The Effect of Property Value on Crime*

- A Case Study of the City of Dallas, Texas -

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재산가치가 범죄에 미치는 영향*

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ABSTRACT : Urban crime undermines the safety of a community and ultimately leads to depressed property values. Consequently crime is seen as a critical determinant of property values. Meanwhile, the causal effect of property values on crime appears to be something of a mystery. Higher property values may contribute to improving the environment of a neighborhood and mitigating the occurrence of crime, while at the same time increasing area's attractiveness as a target to potential criminals. Interestingly, most prior literature has focused merely on the impact of crime on property values and has never clearly examined the possibility of any reverse causality which may exist between property values and crime. This paper analyzes the effect of property values on crime in the City of Dallas, Texas in 2002. Through two stages least squares regression models that control endogeneity of property values and crime, the present study supports the hypothesis that property values influence crime rates. The results demonstrate that the impact of property values on crime rates varies according to the type of property values. Regardless of the types of crime, higher residential property values lead to lower crime rates whereas higher commercial property values are found to cause higher crime rates.

Key Words : Property Value, Crime, Neighborhood, Endogeneity

요약 : 도시 범죄는 지역사회의 안전을 훼손하고 궁극적으로는 재산가치의 하락을 이끌게 된다. 따라서 범죄는 재산가치의 핵심적인 결정 요소라고 볼 수 있다. 한편, 범죄에 대한 재산가치의 인과적 효과는 분명치 않다고 볼 수 있다. 보다 높은 재산가치는 근린지역의 환경을 개선시키고 범죄의 발생을 완화시키는 데 공헌을 하는 반면 동시에 잠재적인 범죄자들에게 범죄 목표로 매력적이기도 하다. 흥미롭게도 대부분의 관련 선행연구들은 단지 범죄가 재산가치에 미치는 영향에 초점을 맞추어 왔고 재산가치와 범죄 간에 존재할지 모르는 역으로의 인과관계 가능성을 명확하게 조사해 본 적이 없다. 그러한 빈틈을 채워주기 위하여 본 연구는 2002년 미국 텍사스주 달라스시에서 재산가치가 범죄에 미친 영향을 분석한

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다. 특히 재산가치와 범죄의 내생성의 문제를 통제하는 이단계 최소제곱회귀모형을 통해 본 연구는 다음의 임무를 수행하고자 한다. 첫째, 어떤 인구통계적, 도시구조적, 그리고 지역적인 요인들이 근린지역 범죄율을 결정하는가를 조사한다. 둘째, 재산가치의 도시 범죄에 대한 영향이 다양한 근린지역 특성들을 통제한 이후에도 유의미한지를 확인한다. 셋째, 어떻게 그 영향의 수준이 두 가지 전형적인 재산가치의 유형들(주거재산 대 상업재산)에 기초해서 달라질 수 있는지 그리고 어떻게 재산가치의 영향이 두 가지 주요 범죄 유형들(폭력범죄 대 재산범죄)에 따라 변할 수 있는지를 측정한다. 회귀분석의 결과들은 재산가치가 범죄에 영향을 미친다는 가설을 지지하는 것으로 나왔다. 특히 범죄에 대한 재산가치의 영향이 범죄의 유형보다는 재산가치의 형태에 따라 다른 것으로 나타났고 높은 주거재산가치는 낮은 범죄율을 이끄는 데 반해서 높은 상업재산가치는 높은 범죄율을 야기하는 것으로 드러났다.

