for the current study is Newark, N.J. Other cities with different demographic, socio-economic, and housing characteristics in different geographic areas (e.g., metropolitan, urban, suburban, and rural areas) should be considered. Such a replication can verify the research design and findings presented in the present study.

The second possible research topic related to the current study is relevant to commercial burglary. All analyses and discussions in the present study solely focused on residential burglary, with the topic of commercial burglary being excluded. In most localities, business owners must install a burglar alarm system and update their licenses on a regular basis. But commercial burglaries affect local businesses and economics. A rigorous and scientific-driven research is necessary to bridge the gap between the wide use of burglar alarms and the dearth of the research-based updated body of knowledge.

The third research agenda relates to the research methodological approach. The current study and the above two agendas involve secondary data sources mainly from local police departments and city halls. Another potential approach to study the impact of alarm systems on burglaries is to interview either active burglars or incarcerated inmates. Such an approach may provide in-depth personalized knowledge and insight about the impact of burglar alarms on burglaries.

The fourth research agenda is associated with repeat victimization. The literature on burglary consistently demonstrates that, in general, the risk of victimization doubles following an initial burglary (Bowers, Johnson, and Hirschfield, 2003; Johnson, Bowers, and Hirschfield, 1997; Weisel, 2002). While most people and places do not get victimized by crime, those who are victimized consistently face a higher risk of being victimized again. Previous victimization is the single best predictor of victimization. It is a better predictor of future victimization than any other characteristic of crime (Weisel, 2002). An experimental research design can

be used to examine the impact of burglar alarms on burglaries on the reduction of repeat victimization.

Finally, the issue of false alarm activation should be included in future research. As discussed in the previous chapters 7 through 10, burglar alarms have a substantial impact on residential burglaries in reducing criminal incidents and spatial diffusion of benefits. So, it is suggested that financial supports to reduce initial and maintenance costs and premiums from the alarm industry and insurance company are imperative so that homeowners can buy and install burglar-alarm systems. However, such a suggestion may generate opposition from local police departments because more alarm means more false alarm reports directly to the police. For example, in Newark, the rate of false alarm activation is, on average, 97 percent. This problem has drained very limited police resources among local police departments. Thus, it is imperative to study the false activation problem of burglar alarms to explore the scope of the problem and to explain the causal relationship for better crime prevention strategies.

V. Conclusion

The foremost question throughout the current study was “do home burglar alarms have the deterrent effect on residential burglary?” This inquiry was answered by analyzing the phenomenon between the gradual decrease of residential burglaries and the increase of residential burglar alarms and by looking at key explanatory variables. Several quantitative analyses in the present study showed that several

key variables played a role in explaining the relationship between burglar alarms and residential burglaries.

Spatial approaches also found and supported a significant relationship between burglar alarms and residential burglaries. Burglar alarms were not installed evenly across the city. Both hotspots and coolspots were observed in many neighborhoods. Residential burglaries also were not spread equally throughout the entire city. Some key variables (e.g., demographic, socio-economic, and housing indicators) were directly linked to these patterns. Spatial analyses suggested that burglar alarms had some positive impact on residential burglaries on the city level by showing that hotspots of burglar alarms did not overlap those of residential burglaries. Several spatial-based analytical approaches (e.g., NNI, Moran's *I*, geographic clustering analysis, and local hotspots [Gi*] analysis) supported this conclusion.

Furthermore, a single-house level analysis using the applied WDQ with the city's land-parcel map supported the lack of geographic displacement of residential burglaries by burglar alarms, but did demonstrate the spatial diffusion of benefits of burglar alarms on residential burglaries. It supported the use of burglar alarms as target-hardening crime prevention tactics. A micro-level approach for a crime prevention strategy in a small geographic area can be effective and substantive in fighting local crime problems, which can then create the effect of diffusion of benefits and produce an overall crime reduction in the city. Those findings were summarized to propose tangible crime prevention and marketing strategies.

By doing so, the present study may bridge the gap between the widespread installation and use of burglar alarms and the dearth of rigorous examination of the impact of such systems on residential burglaries. In addition, this study may update the current body of knowledge on similar and relevant topics so that research findings can be disseminated among academia and practitioners who are working in crime prevention circles.

In conclusion, this study is just one small endeavor and step by both the research institution, AIREF, and the researcher, together with distinguished faculty members, to obtain an in-depth and comprehensive understanding of burglar alarm systems and their use in fighting local residential burglaries.

APPENDICES

Appendix 1. Chi-Square statistics between burglar alarms and residential burglaries annually in Newark, NJ

		YEAR											
		2002				2003				2004			
		Burglarized		Total	Burglarized		Total	Burglarized		Total	Burglarized		Total
		No	Yes		No	Yes		No	Yes		No	Yes	
Burglar	No	92,113	1,359	93,472	97,633	2,089	99,722	95,735	2,647	98,382	96,643	2,772	99,415
Alarm	Yes	2,570	108	2,678	2,331	75	2,406	2,254	54	2,308	1,568	57	1,625
Total		94,683	1,467	96,150	99,964	2,164	102,128	97,989	2,701	100,690	98,211	2,829	101,040

Appendix 2. The rates of alarm installation and NAI/AI residential burglaries annually for 90 census tracts in Newark, NJ

Tract ID	YEAR														
	2002			2003			2004			2005			Overall (2001-05)		
	Alarm	NAI_Bur	AI_Bur	Alarm	NAI_Bur	AI_Bur									
1	0.022	0.020	0.082	0.031	0.015	0.043	0.039	0.013	0.012	0.035	0.006	0.039	0.029	0.013	0.041
2	0.087	0.042	0.023	0.022	0.018	0.000	0.022	0.022	0.000	0.026	0.011	0.000	0.049	0.023	0.023
3	0.005	0.012	0.000	0.006	0.011	0.000	0.008	0.010	0.000	0.009	0.008	0.000	0.007	0.011	0.000
4	0.010	0.009	0.135	0.022	0.024	0.000	0.011	0.016	0.000	0.016	0.007	0.000	0.012	0.015	0.043
5	0.024	0.033	0.150	0.026	0.005	0.000	0.033	0.031	0.167	0.045	0.015	0.000	0.030	0.020	0.060
6	0.028	0.027	0.028	0.031	0.022	0.000	0.033	0.012	0.024	0.032	0.019	0.024	0.028	0.018	0.017
7	0.006	0.023	0.135	0.017	0.019	0.026	0.023	0.023	0.038	0.022	0.021	0.000	0.015	0.022	0.039
8	0.009	0.013	0.084	0.020	0.015	0.120	0.024	0.022	0.000	0.025	0.021	0.000	0.018	0.016	0.035
9	0.005	0.018	0.000	0.011	0.014	0.000	0.010	0.013	0.000	0.011	0.018	0.063	0.008	0.016	0.033
10	0.018	0.027	0.126	0.015	0.026	0.050	0.024	0.022	0.000	0.015	0.021	0.000	0.019	0.025	0.047
11	0.011	0.033	0.000	0.015	0.029	0.125	0.029	0.029	0.000	0.023	0.016	0.083	0.021	0.028	0.055
12	0.021	0.034	0.168	0.022	0.038	0.083	0.031	0.055	0.000	0.048	0.046	0.000	0.026	0.043	0.055
13	0.008	0.038	0.000	0.020	0.032	0.000	0.024	0.037	0.115	0.033	0.022	0.057	0.019	0.031	0.049
14	0.005	0.022	0.000	0.009	0.022	0.000	0.015	0.026	0.000	0.015	0.019	0.000	0.013	0.020	0.000
15	0.007	0.031	0.000	0.016	0.034	0.000	0.038	0.053	0.000	0.030	0.038	0.000	0.019	0.037	0.000
16	0.013	0.025	0.000	0.014	0.033	0.000	0.024	0.036	0.000	0.019	0.014	0.000	0.014	0.027	0.000
17	0.033	0.045	0.000	0.041	0.050	0.030	0.039	0.039	0.000	0.045	0.026	0.056	0.036	0.043	0.028
18	0.016	0.059	0.299	0.024	0.050	0.000	0.037	0.059	0.067	0.046	0.025	0.027	0.029	0.049	0.067
19	0.017	0.022	0.034	0.017	0.021	0.065	0.025	0.020	0.022	0.026	0.012	0.022	0.019	0.019	0.041
20	0.059	0.036	0.063	0.088	0.045	0.022	0.102	0.029	0.019	0.105	0.013	0.009	0.082	0.032	0.037
21	0.017	0.008	0.042	0.025	0.006	0.028	0.029	0.008	0.000	0.031	0.002	0.011	0.023	0.007	0.027
22	0.040	0.024	0.048	0.067	0.020	0.044	0.056	0.020	0.017	0.073	0.011	0.014	0.055	0.018	0.039
23	0.046	0.033	0.081	0.061	0.036	0.041	0.074	0.034	0.017	0.075	0.025	0.008	0.059	0.033	0.049
24	0.025	0.032	0.061	0.043	0.036	0.055	0.041	0.020	0.000	0.036	0.015	0.043	0.034	0.026	0.032
25	0.020	0.033	0.106	0.030	0.035	0.024	0.027	0.023	0.000	0.034	0.014	0.000	0.025	0.025	0.039
26	0.014	0.049	0.000	0.020	0.044	0.000	0.037	0.026	0.050	0.035	0.043	0.053	0.023	0.042	0.032
27	0.064	0.025	0.000	0.085	0.038	0.037	0.078	0.041	0.040	0.096	0.029	0.033	0.082	0.036	0.031
28	0.054	0.050	0.075	0.087	0.048	0.024	0.090	0.050	0.023	0.090	0.050	0.047	0.070	0.051	0.035
29	0.020	0.048	0.000	0.058	0.058	0.000	0.081	0.053	0.000	0.069	0.019	0.040	0.048	0.046	0.034
30	0.002	0.016	0.673	0.006	0.034	0.400	0.009	0.039	0.143	0.004	0.005	0.000	0.006	0.026	0.182
31	0.094	0.063	0.000	0.115	0.060	0.040	0.130	0.102	0.000	0.279	0.032	0.019	0.135	0.078	0.021
32	0.022	0.047	0.224	0.046	0.038	0.056	0.051	0.025	0.050	0.062	0.015	0.000	0.037	0.033	0.081
33	0.031	0.043	0.052	0.032	0.030	0.000	0.050	0.010	0.065	0.057	0.031	0.029	0.041	0.029	0.055
34	0.012	0.038	0.112	0.023	0.070	0.059	0.051	0.042	0.000	0.048	0.038	0.000	0.030	0.047	0.028
35	0.032	0.046	0.112	0.047	0.028	0.079	0.058	0.040	0.021	0.070	0.019	0.036	0.052	0.034	0.057
36	0.003	0.023	0.000	0.007	0.025	0.000	0.007	0.018	0.143	0.005	0.020	0.000	0.007	0.022	0.056
37	0.009	0.043	0.673	0.014	0.023	0.000	0.020	0.035	0.000	0.026	0.015	0.000	0.015	0.031	0.075
38	0.026	0.020	0.096	0.037	0.028	0.000	0.039	0.015	0.022	0.049	0.020	0.000	0.038	0.023	0.027
39	0.014	0.026	0.061	0.019	0.030	0.043	0.021	0.024	0.000	0.023	0.013	0.000	0.017	0.023	0.030
40	0.030	0.051	0.000	0.035	0.034	0.083	0.052	0.042	0.114	0.060	0.036	0.000	0.043	0.039	0.041
41	0.032	0.026	0.096	0.034	0.021	0.045	0.026	0.032	0.000	0.031	0.021	0.000	0.031	0.025	0.039
42	0.015	0.020	0.096	0.028	0.022	0.079	0.039	0.014	0.020	0.029	0.013	0.026	0.027	0.018	0.049
43	0.025	0.035	0.000	0.033	0.023	0.049	0.047	0.019	0.017	0.042	0.015	0.019	0.035	0.024	0.023
44	0.037	0.020	0.031	0.046	0.012	0.025	0.052	0.008	0.011	0.056	0.007	0.010	0.046	0.012	0.022
45	0.020	0.026	0.052	0.024	0.023	0.000	0.021	0.011	0.000	0.033	0.017	0.031	0.022	0.022	0.036
46	0.003	0.028	0.000	0.009	0.018	0.000	0.008	0.026	0.000	0.008	0.018	0.000	0.007	0.023	0.014

