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A STUDY ON THE EFFECT OF U-CITY SECURITY SERVICE ON CRIME RATES

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Abstract. National economy of South Korea has grown rapidly after 1960s, which led to urbanization rate soared from 39.1% in 1960 to 91.5% in 2013. However, unlike the rapid quantitative growth, a slow trend of qualitative growth of the city has caused a number of urban problems, especially in crime. A number of recent studies have been focused on the influence factors of the crime rates, the spatial effect of crime, as well as cities operating Ubiquitous Security service for the purpose of crime prevention. In this background, this study aims to address the effect of Ubiquitous city (U-city) on crime rates within the metropolitan area of Seoul. First, it analyzes geographical distribution of crime rates. Then it identifies the existence of spatial autocorrelation of crime rates within the metropolitan area of Seoul. Finally, it determines whether the execution of U-Security service affects crime rates as well as urban characteristics that influence crime rates by applying spatial regression models, which can control the spatial effects and the other effects of other urban characteristics on crime rates. The result of this analysis reflects U-City security service does not have statistically significant effect on crime rates. In future research, this study can be used to support that U-City security service needs to be applied to regions with high crime rates and to address the needs of the additional studies to compare crime rates before and after the application of U-City security service.

INTRODUCTION

SOUTH KOREA has experienced a rapid process of industrialization and urbanization since the 1960s. Accordingly, a lot of cities of South Korea including Seoul, the capital, have accomplished a fast quantitative growth. The concentration of population in urban areas has been intensified. Urbanization rate of South Korea, a proportion of urban population to total population, increased from 39.1% in 1960 to 90.1% in 2005 to 91.7% in 2014[27] along with economic growth. However, qualitative growth of cities in South Korea has lagged behind the quantitative growth, which caused various urban problems. Among them, crimes are one of the most serious urban problems since the risk of crime is increasing continually. The total number of crime in Korea increased from 1,147,752 cases in 1990 to 1,933,835 cases in 2014, recording 3,768.0 crime incidence per 10 million population [31]. Among crime cases, violent crime cases including robbery, rape, sexual abuse and indecent assault increased by 10.0% over the past five years [23].

Studies on either influence or preventable factors of the crime traditionally focused on judicial and social factors, and personal characteristics of victims or offenders [9][22][32]. Crime that takes place at a specific location, however, is closely associated with spatial characteristics such as location and urban characteristics, but only few studies in South Korea [17][22] [24][33] have examined the extent to which the number of crime cases attributes to urban characteristics [13].

Since the late 1970s, the Chicago School began to understand the crime with spatial dimensions. These studies analyzed the effect of the interaction between people and urban spatial structure on crime with an emphasis on physical and social characteristics of the place of crime on the assumption that crime implies spatial and geographical characteristics [2][3] [11]. They proved that crime has a close relationship with the urban environment [28].

In addition, the number of cities that introduce U-city security service, install intelligent CCTVs for security, and operate an

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integrated control center and crime prevention system is increasing [4][15].

In this context, this study examines the spatial distribution of crime rates and explores the effect of U-city security service on crime rates controlling urban characteristics including demographic variables, socioeconomic variables, physical variables, defense mechanism variables, and U-City security service variable.

THEORETICAL BACKGROUND

Theoretical Background for the Crime Factors

Previous studies on crime factors are traditionally based on personal characteristics that are inherent in human nature. They explored biological and psychological characteristics of offenders. It is in recent years that crime is caused by social structural factors or urban characteristics when major theories such as social disorganization theory, routine activity theory, and environmental criminology emerged [20].

Social disorganization theory was born in the United States by the Chicago School in the 1920s. In the context of the theory, Shaw and Mckay[30], a representative explanatory model of this theory, argued that crime rates are influenced by not only individual properties, but also spatial and social characteristics of the city by identifying that crime rates in the low-income residential area of city center is higher than that in the high-income residential area. After studies of Shaw and Mckay became a foundation, studies on the social and spatial factors that affect crime incidence executed actively [28].