주제어 : 재산가치, 범죄, 근린지역, 내생성

Ⅰ. Introduction

More than any other socio-economic problems, urban crime has been widely perceived as a complicated phenomenon for the fact that it cannot be isolated from neighborhood ecological characteristics. Several urban sociologists from the Chicago School, such as Shaw and McKay(1942) and many criminologists have tried to examine critical neighborhood structures and their strong correlation with urban crime. Thus, a variety of urban structural covariates and socio-economic factors have been analyzed together within a given field of research. In addition, a spatial dynamic due to urban sprawl has continued to appear in both residential and commercial activities and has ultimately caused significant variations with regards to urban development and economic prosperity. More specifically, a migration of the middle and upper classes to suburbs has led to severe social and economic distress of poor and minority households located in disadvantaged neighborhoods of central city and innerring suburbs. Jargowsky(1997) stressed that this typical type of urban blight in U.S. metropolitan areas results in severe economic segregation and vast fiscal gaps between central cities and suburbs. Thus, "class-selective nature" concerning residential choice has necessarily contributed to increasing social and economic problems which are strongly related to fear of crime(Jargowsky, 1997; Jargowsky and Park, 2009). Naroff and his colleagues(1980) also pointed out that the control of crime has been a top urban policy issue, side by side housing or poverty.

Property values embody not only a symbolic meaning of a certain level of economic prosperity but also serve as a reliable indicator of living expenses. In fact, while it is very difficult to estimate the quality of a specific neighborhood accurately, the property values could serve as a good proxy when inferring neighborhood conditions. Using this assumption, relatively stable regions where property values are high are likely to be categorized as "high quality areas", despite arguments that the reliability of property values may not be an

accurate indicator(Ding and Knaap, 2003). Specifically, residential property values, often represented by housing prices, seem to be highly correlated with certain types of neighborhood characteristics. Because of this strong correlation, high or stable property values are used as critical determinants when evaluating neighborhood quality, along with other concerns such as migration patterns, income levels, racial cohesion, and public services(Kain and Quigley, 1970; Ding and Knaap, 2003). Inevitably, property values vary according to location, which means that a significant level of disparity in property values, even between rapidly developing areas, tends to be easily seen in many metropolitan regions. For instance, the 25th percentile of residential property values in the census block group of Dallas, Texas comes to only about $90,000 per square acre whereas the 75th percentile of residential property values in the same area is as high as $470,000 per acre. This large variation between neighborhoods is also present among commercial property values in Dallas communities, meaning that the 75th percentile of land values, $100,000 per acre, is roughly ten times larger than the 25th percentile of values, which is only $10,000 per acre.

Just as property values matter in urban ecological environments, urban crime tends to also be highly related to neighborhood characteristics. Assuming that property values and crime would both serve as potential and realistic ingredients for a shifting neighborhood environment, the relationship between the two might be well expected to receive a scholarly attention. Focusing on the relationship between property values and crime, much prior literature has analyzed the effect of crime on property values by dealing with critical determinants of property values in hedonic price models(for example, Thaler, 1978; Bowes and Ihlanfeldt, 2001; Lynch and Rasmussen, 2001; Gibbons, 2004; Linden and Rockoff, 2006; Tita et al., 2006). Furthermore, not only several hedonic model studies, but also crime-related articles, have dealt with the effect of crime on future property values, by explaining the actual influences of crime spillover(Hakim and Rengert, 1981; Burnell, 1988). Regardless of whether previous studies have utilized hedonic model approaches or crime spillover views, both have commonly argued that urban crime undermines community safety and ultimately causes depressing property values, meaning that we can safely conclude that crime affects property values in a negative way.

Unlike the reasonably consistent arguments over the effect of crime on property values, the effect of property values on crime is somewhat ambiguous(Campbell, 2008), and the hypotheses related to the causal mechanisms that address it were based on two entirely different perspectives. The first approach offers the ideas that higher property values may contribute to improving neighborhood environments, thus discouraging the occurrence of crime. Meanwhile the argument can also be made that areas

with higher property values offer the potential to serve as more attractive targets for would-be criminals, therefore resulting in rising property values promoting higher crime rates. Thus, the conflicting conclusions lead to an uncertainty as to whether a positive or negative effect exists of property values on crime.