Tract ID	YEAR												Overall (2001-05)			
	2002			2003			2004			2005						
	Alarm	NAI_Bur	AI_Bur	Alarm	NAI_Bur	AI_Bur	Alarm									
47	0.016	0.014	0.071	0.026	0.008	0.043	0.031	0.009	0.037	0.035	0.007	0.032	0.027	0.010	0.038	
48	0.020	0.055	0.224	0.027	0.037	0.000	0.042	0.021	0.027	0.051	0.033	0.022	0.034	0.037	0.040	
49	0.011	0.020	0.000	0.027	0.019	0.000	0.030	0.011	0.037	0.031	0.014	0.000	0.023	0.015	0.010	
50	0.032	0.039	0.000	0.043	0.048	0.000	0.043	0.022	0.000	0.039	0.019	0.056	0.040	0.032	0.022	
51	0.031	0.020	0.000	0.037	0.013	0.030	0.038	0.016	0.000	0.036	0.022	0.000	0.034	0.020	0.007	
52	0.006	0.017	0.000	0.006	0.009	0.000	0.007	0.015	0.200	0.013	0.008	0.000	0.008	0.013	0.053	
53	0.012	0.084	0.269	0.020	0.053	0.000	0.022	0.068	0.077	0.026	0.048	0.067	0.018	0.071	0.129	
54	0.019	0.032	0.000	0.017	0.042	0.000	0.022	0.019	0.000	0.019	0.007	0.077	0.017	0.025	0.017	
55	0.011	0.014	0.061	0.008	0.005	0.000	0.008	0.007	0.000	0.012	0.001	0.056	0.011	0.009	0.036	
56	0.017	0.005	0.135	0.035	0.028	0.000	0.028	0.021	0.000	0.018	0.002	0.000	0.023	0.015	0.039	
57	0.000	0.012	0.000	0.000	0.007	0.000	0.000	0.013	0.000	0.002	0.003	0.000	0.001	0.010	0.000	
58	0.001	0.012	0.673	0.004	0.010	0.000	0.007	0.014	0.091	0.007	0.009	0.091	0.004	0.014	0.090	
59	0.015	0.035	0.056	0.020	0.034	0.043	0.025	0.061	0.034	0.020	0.034	0.000	0.018	0.042	0.038	
60	0.005	0.021	0.135	0.006	0.012	0.125	0.009	0.014	0.000	0.019	0.015	0.077	0.010	0.018	0.060	
61	0.003	0.025	0.000	0.005	0.022	0.286	0.009	0.019	0.000	0.009	0.013	0.000	0.006	0.019	0.050	
62	0.006	0.016	0.000	0.010	0.012	0.000	0.012	0.014	0.000	0.016	0.015	0.000	0.011	0.013	0.000	
63	0.002	0.015	0.000	0.005	0.012	0.000	0.003	0.012	0.000	0.008	0.008	0.100	0.005	0.012	0.035	
64	0.004	0.014	0.135	0.009	0.011	0.000	0.016	0.013	0.000	0.015	0.011	0.000	0.011	0.013	0.021	
65	0.007	0.040	0.000	0.010	0.027	0.000	0.016	0.046	0.000	0.025	0.028	0.000	0.013	0.041	0.000	
66	0.005	0.026	0.135	0.011	0.019	0.000	0.009	0.034	0.000	0.009	0.013	0.071	0.009	0.025	0.031	
67	0.004	0.016	0.000	0.005	0.026	0.000	0.006	0.033	0.000	0.007	0.020	0.143	0.005	0.024	0.040	
68	0.006	0.021	0.000	0.005	0.007	0.000	0.007	0.010	0.000	0.010	0.010	0.000	0.006	0.013	0.000	
69	0.005	0.018	0.000	0.005	0.013	0.000	0.012	0.009	0.000	0.006	0.012	0.000	0.008	0.013	0.000	
70	0.005	0.012	0.168	0.004	0.011	0.200	0.005	0.012	0.000	0.003	0.011	0.000	0.004	0.012	0.080	
71	0.001	0.015	0.000	0.007	0.011	0.000	0.010	0.016	0.063	0.007	0.009	0.000	0.006	0.014	0.021	
72	0.007	0.106	0.000	0.008	0.068	0.000	0.015	0.078	0.111	0.018	0.060	0.000	0.010	0.077	0.068	
73	0.001	0.016	0.000	0.003	0.017	0.167	0.004	0.016	0.000	0.003	0.011	0.000	0.004	0.012	0.135	
74	0.000	0.016	0.000	0.000	0.018	0.000	0.008	0.006	0.000	0.007	0.004	0.000	0.003	0.011	0.000	
75	0.009	0.139	0.000	0.016	0.125	0.200	0.016	0.128	0.000	0.019	0.056	0.000	0.015	0.111	0.041	
76	0.004	0.004	0.000	0.000	0.016	0.000	0.001	0.019	0.000	0.003	0.009	0.000	0.002	0.011	0.000	
77	0.019	0.040	0.090	0.016	0.039	0.000	0.024	0.040	0.000	0.023	0.016	0.036	0.019	0.038	0.026	
78	0.034	0.019	0.122	0.035	0.021	0.000	0.046	0.017	0.045	0.037	0.019	0.000	0.033	0.020	0.038	
79	0.006	0.027	0.000	0.008	0.015	0.000	0.016	0.008	0.000	0.008	0.007	0.000	0.008	0.017	0.033	
80	0.002	0.007	0.000	0.003	0.004	0.000	0.002	0.009	0.000	0.001	0.003	0.000	0.002	0.006	0.000	
81	0.015	0.033	0.067	0.024	0.031	0.043	0.027	0.020	0.038	0.021	0.022	0.000	0.020	0.027	0.031	
82	0.009	0.029	0.404	0.009	0.036	0.000	0.020	0.031	0.000	0.015	0.007	0.077	0.013	0.030	0.093	
83	0.009	0.024	0.067	0.017	0.032	0.071	0.023	0.027	0.000	0.026	0.017	0.024	0.017	0.028	0.043	
84	0.021	0.007	0.099	0.025	0.006	0.033	0.029	0.009	0.043	0.037	0.011	0.012	0.027	0.009	0.038	
85	0.007	0.008	0.061	0.015	0.013	0.086	0.024	0.008	0.000	0.027	0.007	0.047	0.016	0.009	0.052	
86	0.007	0.041	0.269	0.025	0.035	0.037	0.022	0.026	0.083	0.021	0.014	0.043	0.017	0.030	0.063	
87	0.004	0.016	0.269	0.010	0.021	0.118	0.014	0.008	0.000	0.023	0.004	0.000	0.012	0.013	0.061	
88	0.040	0.347	0.673	0.054	0.297	0.000	0.054	0.459	0.000	0.026	0.237	0.000	0.042	0.358	0.127	
89	0.003	0.020	0.000	0.013	0.016	0.000	0.013	0.013	0.000	0.021	0.016	0.083	0.011	0.018	0.063	
90	0.000	0.022	0.000	0.002	0.012	0.000	0.001	0.010	0.000	0.002	0.006	0.000	0.001	0.014	0.000	

Appendix 3. Lists of the variables for correlation and regression analyses

Category	Variables*
Demographic	White, black, and other
Age	Age <=14, 15-17, 18-24, 25-34, 35-44, 45-54, 55-59, 60-64, 65-74, and >=75 Median age
Socio-Economic	Median income Unemployment Poverty level in population
Housing Characteristic	Householder's race by white, black, and other Householder's age 15-24, 25-34, 35-44, 45-54, 55-59, 60-64, 65-74, over 75 Poverty level in household House occupied and vacant Owner's and renter's occupied

* All variables listed here are calculated with rates, except "median age" and "media income."

Appendix 4. Multiple correlation coefficients (Person's r) for the rates of burglar alarm installations for 90 census tracts annually, in Newark, NJ

Variable	Year					
	2001	2002	2003	2004	2005	Overall
White Population	-.251*	-.258*	-.366**	-.376**	-.305**	-.339**
Black Population	.279**	.258*	.375**	.386**	.319**	.354**
Other Population	-.245*	-.184	-.281**	-.292**	-.250*	-.276**
Population Age <=14	.123	.182	.220*	.241*	.318**	.249*
Population Age 15-17	.215*	.192	.223*	.177	.132	.198
Population Age >=75	-.041	-.093	-.216*	-.208*	-.204	-.178
Median Age (30.2)	-.218*	-.254*	-.318**	-.331**	-.364**	-.331**
Median Income (\$26,929)	.119	.118	.238*	.203	.101	.168
Unemployment	-.149	-.134	-.251*	-.248*	-.261*	-.232*
White Householder	-.247*	-.236*	-.339**	-.361**	-.298**	-.324**
Black Householder	.280**	.245*	.352**	.372**	.308**	.340**
Other Householder	-.256*	-.186	-.268*	-.276**	-.231*	-.266*
Householder Age 25-34	.078	.173	.217*	.220*	.279**	.221*
Householder Age >=75	.019	-.051	-.249*	-.288**	-.235*	-.195
Owner Occupied	.243*	.249*	.381**	.363**	.180	.302**
Renter Occupied	-.243*	-.249*	-.381**	-.363**	-.180	-.302**

* Statistically significant at the .05 level

** Statistically significant at the .01 level

Appendix 5. Multiple correction coefficients (Pearson's *r*) of the rates of NAI burglary for 90 census tracts annually in Newark, NJ