The studies on the effects of urban characteristics on crime factors in South Korea have begun to be discussed in late 2000s. Most of them analyzed the causal relationship between crime incidence and crime factors by integrating environmental criminology or geography informatics with spatial econometrics analysis [10]. Studies carried out in this context generally considered demographic factors, socioeconomic factors, and physical characteristics of each region as the factors that affect crime rates.

Considering these studies, this study controls the effect of urban characteristics when analyzing the effect of U-City security service on crime rates.

Literature Review on Urban Characteristics as crime factors

Literature review covers previous studies that contain spatial range of South Korea since they take account of ethnic, social, and spatial structure that are indigenous to Korea.

Previous studies of the association between the effects of urban characteristics and crime factors in South Korea focus largely on two tasks. The first is to find out hot spot or cold spot areas where crime rates are intensively high or significantly low. The other is to analyze variables that influence crime incidence and the effect of those variables on crime incidence or prevention [13].

Hot spot analysis, introduced by Brantingham and Brantingham (1982)[18], was utilized in a lot of criminology studies through various research methods including studying the distribution and pattern of crime incidence using spatial econometrics or GIS. However, the result of hot spot analysis highly depends on research purpose or analysis method, which limits the reliability of the study [13][28]. In addition, the existing studies are lack of additional research to explain why a hot spot area is affected by crime factors since they deal with only spatial dependence. Thus, many studies adopted hot spot analysis together with multiple regression model.

Below is more close review to previous studies that estimated various multiple regression models using same spatial range of Seoul.

Yang (2010)[33] examined the effect of crime factors on crime rates using spatial regression model, SAR (Spatial Auto Regression model) and SEM (Spatial Error Model). The setting for the study was 31 police jurisdictions of Seoul, Korea. He set 13 explanatory variables categorized as demographic, socioeconomic, and urban characteristic factors, and chose the violent crime rates as the dependent variable. The study analyzed that the demographic factors, which includes such variables as population density, flow population, and the ratio of youths are highly associated with violent crime rates. Also, it revealed that recipients of basic livelihood ratio as socioeconomic variable and the ratio of park area as a factor of urban characteristics showed high association with violent crime rates.

TABLE 1
SUMMARY OF PREVIOUS STUDIES

Researchers	Model	Type of Variables	Name of Variables
Lee (2015)[9]	Pooled OLS, Fixed-Effects model, Random Effect model	Dependent variables	Violent crime cases
		Explanatory variables	The number of CCTVs, the number of children, the number of elderlies, divorce cases, the number of cars, the number of apartments, commercial area ratio, industrial area ratio, green area ratio
Oh	Spatial Regression	Dependent	Violent crime cases per 1000 population

(2011)[14]	model	variables	
		Explanatory variables	Population density, flow population, the amount of property tax, the number of entertainment establishments, the number of parking lots, park density, industrial area ratio, commercial area ratio
Yang (2010)[8]	Spatial Regression model	Dependent variables	Violent crime cases per 10,000 population
		Explanatory variables	Flow population, college graduate ratio, police men per population, the recipient of national basic livelihood ratio, park area ratio
Lee (2010)[26]	Regression model	Dependent variables	Violent crime cases
		Explanatory variables	Population density, the number of the elderly, the number of foreigners, the amount of property taxes, the number of entertainment establishments
Jung (2010)[10]	Correlation, Regression model, Spatial Regression model	Dependent variables	Violent crime cases per 1000 population
		Explanatory variables	Population per household, the recipient of national basic livelihood ratio, residential area ratio, the number of wholesale and retails, the number of accommodations and restaurants, the number of police men
Jung (2008)[18]	Spatial Regression model	Dependent variables	Violent crime cases per 100 population
		Explanatory variables	Youth ratio, population density, rate of population growth, the recipient of national basic livelihood ratio, the level of mixed land use, the ratio of apartments, the ratio of old housing, the number of entertainment establishments, park area ratio

Oh(2011)[28] sought to reveal the impact of urban characteristics categorized by demographic, socioeconomic, and physical characteristics on the violent crime rates in Seoul by using spatial regression models. In each of 31 police jurisdictions, the study determined the effect of these characteristics on five types of violent crime per 1,000 people in Seoul. Among demographic variables, flow population affected all types of violent crime, while population density influenced only robbery, theft, and violence. In addition, the amount of property taxes and the recipients of national basic living ratio as socioeconomic characteristics and the number of entertainment establishments as a physical characteristics showed a significant impact on the violent crime rates. Nevertheless, the study has not looked at the pattern of urban pattern.

Jung (2008)[16] studied that urban characteristics are of great importance in preventing crime by utilizing spatial regression models (SEM and SAR). It revealed that the ratio of youths, population growth rate, and population density among demographic variables have positive(+), positive(+), and negative(-) relationship with crime rates, respectively. Also, the recipients of national basic livelihood ratio and the average of property taxes as socioeconomic variables are associated with crime rates. Building density, the ratio of old houses, the ratio of buildings for accommodations, the number of entertainment establishments, the level of mixed land use, apartment area ratio, and park area have the effect on crime rates as physical variables.

Besides these studies, [Table 1] shows the summarization of recent studies on crime factors in South Korea. Most studies used multiple regression models and spatial regression models to analyze the effect of factors on crime rates and the dependent variable in most studies was five major types of crime rates. These studies divided explanatory variables mainly into four categories: demographic, socioeconomic, physical, and defense mechanism variables. However, the results of each study regarding the effects of the independent variables on dependent variables were not identical, rather varying with the paper. Therefore, this study will select explanatory variables that are proved to affect crime rates in more than three of previous studies.

Literature Review on the Effect of U-City Security Service on Crime Rates

Only few studies attempted to investigate the association between U-City security service and crime rates, although the Ubiquitous City Comprehensive Plan takes it as a major initiative. Jeong and Park (2005)[30] reviewed the research literature on U-City and discussed the way to promote U-City security service for crime prevention in urban areas in the future. However, their study is not an empirical research but more likely to say a mere theoretical consideration. On the other hand, Choi and Hwang (2014)[4] analyzed the effect of U-City security service on the satisfaction of citizens. There is a high need for researches that study the

effect of U-City security service on crime rates since the service has begun its operation.

RESEARCH MODEL AND ANALYSIS METHOD

Research Scope and the Unit of Analysis

The temporal scope of this study is set to 2012 which is the most recent time to obtain data. The spatial range is set to the Seoul metropolitan area, where 48.1% of total crime cases occur and a half of population lives in South Korea in 2014. There is a need for studies on crime factors within the Seoul metropolitan area because six areas of top 10 areas that records the highest violent crime outbreak per population in 2012 in the country is located in the Seoul metropolitan area. Also, most areas applying U-City security service area within Seoul metropolitan area. Therefore, this study is to examine the impact of U-City security service in the Seoul metropolitan area.

In order to analyze, this study divides the Seoul metropolitan area into 62 regions depending on the police jurisdiction and the administrative division (sigungu) and use it as the unit of analysis.

TABLE 2
UNIT OF ANALYSIS

Area		Regions
Seoul Metro-politan Area (62)	Seoul (24)	Jongno-gu, Jung-gu, Yongsan-gu, Seongdong-gu, Gwangjin-gu, Dongdaemun-gu, Jungnang-gu, Seongbuk-gu, Gangbuk-gu, Dobong-gu, Nowon-gu, Eunpyeong-gu, Seodaemun-gu, Mapo-gu, Yangcheon-gu, Gangseo-gu, Guro-gu, Geumcheon-gu and Gwanak-gu, Yeongduengpo-gu, Dongjak-gu, Seocho-gu, Gangnam-gu, Songpa-gu, Gangdong-gu
	Incheon (8)	Jung-gu&Dong-gu&Ongjin-gun, Nam-gu, Yeonsu-gu, Namdong-gu, Bupyeong-gu, Gyeyang-gu, Seo-gu, Ganghwa-gun
	Gyeonggi-do (30)	Suwon-si, Seongnam-si, Anyang-si, Bucheon-si, Gwangmyeong-si, Pyeongtaek-si, Ansan-si, Gwacheon-si, Osan-si&Hwaseong-si, Siheung-si, Gunpo-si, Uiwang-si, Hanam-si, Yongin-si, Icheon-si, Anseong-si, Gimpo-si, Gwangju-si, Yeoju-gun, Yangpyeong-gun, Uijeongbu-si, Dongducheon-si, Goyang-si, Guri-si, Namyangju-si, Paju-si, Yangju-si, Pocheon-si, Yeoncheon-gun, Gapyeong-gun