Variable	Year					
	2001	2002	2003	2004	2005	Overall
Population Age <=14	-.290 **	-.300 **	-.302 **	-.334 **	-.273 **	-.306 **
Population Age 15-17	-.218 *	-.238 *	-.207	-.250 **	-.178	-.226 *
Population Age 25-34	.582 **	.578 **	.549 **	.617 **	.550 **	.591 **
Population Age 35-44	.407 **	.448 **	.396 **	.427 **	.462 **	.432 **
Population Age 45-54	-.234 *	-.175	-.189	-.172	-.181	-.197
Population Age 55-59	-.253 *	-.222 *	-.240 *	-.235 *	-.177	-.234 *
Population Age 60-64	-.251 *	-.246 *	-.212 *	-.296 **	-.269 *	-.262 *
Population Age 65-74	-.299 **	-.328 **	-.301 **	-.302 **	-.307 **	-.313 **
Population Age >=75	-.226 *	-.271 **	-.240 *	-.221 *	-.287 **	-.250 *
Unemployment	.478 **	.430 **	.400 **	.471 **	.447 **	.457 **
Householder Age 60-64	.640 **	.600 **	.615 **	.585 **	.567 **	.616 **
Householder Age 65-74	-.294 **	-.320 **	-.277 **	-.283 **	-.255 *	-.294 **
Householder Age >=75	-.251 *	-.278 **	-.283 **	-.249 *	-.279 **	-.272 **

* Statistically significant at the .05 level

** Statistically significant at the .01 level

Appendix 6. A series of forward selection multiple regressions for burglar alarm annually in Newark, NJ (N=90 census tracts)

For Year 2001

Independent Variables	Dependent Variable (=Burglar Alarm)											
	Model 1				Model 2				Model 3			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Black Householder	.014	.005	.280	2.738**	.014	.005	.284	2.855**	.014	.005	.277	2.835**
Owner Occupied					.032	.013	.247	2.483*	.031	.013	.243	2.489*
NAI Residential Burglary									.075	.036	.204	2.093*
F	7.498**				7.052**				6.345**			
Constant	.009				.002				-.001			
R ²	.079				.139				.181			

For Year 2002

Independent Variables	Dependent Variable (=Burglar Alarm)																			
	Model 1				Model 2				Model 3				Model 4				Model 5			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Black Population	.013	.005	.258	2.510*	.013	.005	.259	2.591*	.015	.005	.313	3.17**	.014	.005	.296	3.05**	.008	.006	.166	1.46
Owner Occupied					.031	.013	.250	2.501*	.035	.012	.279	2.87**	.033	.012	.265	2.77**	.040	.012	.317	3.27**
Householder Age 25-34									.091	.034	.266	2.68**	.089	.033	.258	2.65*	.072	.034	.208	2.11*
NAI Residential Burglary													.092	.043	.205	2.16*	.129	.045	.287	2.83**
Population Age <=14																	.066	.032	.250	2.07*
F	6.3000*				6.465**				7.002***				6.635***				6.367***			
Constant	.010				.002				-.019				-.020				-.032			
R ²	.067				.129				.196				.238				.275			

For Year 2003

Independent Variables	Dependent Variable (=Burglar Alarm)																			
	Model 1				Model 2				Model 3				Model 4				Model 5			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Owner Occupied	.058	.015	.381	3.87***	.058	.014	.382	4.22***	.064	.013	.420	5.02***	.060	.012	.394	4.82***	.068	.012	.445	5.49***
Black Population					.022	.005	.376	4.15***	.026	.005	.447	5.26***	.025	.005	.415	4.99***	.016	.006	.265	2.71**
Householder Age 25-34									.147	.036	.352	4.12***	.142	.035	.341	4.12***	.119	.035	.285	3.45**
NAI Residential Burglary													.135	.052	.214	2.61*	.197	.055	.313	3.58**
Population Age <=14																	.088	.033	.275	2.68**
F	14.963 ***				17.468 ***				19.425 ***				17.264 ***				16.252 ***			
Constant	.010				-.004				-.037				-.038				-.053			
R ²	.145				.287				.404				.448				.492			

For Year 2004

Independent Variables	Dependent Variable (=Burglar Alarm)																			
	Model 1				Model 2				Model 3				Model 4				Model 5			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Black Population	.025	.006	.386	3.93***	.025	.006	.387	4.26***	.030	.005	.459	5.39***	.029	.005	.446	5.40***	.019	.006	.293	3.08**
Owner Occupied					.060	.015	.364	4.01***	.066	.014	.402	4.79***	.065	.013	.393	4.83***	.075	.013	.457	5.64***
Householder Age 25-34									.162	.039	.356	4.15***	.159	.038	.350	4.22***	.132	.037	.291	3.55**
NAI Residential Burglary													.098	.038	.212	2.62**	.148	.040	.318	3.71***
Population Age <=14																	.103	.035	.297	2.90**
F	15.428 ***				17.061 ***				19.249 ***				17.142 ***				16.586 ***			
Constant	.014				-.001				-.038				-.039				-.057			
R ²	.149				.282				.402				.446				.497			

For Year 2005

Independent Variables	Dependent Variable (=Burglar Alarm)															
	Model 1				Model 2				Model 3				Model 4			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Black Population	.030	.010	.319	3.15**	.037	.009	.391	4.05***	.038	.009	.397	4.22***	.028	.010	.290	2.72**
Householder Age 25-34					.240	.065	.357	3.71***	.257	.063	.382	4.05***	.230	.064	.342	3.60**
Owner Occupied									.054	.023	.222	2.40**	.067	.023	.273	2.89**
Population Age <=14													.111	.055	.217	2.01*
F	9.946 **				12.565 ***				10.764 ***				9.365 ***			
Constant	.013				-.039				-.055				-.074			
R ²	.102				.224				.273				.306			

* Statistically significant at the .05 level

** Statistically significant at the .01 level

*** Statistically significant at the .001 level

Appendix 7. A series of hierarchical multivariable regressions for NAI residential burglary annually in Newark, NJ (N=90 census tracts)

For Year 2001

Independent Variables	Dependent Variable (=NAI Residential Burglary)																			
	Model 1				Model 2				Model 3				Model 4				Model 5			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Burglar Alarm	.599	.285	.219	2.102*	.812	.246	.296	3.303**	.842	.177	.307	4.768***	.606	.149	.221	4.079***	.614	.151	.224	4.07***
Unemployment					.256	.044	.522	5.819***	.244	.032	.497	7.522***	.183	.028	.374	6.532***	.186	.029	.379	6.37***
Population Age <=17									-.163	.077	-.254	-2.135*	-.150	.063	-.233	-2.395*	-.147	.063	-.229	-2.33*
Population Age 25-44									.135	.087	.196	1.548	.072	.072	.105	1.008	.070	.072	.102	.974
Population Age >=45									-.329	.078	-.422	-4.202***	-.340	.064	-.436	-5.32***	-.322	.081	-.413	-3.99***
Householder Age 60-64													.578	.088	.383	6.55***	.575	.089	.381	6.46***
Householder Age >=65																	-.021	.056	-.031	-.365
F	4.419*				19.962***				33.62***				49.145***				41.704***			
Constant	.024				-.074				.024				.026				.024			
R ²	.048				.315				.667				.780				.781			

For Year 2002

Independent Variables	Dependent Variable (=NAI Residential Burglary)																			
	Model 1				Model 2				Model 3				Model 4				Model 5			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Burglar Alarm	.554	.231	.248	2.403*	.695	.205	.311	3.39**	.676	.153	.303	4.407***	.505	.137	.226	3.693***	.516	.138	.231	3.753***
Unemployment					.184	.036	.472	6.14***	.170	.027	.436	6.277***	.126	.026	.324	5.099***	.132	.026	.338	5.141***
Population Age <=17									-.146	.064	-.284	-2.264*	-.131	.056	-.256	-2.349*	-.126	.056	-.246	-2.241*
Population Age 25-44									.108	.073	.198	1.484	.068	.064	.124	1.063	.063	.064	.116	.989
Population Age >=45									-.247	.065	-.398	-3.771***	-.255	.057	-.411	-4.490***	-.218	.071	-.352	-3.069**
Householder Age 60-64													.419	.078	.349	5.368***	.414	.078	.345	5.283***
Householder Age >=65																	-.042	.050	-.080	-.850
F	5.773*				16.939***				28.824***				36.779***				31.522***			
Constant	.023				-.047				.034				.032				.028			
R ²	.062				.280				.632				.727				.729			

For Year 2003

Independent Variables	Dependent Variable (=NAI Residential Burglary)																			
	Model 1				Model 2				Model 3				Model 4				Model 5			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Burglar Alarm	.508	.160	.321	3.18**	.681	.142	.430	4.803***	.673	.110	.425	6.109***	.511	.101	.323	5.062***	.511	.102	.323	5.032***
Unemployment					.166	.030	.495	5.530***	.154	.023	.459	6.663***	.114	.022	.339	5.266***	.115	.022	.342	5.141***
Population Age <=17									-.168	.054	-.381	-3.086**	-.152	.048	-.345	-3.195**	-.151	.048	-.343	-3.131**
Population Age 25-44									.046	.062	.097	.739	.013	.054	.027	.235	.012	.055	.025	.217
Population Age >=45									-.211	.055	-.395	-3.807***	-.221	.048	-.415	-4.58***	-.214	.061	-.402	-3.536**
Householder Age 60-64													.354	.068	.343	5.222***	.353	.068	.342	5.176***
Householder Age >=65																	-.008	.042	-.018	-.196
F	10.096**				22.037***				30.547***				37.964***				32.169***			
Constant	.018				-.047				.049				.050				.049			
R ²	.103				.336				.645				.733				.733			

For Year 2004

Independent Variables	Dependent Variable (=NAI Residential Burglary)																			
	Model 1				Model 2				Model 3				Model 4				Model 5			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Burglar Alarm	.557	.222	.258	2.510*	.862	.189	.400	4.558***	.870	.132	.403	6.607***	.709	.123	.329	5.748***	.710	.124	.329	5.720***
Unemployment					.284	.044	.570	6.497***	.259	.030	.520	8.602***	.212	.029	.425	7.323***	.209	.030	.421	7.020***
Population Age <=17									-.205	.070	-.314	-2.918**	-.191	.063	-.292	-3.016**	-.193	.064	-.296	-3.018**
Population Age 25-44									.155	.080	.221	1.939	.111	.072	.160	1.543	.113	.073	.162	1.556
Population Age >=45									-.274	.072	-.346	-3.805***	-.288	.065	-.364	-4.450***	-.304	.081	-.384	-3.760***
Householder Age 60-64													.412	.090	.269	4.593***	.414	.090	.270	4.579***
Householder Age >=65																	.019	.056	.028	.334
F	6.299*				25.729***				45.173***				50.165***				42.554***			
Constant	.015				-.097				-.004				.000				.002			
R ²	.067				.372				.729				.784				.784			

For Year 2005

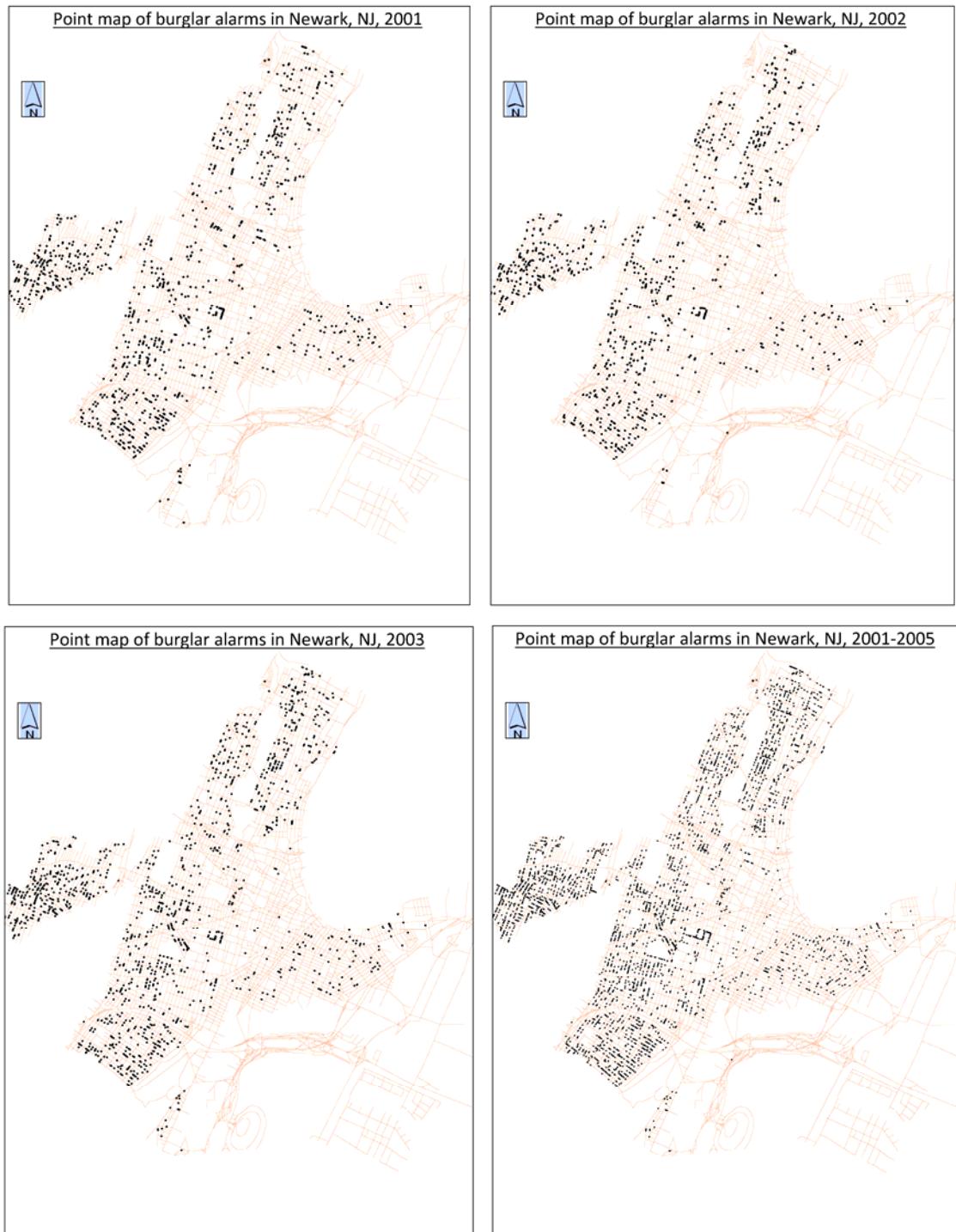
Independent Variables	Dependent Variable (=NAI Residential Burglary)															
	Model 1			Model 2			Model 3			Model 4			Model 5			
	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t	b	SE	Beta	t
Burglar Alarm	.105	.081	.137	1.300	.208	.073	.273	2.87 **	.219	.057	.287	3.820 ***	.161	.054	.211	3.000 **
Unemployment					.135	.025	.518	5.455 ***	.124	.019	.476	6.509 ***	.096	.018	.368	5.223 ***
Population Age <=17									-.056	.044	-.164	-1.259	-.048	.040	-.140	-1.187
Population Age 25-44									.116	.051	.318	2.305 *	.088	.046	.241	1.908
Population Age >=45									-.127	.046	-.305	-2.767 **	-.135	.041	-.326	-3.265 **
Householder Age 60-64													.250	.057	.312	4.408 ***
Householder Age >=65																.001 .036 .003 .027
F	1.690			16.000 ***			25.630 ***			29.284 ***			24.799 ***			
Constant	.017			-.036			-.019			-.016			-.016			
R ²	.019			.269			.604			.679			.679			

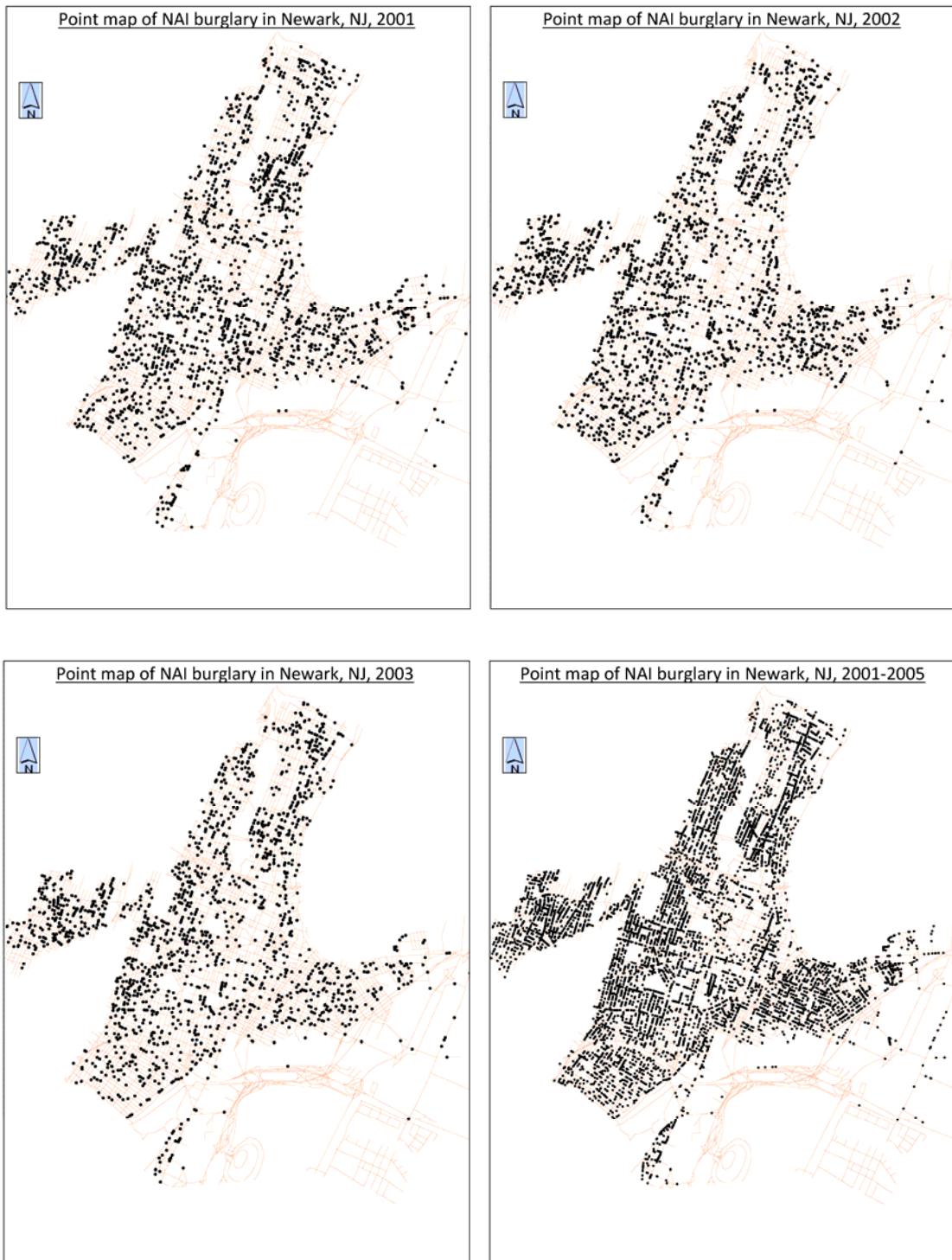
* Statistically significant at the .05 level

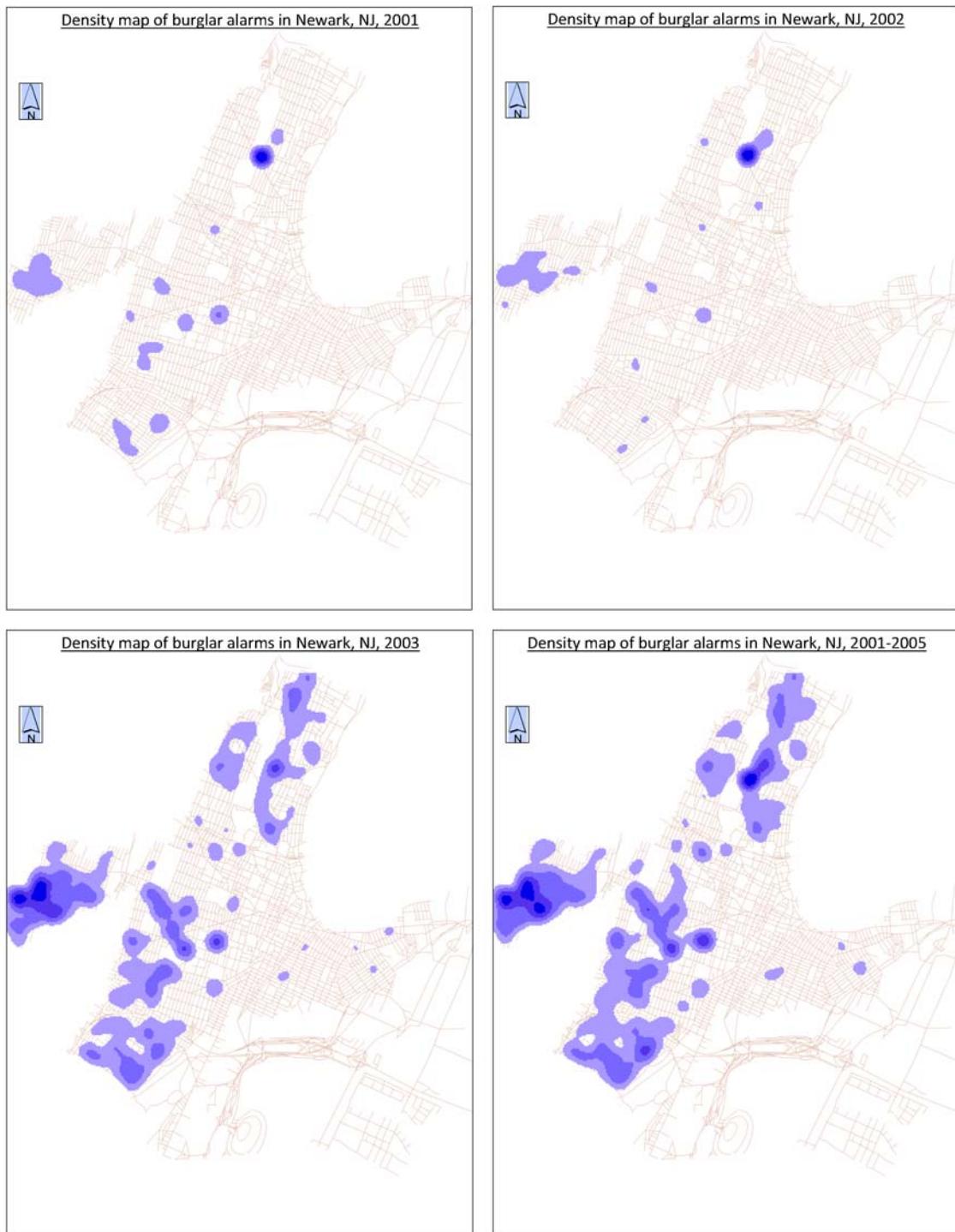
** Statistically significant at the .01 level