Definition of U-City Security Service

Before examining the effect of U-City security service on crime rates, U-City security service should be defined. South Korea is currently executing 'the secondary Ubiquitous City (U-City) Comprehensive Plan (2014~2018)' under the leadership of the Ministry of Land, Infrastructure, and Transport (MOLIT). One of the major initiatives of this plan is U-City security service. U-City security service induces to build U-City integrated operation center that unify existing CCTV control, transportation, and facility management centers in order to avoid redundant investment and to enhance the efficiency of urban management and social security. Many regions are now operating integrated CCTV control centers that unify various systems, yet not all these regions are included in Ubiquitous City Comprehensive Plan. Therefore, the regions with U-City Security in this study mean all localities where run either U-City operation center or integrated CCTV control center.

Research Model and Analysis Method

This study will adopt the spatial regression model in order to examine the relationships between crime rates and multiple explanatory variables by controlling spatial effects. Taking into account that previous studies consider the spatial dependence of crime rates and use spatial regression models as a research method, this study first examines whether spatial autocorrelation of crime rates exists. If the spatial autocorrelation exists, this study will use spatial regression model. If not, multiple linear regression model will be adopted as a research method.

Variables are chosen based on previous studies on the factors that influence crime rates, in addition to the variable to figure out the effect of the U-City security service on crime rates.

Dependent Variable

The dependent variable for this study is the number of five types of violent crime (robbery, rape, sexual abuse and indecent assault)

cases per 100,000 population, utilizing data of Korean National Policy Agency on violent crime cases in 2012. To control the local population size, the violent crime cases are divided by resident registration population in 2012.

Explanatory Variables

Explanatory variables are categorized into five groups: demographic variables, socioeconomic variables, physical variables, defense mechanism variables, and U-City security service variable [13][16][19][28][33].

Demographic Variables

Crime is a phenomenon caused by human interaction. Thus, demographic variables have been included as major factors that influence the crime rates in previous studies on crime factors. Primarily selected demographic variables based on the previous studies are resident registration population, population density, infant population rate, aged population rate, and per household population. To identify the best subset among these, the variables showing high correlation with the others are removed. As a result of this process, population density and per household population are used as explanatory variables in the analysis.

Regarding research on the effect of population density on crime rates, previous studies have shown conflicting results as to whether high population density brings a positive or negative impact on crime rates. While one argues that high population density has a negative (-) impact on crime rates because of increasing resident registration population, other studies indicate that high population density has a positive (+) impact on crime rates, which he explained that an increase in the stress level of the residents caused by social contact or the high possibility of social involvement can be the potential factor affecting offenders to commit a crime [16][28][33]. This study attempts to identify whether population density has positive or negative impact on crime rates. Population density is calculated by dividing the resident registration population by local area. Data for resident registration population is recorded by Korean Statistical Information Service (KOSIS) and data for local area is by Statistics of Land Registration.

Previous studies have used per household population under the assumption that the higher per household population acts as social defense for a crime, which in other words, per household population has negative (-) impact on crime rates [13][16]. In this study, per household population is calculated by dividing resident registration population by the number of households and data is from KOSIS.

Socioeconomic Variables

Social disorganization theory suggests that socio-economic level of each region affects the social control and thus, low socio-economic level increases crime rates [16][28]. Recipients of national basic livelihood ratio and the amount of property tax per population are chosen as socio-economic explanatory variables.

In general, the higher the recipients of national basic livelihood ratio, the lower the income level of a region. The region with lower economic level has higher level of crime rates since the social control is relatively weak, which makes almost impossible to suppress criminal motives [16][28]. Recipients of national basic livelihood ratio is calculated by dividing the number of recipients of national basic livelihood by resident registration population of each region and data is from enrollment of recipients of basic livelihood and people with disabilities of Statistics Korea.