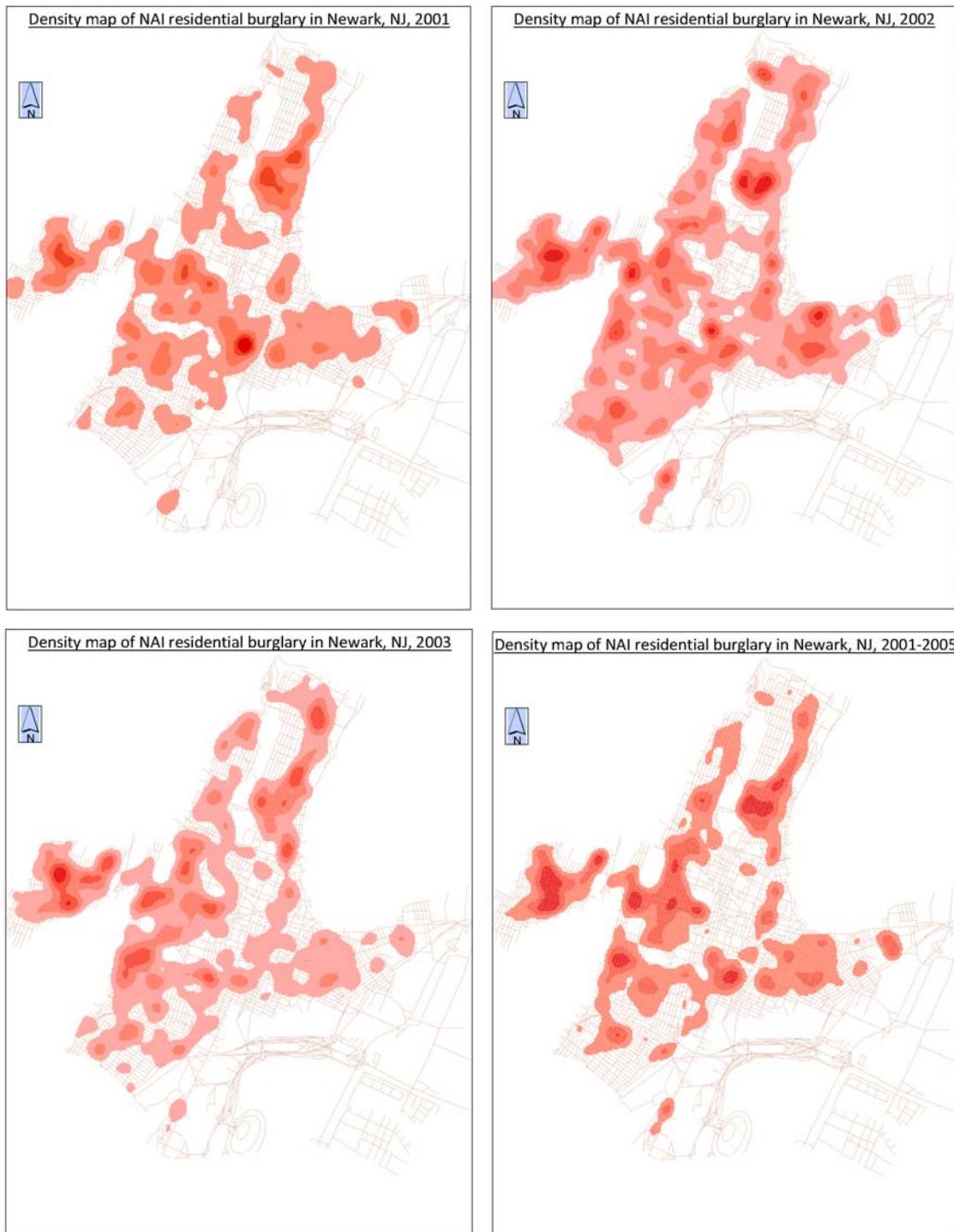
*** Statistically significant at the .001 level