As for the amount of property tax, previous studies are unclear about whether the amount of property tax brings a positive or negative impact on crime rates. One indicates that property tax has a positive (+) effect on crime rates because it is more likely to be the target of crime, whereas the other argues that the amount of property tax has a negative (-) effect on crime rates since households with higher property have a better defense mechanism such as security equipment and security guards. This study attempts to identify whether the amount of property tax per population has positive or negative impact on crime rates [16][33]. Data is from a property tax burden of local tax statistics of each region and it is calculated by dividing property tax burden by resident registration population of each region.

Physical Variables

Residential area ratio, commercial area ratio, industrial area ratio, park area ratio, and the number of entertainment establishments are chosen as physical variables. Among them, residential area ratio, commercial area ratio and the number of entertainment establishments are chosen regarding the correlation with other variables.

Variables regarding residential area are various as the number of apartments, residential area ratio and apartment ratio in previous studies. According to previous studies, residential area is less likely to vulnerable to violent crime incidence since there is less flow population in residential areas [4][5][16][33]. Residential area ratio refers to the proportion of residential area to the total area in each region and the data used is from statistics of land registration.

Regions with high commercial area ratio are more likely to be exposed to crime, especially larceny and violence [13][16][33]. Commercial area ratio is calculated by dividing commercial area by the total area of each region using data from statistics of land registration.

The entertainment establishments refer to type of businesses that is designated as entertainment establishments by the act on the regulation of entertainment establishments. A large number of

liquor stores and bars increase neighborhood crime rates and alcohol consumption causes a criminal offense [1][8]. A lot of empirical studies have been revealed that the number of the entertainment establishments has a positive (+) effect on crime rates [12][15][21]. In this study, the number of the entertainment establishments is the sum of the number of karaoke bars and general bars that create harmful environment of the city using data from annual statistics report of Seoul, Incheon, and Gyeonggi-do.

Defense Mechanism Variables

Previous studies have included defense mechanism variables as explanatory variables to examine their impact on crime rates according to routine activity approach. Routine activity approach, one of traditional criminal opportunity theory, says that interaction of the presence of potential offenders, subject compliance and the absence of ability to protect [6][34]. The number of police stations and CCTVs in each region is selected as defense mechanism variables in this study.

The more the number of police is, the stronger the police force. Few preceding studies indicate strengthened police force that represents the level of defense mechanism has negative (-) impact on crime rates [13][22[25][33]. On the other hand, other studies argue that the concentration of criminal acts increases police force [7]. Data of the number of police stations is from annual statistics report of each region and Korean National Police Agency.

The number of CCTVs includes only CCTVs for crime prevention installed by local police agencies using data from Korean National Police Agency. Previous studies have investigated the effect of the number of CCTVs on crime rates individually notwithstanding other factors [24], but much is still unclear. With regard to the effects of CCTVs, studies revealed mixed findings; whereas some studies found that CCTVs have a negative (-) impact on crime incidence, others suggested that installation of CCTVs is not an effective solution to reduce crime rates [24][26][29][35]. Therefore, this study will examine the effect of the number of CCTVs on crime rates by controlling other factors.

U-City Security Service Variable

Although U-City security service has been applied to many cities along with Ubiquitous City Comprehensive Plan, empirical studies that investigated the effect of U-City security service on crime rates is woefully deficient [14]. Therefore, this study would like to analyze the effect of U-City Security Service on crime rates empirically in 2012, when the plan had been implemented for four years. U-City security service variable is a dummy variable: regions operating integrated control center have a value of 1 and others have a value of 0.

TABLE 3
VARIABLES OF ANALYSIS

	Name of Variables	
Dependent Variable	**Violent crime cases per 100,000 population**	
Explanatory Variables	Demographic Variables	Population density
		Per household population
	Socioeconomic Variables	Recipients of national basic livelihood ratio
		The amount of property tax per population
	Physical Variables	Residential area ratio
		Commercial area ratio
		The number of entertainment establishments
	Defense Mechanism Variables	The number of police stations
		The number of CCTVs for crime prevention
	U-City Security Service Variable	

Descriptive statistics of these variables is shown in [Table 4] below.

TABLE 4
DESCRIPTIVE STATISTICS

Variables		Unit	Obs.	Mean	Std. Dev.	Min.	Max.
Violent crime cases per 100,000 population		Cases/person	62	52.78	21.13	27.00	154.40
Demographic variables	Population density	1000 people/㎢	62	9.47	8.22	0.07	28.50
	Per household population	Person/household	62	2.53	0.29	1.89	3.75
Socioeconomic variables	Recipients of national basic livelihood ratio	Person/person	62	2.06	0.95	0.61	5.84
	The amount of property tax per population	Million won	62	200.69	120.82	73.51	697.23
Physical variables	Residential area ratio	%	62	30.82	28.58	0.47	95.14
	Commercial area ratio	%	62	3.24	5.54	0.02	36.35
	The number of entertainment establishments	Count	62	235.32	172.23	9.00	724.00
Defense Mechanism variables	The number of police stations	Count	62	14.45	6.92	3.00	35.00
	The number of CCTVs for crime prevention	Count	62	456.28	360.04	63.91	1,902.82
U-City Security Service		Dummy	62	0.50	0.50	0.00	1.00

ANALYSIS RESULTS

Exploratory Spatial Data Analysis

Before analyzing the effect of U-City security service on crime rates, this study conducts exploratory spatial data analysis (ESDA) in order to identify the spatial pattern of crime rates in Seoul metropolitan area and to confirm the existence of spatial effects. First, it looks at the distribution of violent crime incidence and then identifies the existence of spatial dependence through Moran's I.

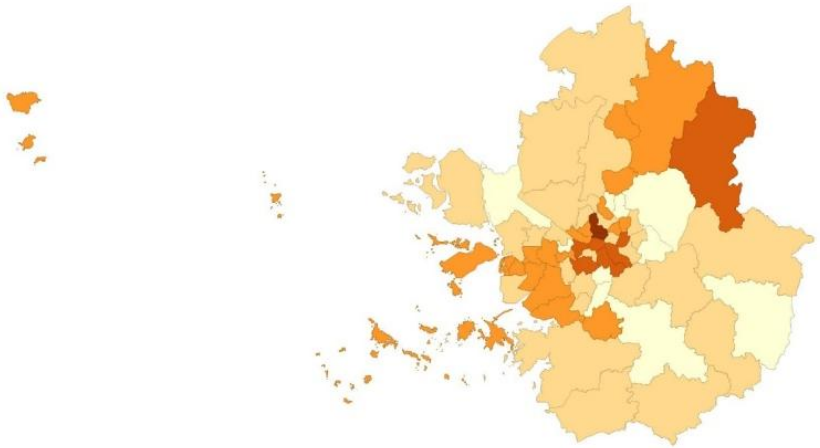

Figure 1. The Spatial Distribution of Violent Crime Rates

[Figure 1] shows the spatial pattern of violent crime rates in Seoul metropolitan area subdivided into 62 regions using the classification criteria used of Natural Break. As shown in [Figure 1], the darkest brown colored areas indicate the highest the violent crime. The top three regions with the highest violent crime rates are Jung-gu, Jongno-gu, and Yongsan-gu. As examining the distribution of violent crime rates through the map, it is able to find that spatial distribution of high violent crime rates occurs in neighborhoods located on the center of Seoul.