Appendix 8. Points maps of residential burglar alarms annually

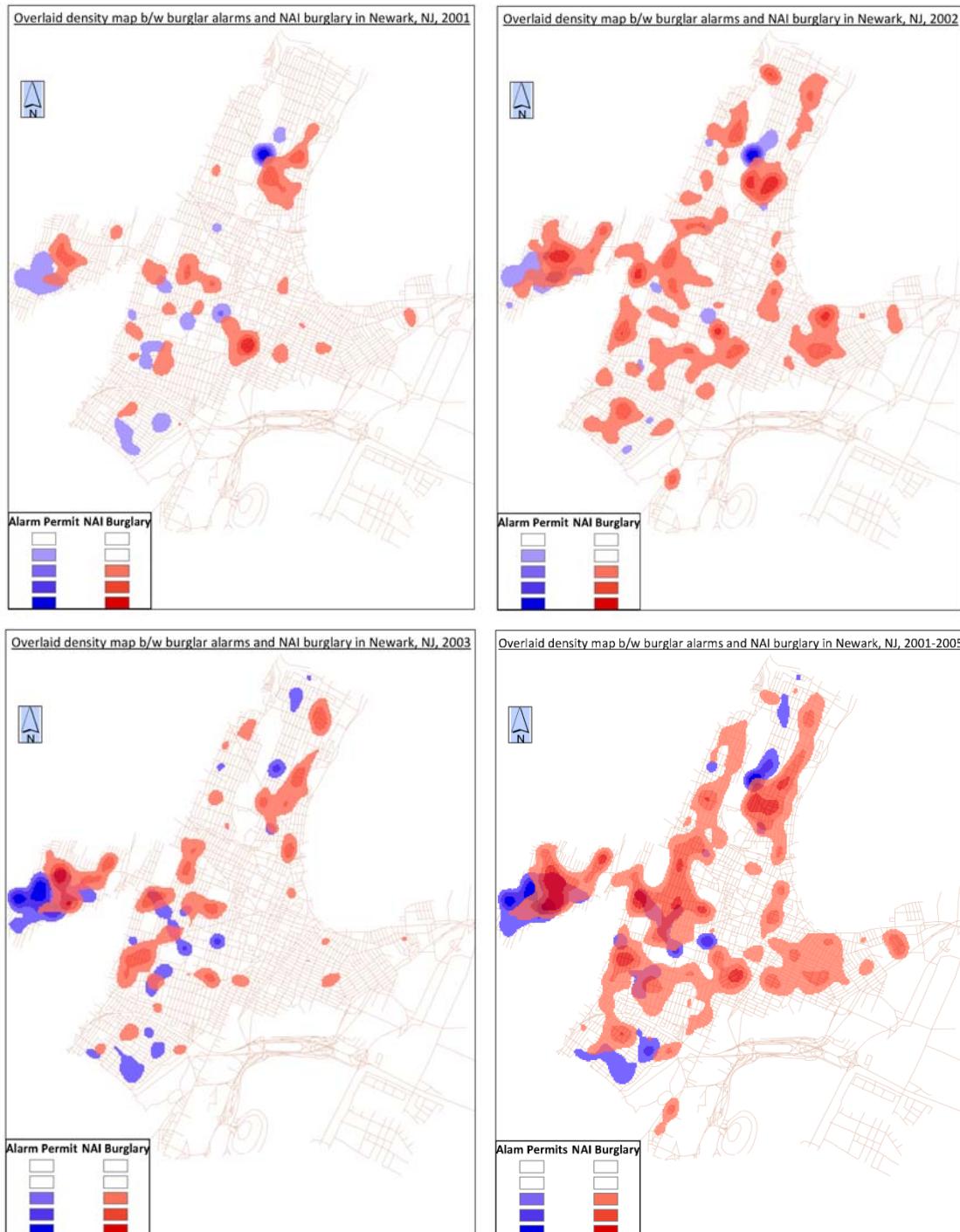


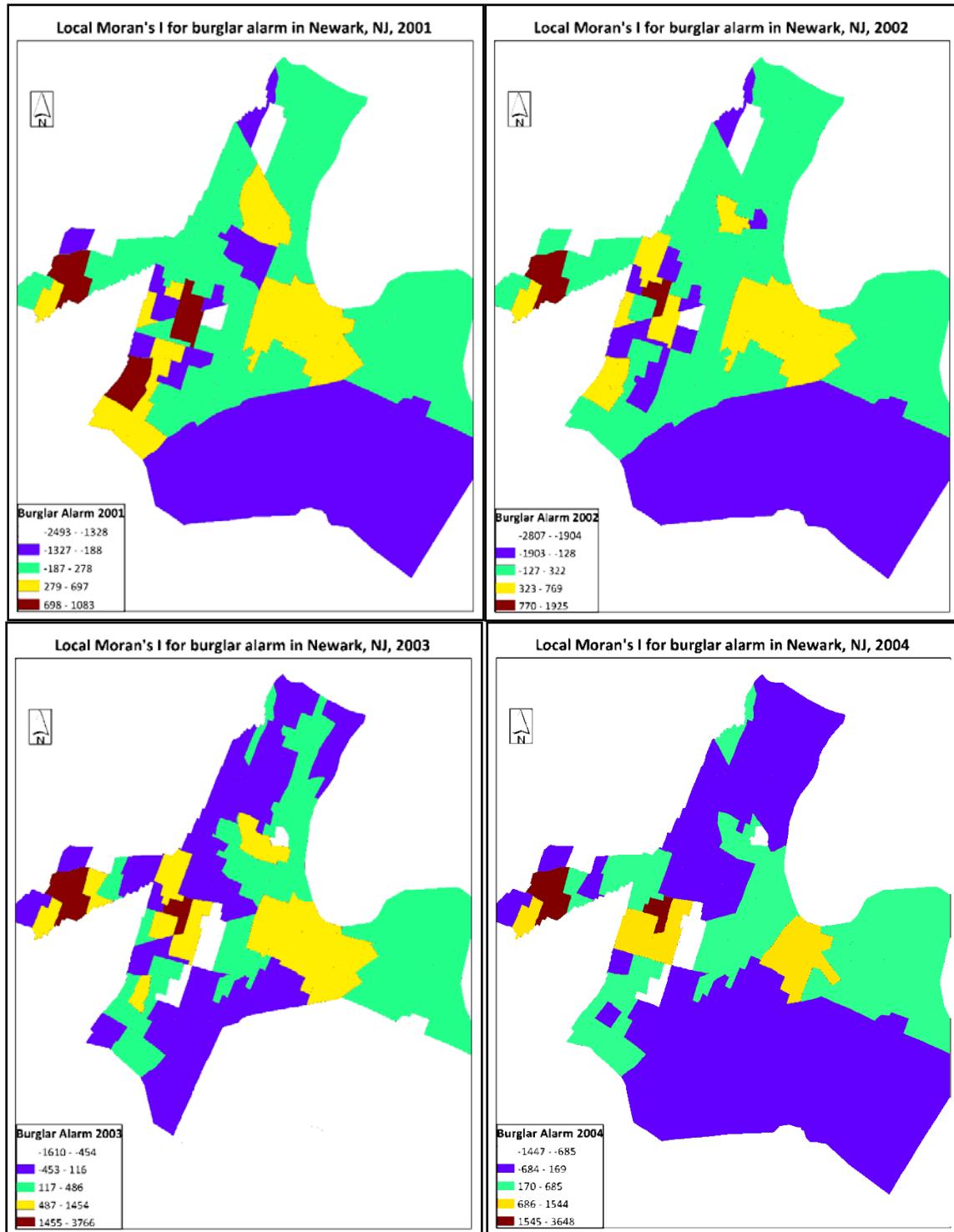
Appendix 9. Points maps of the NAI residential burglary annually

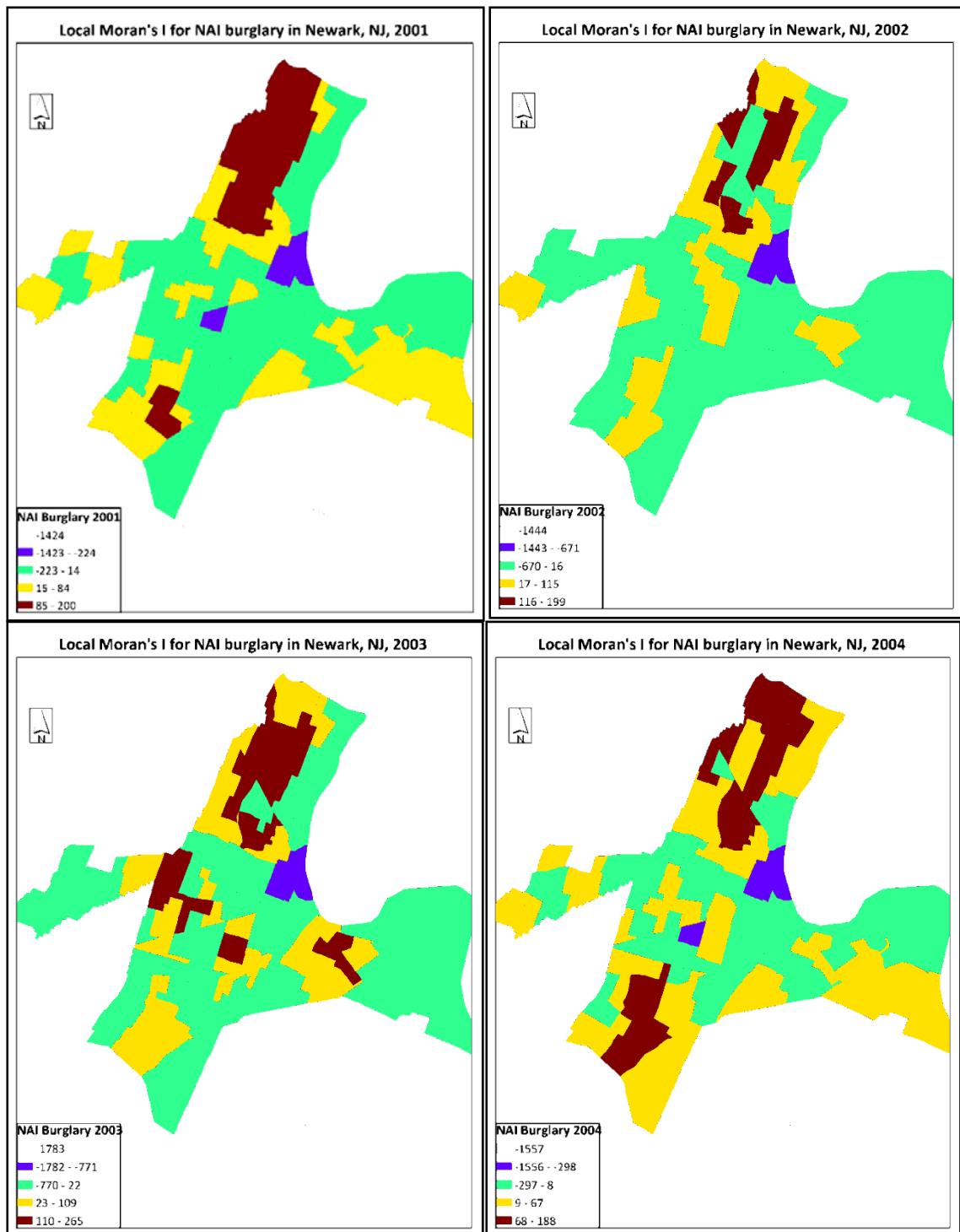
Appendix 10. Density maps of residential burglar alarms Annually

Appendix 11. Density maps of the NAI residential burglary annually

Appendix 12. Superimposed density maps between burglar alarms and the NAI residential burglary annually in Newark, NJ



Appendix 13. Census tract maps of Local Moran's I for residential burglar alarms annually in Newark, NJ

Appendix 14. Census tract maps of Local Moran's I for NAI residential burglary annually in Newark, NJ

BIBLIOGRAPHY

- Allison, Paul D. (1999). *Multiple regression: A primer*. Thousand Oaks, CA: Pine Forge Press.
- Andresen, Martin A. and Greg W. Jenion. (2004). "The unspecified temporal criminal event: What is unknown is known with aoristic analysis and multinomial logistic regression." *Western Criminology Review*, 5(3): 1-11.
- Arscott, Robert D., Marc P. Lambert, and Sharon W. Revis. (June, 1991). "Choosing and using contract security." *Security Management*, 31-33.
- Bachman, Ronet and Raymond Paternoster. (2004). *Statistics for criminology and criminal justice* (2nd ed.). Boston, MA: McGraw Hill.
- Barnes, Geoffrey C. (1995). "Defining and optimizing displacement." In: Eck, John E. and David Weisburd, (eds.), *Crime and place, Crime Prevention Studies*, Vol. 4. Monsey, NY: Criminal Justice Press.
- Bennett, Trevor and Richard T. Wright. (1984). *Burglars on burglary: Prevention and the offender*. Hampshire, U.K.: Gower.
- Benson, Bruce L. (1998). "Crime control through private enterprise." *Independent Review*, 2(3): 340-369.
- Bittner, Egon. (1980). *The functions of the police in modern society: A review of background factors, current practices, and possible role models*. Cambridge, MA: Oelgeschlager, Gunn, and Hain.
- Blackstone, Erwin A. and Simon Hakim. (1996). *Police services: The private challenge*. Oakland, CA: The Independent Institute.
- Blumstein, Alfred and Joel Wallman (eds.). (2000). *The crime drop in America*. New York, NY: Cambridge University Press.
- Boba, Rachel. (2005). *Crime analysis and crime mapping*. Thousand Oaks, CA: Sage.
- Boba, Rachel. (2001). *Introductory guide to crime analysis and mapping*. Washington, D.C.: U.S. Department of Justice, Community Oriented Policing Services.
- Bowers, Kate J. and Shane D. Johnson. (2003). "Measuring the geographical displacement and diffusion of benefit effects of crime prevention activity." *Journal of Quantitative Criminology*, 19(3): 275-301.

- Bowers, Kate J., Shane D. Johnson, and Alex Hirschfield. (2003). "Pushing back the boundaries: New techniques for assessing the impact of burglary schemes." *Home Office Online Report*, 24/03. London, U.K.: Home Office.
- Brantingham, Paul J. and Patricia L. Brantingham. (1984). *Patterns in crime*. New York, NY: MacMillan.
- Buck, Andrew J., Simon Hakim, and George F. Rengert. (1993). "Burglar alarms and the choice behavior of burglars: A suburban phenomenon." *Journal of Criminal Justice*, 21(5): 497-507.
- Budd, Tracey. (1999). "Burglary of domestic dwellings: Findings from the British Crime Survey." *Home Office Statistical Bulletin*, 4/99. London, U.K.: Home Office.
- Bureau of Labor Statistics (BLS). (2004). *Occupational outlook handbook, 2003 Edition*. Washington, D.C.: U.S. Department of Labor, Bureau of Labor Statistics.
- Bureau of Municipal Research, Inc. (1943). *Police problems in Newark*. Newark, NJ: Barton Press.
- Button, Mark. (1998). *Under-researched, under-utilized and underestimated: Private security and its contribution to policing*. Occasional Paper, No. 8. Hampshire, England: University of Portsmouth, Institute of Criminal Justice Studies.
- Central Station Alarm Association. (1994). *An insurance guide to selecting a burglar alarm system*. Bethesda, MD: Central Station Alarm Association.
- Chainey, Spencer and Jerry H. Ratcliffe. (2005). *GIS and crime mapping*. England: John Wiley & Sons.
- Clarke, Ronald V. (1997a). "Deterring obscene phone callers: The New Jersey experience." In: Clarke, Ronald V., (eds.), *Situational crime prevention: Successful case studies* (2nd ed.). Guilderland, NY: Harrow and Heston.
- Clarke, Ronald V. (1997b). "Introduction." In: Clarke, Ronald V., (eds.), *Situational crime prevention: Successful case studies* (2nd ed.). Guilderland, NY: Harrow and Heston.
- Clarke, Ronald V. (1995). "Situational crime prevention: Achievements and challenges." In: Tonry, Michael and David Farrington, (eds.). *Building a safer society: Strategic approaches to crime prevention. Crime and Justice: A Review of Research*, Vol. 19. Chicago, IL: University of Chicago Press.

- Clarke, Ronald V. and John E. Eck. (2005). *Crime analysis for problem solvers in 60 small steps*. Washington, D.C.: U.S. Department of Justice, Office of Community Oriented Policing Services.
- Clarke, Ronald V. and David Weisburd. (1994). "Diffusion of crime control benefits: Observations on the reverse of displacement." In: Clarke, Ronald V., (eds.). *Crime Prevention Studies*, Vol. 2. Monsey, NY: Criminal Justice Press.
- CMAP. (2007). *Crime mapping and analysis using ArcGIS 9.x*. Denver, CO: Office of Justice Programs, National Law Enforcement & Corrections Technology Center.
- Cohen, Jacob. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.
- Cohen, Lawrence E. and Marcus Felson. (1979). "Social change and crime rate trends: A routine activity approach." *American Sociological Review*, 44: 588-608.
- Collins, Pamela A., Truett A. Ricks, and Clifford W. Van Meter. (2000). *Principles of security and crime prevention* (4th ed.). Cincinnati, OH: Anderson Publishing Co.
- Conklin, John E. and Egon Bittner. (1973). "Burglary in a suburb" *Criminology*, 11(2): 206-232.
- Cornish, Derek B. and Ronald V. Clarke. (1986). *The reasoning criminal*. New York: Springer-Verlag.
- Cornish, Derek B. and Ronald V. Clarke. (1987). "Understanding crime displacement: An application of rational choice theory." *Criminology*, 25(4): 933-947.
- Cornish, Derek B. and Ronald V. Clarke. (2003). "Opportunities, precipitators and criminal decisions: A reply to Wortley's critique of situational crime prevention." In: Smith, Martha J. and Derek B. Cornish (eds.), *Theory for practice in situational crime prevention*, Crime prevention studies, Vol. 16. Monsey, NY: Criminal Justice Press.
- Crawford, Adam. (1998). *Crime prevention & community safety: Politics, policies & practices*. London, UK: Longman.
- Cromwell, Paul F. (1999). *In their own words; Criminals on crime*. Los Angeles, CA: Roxbury.
- Cromwell, Paul F., James N. Olson. (2004). *Breaking and entering: Burglars on burglary*. Belmont, CA: Wadsworth/Thomson.

- Cromwell, Paul F., James N. Olson, and D'Aunn W. Avary. (1991). *Breaking and entering: An ethnographic analysis of burglary*. Newbury Park, CA: Sage.
- Cromwell, Paul F., James N. Olson, and D'Aunn Avary. (1990). *Residential burglary: An ethnographic analysis*. Odessa, TX: University of Texas-Permian Basin.
- Cunningham, William C., John J. Strauchs, and Clifford W. Van Meter. (1990). *Private security trends 1970-2000: The Hallcrest Report II*. Stoneham, MA: Butterworth-Heinemann.
- Cunningham, William C. and Todd H. Taylor. (1985). *Private security and police in America: The Hallcrest Report I*. Portland, OR: Chancellor Press.
- de Waard, Jaap. (1999). "The private security industry in international perspective." *European Journal of Criminal Policy & Research*, 7: 143-174.
- Eck, John E. (1998). "Preventing crime at places." In: Sherman, Lawrence W. et al., *What works, what doesn't, what's promising*. Washington, D.C.: U.S. Department of Justice, National Institute of Justice.
- Eck, John. (1993). "The threat of crime displacement." In: McNamara, Robert P., (eds.), *Crime prevention: The other side of prevention*. East Rockaway, NY: Cummings & Hathaway.
- Eck, John E. and Edward R. Maguire. (2000). "Have changes in policing reduced violent crime?: An assessment of the evidence." In: Blumstein, Alfred and Joel Wallman, (eds.), *The crime drop in America*. New York, NY: Cambridge University Press.
- Faul, Franz and Edgar Erdfelder. (1992). *GPOWER: A priori, post-hoc, and compromise power analyses for MS-DOS* [Computer program]. Bonn, FRG: Bonn University, Department of Psychology.
- Felson, Marcus. (2002). *Crime and everyday life* (3rd ed.). Thousand Oaks, CA: Sage.
- Felson, Marcus. (1995). "Those who discourage crime." In: Eck, John E. and David Weisburd, (eds.), *Crime and place, Crime Prevention Studies*, Vol. 4. Monsey, NY: Criminal Justice Press.
- Felson, Marcus and Ronald V. Clarke. (1998). "Opportunity makes the thief: Practical theory for crime prevention." *Police Research Series Paper*, 98. London, UK: Home Office, Policing and Reducing Crime Unit.
- Fischer, Robert J. and Gion Green. (2004). *Introduction to security* (7th ed.). Boston, MA: Elsevier.

- Forst, Brian. (2000). "The privatization and civilianization of policing." *Boundary changes in criminal justice organizations*, Criminal Justice 2000 (Vol. 2). Washington, D.C.: U.S. Department of Justice, National Institute of Justice.
- Gabor, Thomas. (1990). "Crime displacement and situational prevention: Toward the development of some principles." *Canadian Journal of Criminology*, 32(1): 41-73.
- Garland, David. (2001). *The culture of control: Crime and social order in contemporary society*. Chicago, IL: The University of Chicago Press.
- Gest, Ted. (1995). "Street crime: People fight back." *U.S. News & World Report*, 15 April.
- Gill, Martin and Angela Spriggs. (2005). "Assessing the impact of CCTV." *Home Office Research Study*, 292. London, UK: Home Office, Her Majesty's Stationery Office.
- Gill, Martin et al. (2005). "Technical annex: Methods used in assessing the impact of CCTV." *Home Office Online Report*, 17/05. London, UK: Home Office, Research, Development and Statistics Directorate.
- Gillham, James R. (1992). *Preventing residential burglary: Toward more effective community programs*. New York, NY: Springer-Verlag.
- Greer, William. (1991). *A history of alarm security* (2nd ed.). Bethesda, MD: National Burglar & Fire Alarm Association.
- Hakim, Simon and Andrew J. Buck. (1991). *Deterrence of suburban burglaries*. Cheltenham, PA: Metrica, Inc.
- Hakim, Simon and Erwin A. Blackstone. (1997). *Securing home and business: A guide to the electronic security industry*. Boston, MA: Butterworth-Hinemann.
- Hakim, Simon and George F. Rengert. (1981). "Introduction." In: Hakim, Simon and George F. Rengert (eds.). *Crime spillover*. Beverly Hills, CA: Sage.
- Hakim, Simon, George F. Rengert, and Yochana Shachmurover. (2001). "Target search of burglars: A revised economic model." *Papers in Regional Science*, 80:121-137.
- Hakim, Simon, George F. Rengert, and Yochana Shachmurover. (1996). "Estimation of net benefits of residential electronic security." *Justice Quarterly*, 13(1): 153-176.

- Hakim, Simon, George F. Rengert, and Yochana Shachmurover. (1995). "Burglar and fire alarms: Costs and benefits to the locality." *American Journal of Economics and Sociology*, 54(2): 145-161.
- Hakim, Simon and Yochana Shachmurover. (1996a). "Social cost benefit analysis of commercial and residential burglar and alarms." *Journal of Policy Modeling*, 18(1): 49-67.
- Hakim, Simon and Yochanan Shachmurover. (1996b). "Spatial and temporal patterns of commercial burglaries: The evidence examined." *American Journal of Economics and Sociology*, 55(4): 443-456.
- Hamilton-Smith, Niall. (2002). "Anticipated consequences: Developing a strategy for the targeted measurement of displacement and diffusion of benefits." In: Tilley, Nick, (eds.). *Evaluation for crime prevention. Crime prevention studies*, Vol. 14: 11-52. Monsey, NY: Criminal Justice Press.
- Hamilton-Smith, Niall and Andrew Kent. (2005). "The prevention of domestic burglary." In: Tilley, Nick (eds.). *Handbook of crime prevention and community safety*: 417-457. Portland, Oregon: Willan Publishing.
- Harries, Keith. (1999). *Mapping crime: Principle and practice*. Washington, D.C.: Crime Mapping Research Center, National Institute of Justice.
- Hesseling, Rene B. P. (1994). "Displacement: A review of the empirical literature." In: Clarke, Ronald V., (eds.). *Crime prevention studies*, Vol. 3. Monsey, NY: Criminal Justice Press.
- Hess, Karen M. and Henry M. Wrobleksi. (1996). *Introduction to private security* (4th ed.). Minneapolis, MN: West Publishing Company.
- Hope, Tim and Richard Sparks. (2000). "For a sociological theory of situations (or how useful is pragmatic criminology?)" In: von Hirsch, Andrew, David Garland, and Alison Wakefield (eds.). *Ethical and social perspectives on situational crime prevention*. Portland, OR: Hart Publishing.
- Joh, Elizabeth E. (Sep., 2004). *Within the law, without the state, and for a profit: The rise of private policing*. Unpublished doctoral dissertation. New York: New York University.
- Johnson, Shane D., Kate J. Bowers, and Alex Hirschfield. (1997). "New insights into the spatial and temporal distribution of repeat victimization." *British Journal of Criminology*, 37(2): 224-241.
- Johnson, Shame D., Kate J. Bowers, Peter Jordan, Jacqueline Mallender, Norman Davidson, and Alexander F. G. Hirschfield. (2004). "Evaluating crime

- prevention scheme success: Estimating ‘outcomes’ or how many crimes were prevented.” *Evaluation*, 10(3): 327-348.
- Jones, Trevor and Tim Newburn. (1998). *Private security and public policing*. Oxford: Clarendon Press.
- Kakalik, James S. and Sorrel Wildhorn. (1972). *Private police in the United States: Findings and recommendations*, Vol. I. Santa Monica, CA: The Rand Corporation.
- Kakalik, James S. and Sorrel Wildhorn. (1972). *The private security industry: Its nature and extent*, Vol. II. Santa Monica, CA: The Rand Corporation.
- Kakalik, James S. and Sorrel Wildhorn. (1972). *Current regulation of private police: Regulatory agency experience and views*, Vol. III. Santa Monica, CA: The Rand Corporation.
- Kakalik, James S. and Sorrel Wildhorn. (1972). *The law and private police*, Vol. IV. Santa Monica, CA: The Rand Corporation.
- Kaye, Michael S. (1987). “Residential security in the Year 2000.” In: Tyska, Louis A. and Lawrence J. Fennelly (eds.). *Security in the Year 2000 and beyond*. Palm Springs, CA: ETC Publications.
- Kelling, George L. and Catherine M. Coles. (1996). *Fixing broken windows: Restoring order and reducing crime in our communities*. New York, NY: The Free Press.
- Kelling, George L. and William H. Sousa, Jr. (2001). “Do police matter?: An analysis of the impact of New York City’s police reforms.” *Civic Report*, No. 22. New York, NY: The Manhattan Institute, Center for Civic Innovation.
- Kirzner, Israel. (1997). “Entrepreneurial discovery and the competitive market process: An Austrian approach.” *Journal of Economic Literature*, 35(1): 60-85.
- LeBeau, James L. and Karen L. Vincent. (1998). “Mapping it out: Repeat-address burglar alarms and burglaries.” In: Weisburd, David and Tom McEwen (eds.). *Crime mapping and crime prevention*, Vol. 8. Monsey, NY: Criminal Justice Press.
- Lehman Brothers. (2006). *Security annual 2006*. Chardon, OH: Sandra Jones and Company.
- Lipson, Milton. (1988). “Private security: A retrospective.” *The Annals of the American Academy of Political and Social Science*, 498: 11-22.