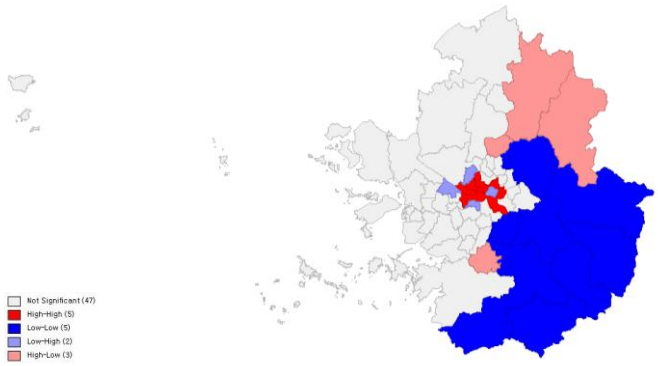

Figure 1. Lisa Cluster Map of Crime Rates

[Figure 2] presents the LISA (Local Indicators of Spatial Association) Cluster Map of crime rates using the spatial weight matrix of Queen Contiguity (order of contiguity=2). Regions with dark red color refer to HH (High-High) regions where both the region and surrounding regions recorded high crime rates, while regions colored with dark blue color refer to LL (Low-Low) regions where both the region and surrounding regions recorded low crime rates. The HH and LL regions denote the regions with positive spatial autocorrelation. On the other hand, HL (High-Low) and LH (Low-High) regions are where the distribution of crime rates of the region and the surrounding regions is different and these regions denote negative spatial autocorrelation. It is apparent that HH regions are clustered in the center of Seoul, while LL regions are clustered at the southeastern side of Gyeonggi-do. It seems that LL regions are distributed widely but the number of HH regions and that of LL regions are the same.

Next, this study reviewed the spatial dependence of crime rates of 62 regions in Seoul metropolitan area using Moran's I index. Moran's I index, when applying spatial weight matrix of Queen Contiguity (order of contiguity=1), is 0.236 and the result is statistically significant, which means there is positive spatial autocorrelation in violent crime cases per 100,000 populations. In addition, it is identified that there is also positive spatial autocorrelation using spatial weight matrices of Rook Contiguity (order of contiguity=1), 4-nearest, and 6-nearest. As a result, there exists positive spatial autocorrelation using all spatial weight matrices, although there is a slight difference between Moran's I index depending on the spatial weight matrices.

TABLE 5
RESULT OF ESTIMATING MORAN'S I INDEX

	I	E(I)	sd(I)	z	p-value
Queen contiguity	0.236	-0.016	0.071	3.553	0.004
Rook contiguity	0.251	-0.016	0.075	3.601	0.002
4nearest	0.226	-0.016	0.071	3.421	0.005
6nearest	0.182	-0.016	0.057	3.475	0.002

The Effect of U-City Security Service on Crime Rates

Since it is proved that there is spatial autocorrelation in crime rates within Seoul metropolitan area, this study analyzes the effect of U-City security service on crime rates by estimating a spatial regression model. First of all, LM (Lagrange Multiplier) tests are conducted by applying four types of spatial weight matrices. The results show that SLM (Spatial Lag Model) is the most appropriate model to analyze the effect of U-City security service on crime rates.

TABLE 6
RESULT OF LAGRANGE MULTIPLIER TESTS

	Queen contiguity	**Rook contiguity**	**4-nearest**	**6-nearest**
LM (lag)	4.1544 (0.04153)	4.5344 (0.03322)	1.7256 (0.18897)	4.4600 (0.03470)
Robust LM (lag)	7.1952 (0.00731)	7.5164 (0.00611)	4.2128 (0.04012)	7.2340 (0.00715)
LM (error)	0.0164 (0.89819)	0.0657 (0.79767)	0.2135 (0.64402)	0.0156 (0.90049)
Robust LM (error)	3.0572 (0.08038)	3.0476 (0.08085)	2.7006 (0.10031)	2.7897 (0.09487)

The results of analysis on the effect of U-City security service on crime rates using spatial regression models are as following [Table 7].

TABLE 7
RESULT OF SPATIAL REGRESSION ANALYSIS

Variables		**Coef.**	**Std. Err.**	**t-stat**	**Prob**
Weighted (violent crime cases per 100,000 population)		0.272513	0.123245	2.211153	**
Demographic variables	Population density	1.044823	0.264628	3.948271	***
	Per household population	-21.2152	5.580164	-3.8019	***
Socioeconomic variables	Recipients of national basic livelihood ratio	0.065836	0.016114	4.08563	***
	The amount of property tax per population	3.61444	1.764742	2.048141	**
Physical variables	Residential area ratio	-0.17804	0.08451	-2.10676	**
	Commercial area ratio	1.405637	0.395402	3.554957	***
	The number of entertainment establishments	0.045811	0.010557	4.33946	***
Defense Mechanism variables	The number of police stations	-0.2473	0.279316	-0.88537	
	The number of CCTVs for crime prevention	-0.00904	0.004567	-1.97988	**
U-City Security Service		1.72545	3.221578	0.535592	
constant		58.4471	17.2587	3.386529	***

***p<0.01, **p<0.05, *p<0.1

The adjusted R-squared of the model is 75.5% and the result of Breusch-Pagan test indicates the model does not suffer any problem of heteroscedasticity. In addition, likelihood ratio test verifies that there exists spatial dependence. The result of the SLM shows that all variables have an impact on crime rates at a statistically significant level except for the number of the police station and the U-City security service variable.

According to the result of the analysis, the application of U-City security service is not statistically significant, which, in other words, does not have an impact on crime rates, while it is expected that regions with U-City security service are likely to have lower crime rates. This seems to be because the installation of U-City security service is decided by the budget or policy purposes, rather than the level of crime rates. Otherwise, it had been only 3 years after the enforcement of the primary Ubiquitous City Comprehensive Plan so the real impact of the U-City security service is not reflected on the analysis. Additional research is needed to study at more recent time and to compare crime rates before and after the application of the U-City security service.

Population density, one of demographic variables, was found to have a positive (+) impact on crime rates. Thus, this result suggests that this study supports the argument of some studies that found a high level of population density increases stress level from social interaction, which results in an increase in crime incidence. In accordance with previous researches, per household population negatively (-) affects crime rates since more people in each household are able to prevent crime effectively.

Both the recipient of national basic livelihood ratio and the amount of property tax per population that are categorized as

socioeconomic variables are found to have positive (+) effects on crime rates. There have been arguments regarding the effect of the amount of property tax on crime rates and this study confirms that regions with high level of property tax easily become targets of violent crimes. Like the results of previous studies, this study also revealed that regions with higher ratio of the recipient of national basic livelihood present low level of economic status and eventually likely to have more violent crime incidence.

The result of residential area ratios suggests that it has a negative (-) impact on crime rates, which proves the argument of previous studies that residential area is less vulnerable to violent crime incidence. On the other hand, commercial area ratio and the number of entertainment establishments are found to have positive (+) effects on crime rates, which is the same result as previous studies. Regions with commercial area appeared to be prone to violent crime incidence. Also, it indicates that the more the entertainment establishments are in a region the higher crime rates of the region are.

Among defense mechanism variables, the effect of the number of police stations on crime rates is not statistically significant. In addition, the result shows that the number of CCTVs have a negative (-) impact on crime rates. It indicates CCTV is a good means of defense against crime.

CONCLUSION

This study analyzed the effect of the U-City security service on crime rates based on 2012 within Seoul metropolitan area classified with 62 regions by estimating a spatial regression model. Before estimating the model, it conducted ESDA by examining the spatial pattern of crime cases per 100,000 populations and confirmed the existence of spatial autocorrelation on crime rates. The analysis found that the center of Seoul shows higher level of crime rates and there is statistically significant spatial autocorrelation in crime rates. Thus, this study utilized a spatial regression model instead of the multiple linear regression model. Urban characteristics variables used in the model other than the existence of U-City security service are selected after reviewing previous studies. As a result of analysis of the spatial regression model, the U-City security service is found to have statistically insignificant effect on crime rates. It seems that this result is because of the unambiguous criteria to apply U-City security service in each region and the effect of U-City security service to reduce crime rates is not displayed yet in 2012. In addition, population density, the recipient of national basic livelihood ratio, the amount of property tax per population, commercial area ratio, the number of entertainment establishments, and the existence of metropolitan policy agency have a positive (+) impact on crime rates, whereas population per household, residential area ratio, and the number of CCTVs have a negative (-) influence on crime rates.

This study provides insights into the extent to which it analyzes the effect of U-City security service on crime rates empirically and also, identifies the effect of urban characteristics on crime rates that were vague in previous studies. However, this study has a limitation which should be considered when collecting the data for the analysis. The analysis was conducted in a single year due to a lack of data, so it was not able to observe the variation in the crime rates after the year of the application of U-City security service. Also, the unit of analysis is a relatively large unit to compare the factors affecting the crime. Therefore, additional research is needed to examine whether U-City security service positively impacted on crime rates.

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