- Macintyre, Stuart D. (2001). *Burglar decision making*. Unpublished doctoral dissertation: Griffith University.
- Maxfield, Michael G. and Earl Babbie. (2008) *Research methods for criminal justice and criminology* (5th ed.). Belmont, CA: Wadsworth Thomson Learning.
- McCrie, Robert D. (1997). "A brief history of the security industry in the United States." In: Felson, Marcus and Ronald V. Clarke (eds.). *Business and crime prevention*. Monsey, New York: Criminal Justice Press.
- McCrie, Robert D. (1988). "The development of the U.S. security industry." *The Annals of the American Academy of Political and Social Science*, 498: 23-33.
- Mitchell, Andy. (2005). *The ESRI guide to GIS analysis. Volume 2: Spatial measurements & statistics*. Redlands, CA: ESRI Press.
- Mitchell, Andy. (1999). *The ESRI guide to GIS analysis. Volume 1: Geographic patterns & Relationships*. Redlands, CA: ESRI Press.
- Moolman, Val. (1970). *Practical ways to prevent burglary and illegal entry*. New York, NY: Cornerstone Library Publications.
- Morenoff, Jeffrey D. and Robert J. Sampson. (1997). "Violent crime and the spatial dynamics of neighborhood transition: Chicago, 1970-1990." *Social Forces*, 16(1): 31064.
- National Advisory Committee on Criminal Justice Standards and Goals. (1976). *Private security: Report of the task force on private security*. Washington D.C.: U.S. Department of Justice, Law Enforcement Assistance Administration.
- National Research Council. (2004). *Fairness and effectiveness in policing: The evidence*. Washington, D.C.: The National Academies Press.
- O'Shea, Timothy C. (2000). "The efficacy of home security measures." *American Journal of Criminal Justice*, 24(2): 155-167.
- Paulsen, Derek J. and Matthew B. Robinson. (2004). *Spatial aspects of crime: Theory and practice*. Boston, MA: Allyn and Bacon.
- Ratcliffe, Jerry H. (2005). "Detecting spatial movement of intra-region crime patterns over time." *Journal of Quantitative Criminology*, 21(1): 103-123.
- Ratcliffe, Jerry H. (2004). "The hotspot matrix: A framework for the spatio-temporal targeting of crime reduction." *Police Practice and Research*, 5(1): 5-23.
- Ratcliffe, Jerry H. (2002a). "Aoristic signatures and the temporal analysis of high volume crime patterns." *Journal of Quantitative Criminology*, 18(1): 23-43.

- Ratcliffe, Jerry H. (2002b). "Burglary reduction and the myth of displacement." *Trends & Issues in Crime and Criminal Justice*, No. 232. Canberra, Australia: Australian Institute of Criminology.
- Ratcliffe, Jerry H. (2001a). "On the accuracy of TIGER-type geocoded address data in relation to cadastral and census areal units." *International Journal of Geographical Information Science*, 15(5): 473-485.
- Ratcliffe, Jerry H. (2001b). "Policing urban burglary." *Trends & Issues in Crime and Criminal Justice*, No. 213. Canberra, Australia: Australian Institute of Criminology.
- Ratcliffe, Jerry H. (2000). "Aoristic analysis: The spatial interpretation of unspecific temporal events." *International Journal of Geographical Information Science*, 14(7): 669-679.
- Ratcliffe, Jerry H. and Michael J. McCullagh. (1999). "Hotbeds of crime and the search for spatial accuracy." *Geographical Systems*, 1(4): 385-398.
- Ratcliffe, Jerry H. and Michael J. McCullagh. (1998). "Aoristic crime analysis." *International Journal of Geographical Information Science*, 12(1): 751-764.
- Rengert, George and Simon Hakim. (1998). "Burglary in affluent communities: A planning perspective." In: Felson, Marcus and Richard B. Peiser (eds.). *Reducing crime through real estate development and management*. Washington, DC: Urban Land Institute.
- Rengert, George F. and John Wasilchick. (2000). *Suburban burglary: A tale of two suburbs* (2nd ed.). Springfield, IL: Charles C Thomas.
- Rengert, George F. and John Wasilchick. (1985). *Suburban burglary: A time and a place for everything*. Springfield, IL: Charles C Thomas.
- Repetto, Thomas A. (1974). *Residential crime*. Cambridge, MA: Ballinger Publishing Company.
- Repetto, Thomas A. (1976). "Crime prevention and the displacement phenomenon." *Crime & Delinquency*, 22: 166-177.
- Rubenstein, Herb, Charles Murray, Tetsuro Motoyama, W. V. Rouse, and Richard M. Titus. (1980). *The link between crime and the built environment: The current state of knowledge*, Vol. 1. Washington, D.C.: U.S. Department of Justice, National Institute of Justice.
- Security Sales & Integration. (2004). *The 2004 security sales & integration annual installation business report*. Torrance, CA: Research Department of Bobit

- Business Media. Available on line at:
http://www.securitysales.com/t_stats_factbook.cfm
- Shadish, Williams R., Thomas D. Cook, and Donald T. Campbell. (2002). *Experimental and quasi-experimental designs for generalized causal inference*. Boston, MA: Houghton Mifflin.
- Shearing, Clifford D. and Philip C. Stenning. (1987). "Reframing policing." In: Shearing, Clifford D. and Philip C. Stenning (eds.). *Private policing*. Beverly Hills, CA: Sage.
- Shover, Neal. (1991). "Burglary." In: Tonry, Michael, (eds.). *Crime and Justice: A Review of Research*, Vol. 14: 73-113. Chicago, IL: The University of Chicago.
- Sklansky, David A. (1999). "The private police." *UCLA Law Review*, 46(4): 1165-1287.
- Smith, Martha J., Ronald V. Clarke, and ken Pease. (2002). "Anticipatory benefits in crime prevention." In: Tilley, Nick (eds.). *Analysis for crime prevention*, Vol. 13. Monsey, NY: Criminal Justice Press.
- Sorensen, David W. M. (2005). *The absence of evidence concerning the effects of situational crime prevention on burglary – and Scandinavian prospects for improvement*. Stockholm, Sweden: Scandinavian Research Council for Criminology.
- Sorensen, David W. M. (2004). *Temporal patterns of Danish residential burglary: By month, day of week, and hour of day*. Copenhagen, Denmark: Denmark's Ministry of Justice.
- Sorensen, David W. M. (2004). *Repeat burglary in the private Danish home: Extent, time course, and implications for prevention*. Copenhagen, Denmark: Denmark's Ministry of Justice.
- Sorensen, David W. M. (2003). *The nature and prevention of residential burglary: A review of the international literature with an eye toward prevention in Denmark*. Copenhagen, Denmark: Denmark's Ministry of Justice.
- Sousa, William H. (2003). *Crime reduction in New York City: The impact of the NYPD*. Unpublished doctoral dissertation. Newark, NJ: Rutgers University.
- Spradley, James P. (1979). *The ethnographic interview*. Belmont, CA: Wadsworth Thomson Learning.
- SPSS Inc. (2004). *SPSS 13.0 base user's guide*. Chicago, IL: SPSS Inc.

- Velasco, Mary and Rachel Boba. (2000). *Manual of crime analysis map production*. Washington, D.C.: U.S. Department of Justice, Community of Oriented Policing Services.
- Walsh, Dermot. (1980). *Break-ins: Burglary from private houses*. London, U.K.: Constable.
- Weisburd, David. (1997). *Reorienting crime prevention research and policy: From the causes of criminality to the context of crime*. Washington D.C.: U.S. Department of Justice, National Institute of Justice.
- Weisburd, David. (1993). "Design sensitivity in criminal justice experiments." In: Tonry, Michael, (eds.). *Crime and Justice: A Review of Research*, Vol. 17: 337-379. Chicago, IL: The University of Chicago.
- Weisburd, David and Chester Britt. (2003). *Statistics in criminal justice* (2nd ed.). Belmont, CA: Wadsworth/Thomson.
- Weisburd, David, Laura A. Wyckoff, Justice Ready, John E. Eck, Joshua C. Hinkle, and Frank Gajewski. (2006). "Does crime just move around the corner? A controlled study of spatial displacement and diffusion of crime control benefits." *Criminology*, 44(3): 549-591.
- Weisel, Deborah L. (2002). "Burglary of single-family houses." *Problem-Oriented guides for Police Series*, No. 18. Washington, D.C.: U.S. Department of Justice, Office of Community Oriented Policing Services.
- Widom, Cathy S. (1989). "Child abuse, neglect, and adult behavior: Research design and findings on criminality, violence, and child abuse." *American Journal of Orthopsychiatry*, 59(3): 355-367.
- Wilson, James Q. and George L. Kelling. (1982). "Broken windows: The police and neighborhood safety." *The Atlantic Monthly* (March): 29-38.
- Wright, Richard T. and Scott H. Decker. (1994). *Burglars on the job: Street life and residential break-ins*. Boston, MA: Northeastern University Press.
- Wortley, Richard. (2001). "A classification of techniques for controlling situational precipitators of crime." *Security Journal*, 14(4): 63-82.

VITA

Seungmug (a.k.a. Zech) Lee

- 1968 Born 24 of August (lunar calendar) in Hae-nam, South Korea.
- 1975-1980 Attended San-dong Elementary School, Hae-nam, South Korea.
- 1981-1983 Attended Doo-Ryun Middle School, Hae-nam, South Korea.
- 1984-1986 Attended Salesian High School, Kwang-joo, South Korea.
- 1987 Attended Cho-sun University, Kwang-joo, South Korea; majored in public administration.
- 1988-1991 Attended Dong-guk University, Seoul, South Korea; majored in police administration.
- 1991 B.A. in Police Administration.
- 1992 Began Graduate Studies in Criminal Justice, Dong-guk University, Seoul, South Korea.
- 1993-1995 A sergeant, Korean Army.
- 1997 M.A. in Criminology.
- 1999-2001 Graduate Studies in Protection Management, John Jay College of Criminal Justice, New York, New York.
- 2001 M.S. in Protection Management.
- 2001 Began Doctoral Studies at the Graduate School – Newark, Rutgers University, School of Criminal Justice.
- 2002 M.A. in Criminal Justice
- 2003-2007 Part-time Lecturer in Criminal Justice, Rutgers University, Newark, New Jersey.
- 2005 AIREF Dissertation Fellowship Award, Alarm Industry Research & Educational Foundation (AIREF), Washington, D.C.
- 2007 Assistant Professor in the Department of Criminal Justice, Kean University, Union, New Jersey.
- 2008 Ph. D. in Criminal Justice.