The purpose of the present study, therefore, is to address the effect of property values on crime, something which most prior literature has failed to discover. To capture the effect successfully, several analytical strategies are manipulated here. First, this paper performs a composite variable approach through factor analysis. A significant number of previous studies related to urban crime have suffered from problems related to multicollinearity because socio-economic variables and neighborhood characteristics are likely to be correlated to one another(see more Baller et al., 2001). As a data reduction process, this approach offers the potential to include many socio-economic variables in an analysis without losing much variation(Sampson et al., 1997). Second, property values and crime rates are disaggregated to census block group level and decomposed by two critical sub-types respectively. Through this process, the present research possibly not only captures more dynamic differences of neighborhood characteristics in various urban areas but also examines how the effect of property values on crime differs according to type of property(residential vs. commercial) and how the effect of property values also varies according to different types of crime(violent vs. property) across different neighborhoods. Finally, it is necessary to consider the possible endogeneity problem which may lead to biased results in the regression models because the relationship between property values and urban crime is reciprocal. Thus, this paper employs a two-stage least squares model using instrumental regression estimation.

The rest of this paper is organized as follows. First, the next section reviews prior literature that had dealt with relationships between property values and crime rates. The methodology section covers data, variables, and analytical strategies. Then the next section reports the results of two-stage least squares regression models estimating the effect of property values on crime and compares them with OLS results. Lastly, conclusions and discussions are following at the end.

Ⅱ. Prior Literature

A majority of previous studies which have dealt with the relationship between crime and property values have been more focused on the effect of crime on property values rather than the effect of property values on crime(Linden and Rockoff, 2006). This trend originates from the fact that the causality between crime and property values has been investigated from a perspective of determinants of property values. In particular, most studies which have disclosed determinants of property values have relied on a hedonic approach which aims to estimate

demand or value for a specific good(such as housing) and to show that various constituent characteristics are decomposed from the property values(Thaler, 1978; Bowes and Ihlanfeldt, 2001; Lynch and Rasmussen, 2001; Gibbons, 2004; Linden and Rockoff, 2006; Tita et al., 2006). In these papers, crime is only one of the control variables which are used to explain variations in property values. Although a hedonic approach has been widely utilized to capture impacts of neighborhood characteristics on property values, many studies have tried to isolate the effect of crime among all determinants of property values(for example, Thaler, 1978; Tita et al., 2006).

A great deal of prior literature focusing on the effect of crime on property values commonly hypothesized that the occurrence of crime negatively influences neighborhood environments. Theoretically, the effect of crime on the property values may appear indirectly through mobility(Tita et al., 2006). It is also simply argued that crime can easily boost the possibility of individuals moving to new residences which are safer and more comfortable (Dugan, 1999). More specifically, if crime rates rise, their effect is likely to cause urban flight out of high crime neighborhoods, thereby entailing a structural change of neighborhoods which is largely associated with racial composition and socio-economic shift(Cullen and Levitt, 1999). Such changes in neighborhoods, which originate from urban crime, result in concentrations of poverty which thereby trigger "a difficult cycle" which leads to even more crime(Miethe and Meier, 1994). Consequently, disadvantaged neighborhoods in which minority groups are spatially concentrated are likely to experience additional impacts related to their property values. Thus, the demand for(residential or commercial) property in such disadvantaged neighborhoods is likely to shrink on the market, meaning that property values are likely to decrease in areas where crime is prevalent (Naroff et al., 1980, Campbell, 2008). As hypothesized and supported by empirical evidence from most prior literature, the argument that crime discourages property values is supported (for example, Thaler, 1978; Hellman and Naroff, 1979; Rizzo, 1979; Buck et al., 1993; Bowes and Ihlanfeldt, 2001; Gibbons, 2004; Linden and Rockoff, 2006). However, estimated effects of crime on property values in various studies are contingent upon the measurements of variables, study areas, methodological models, and so on(Bowes, 2007; Campbell, 2008).

Thaler's work(1978) is likely to be the first attempt to solely extract the effect of crime among a variety of determinants of property values. Using a hedonic price model, the author ran regressions of the per-acre price of land on a series of neighborhood characteristics including crime rates and confirmed a negative relationship between crime rates and property values thus implying that a one-standard deviation increase of property crime rates leads to a decline of home values by about 3 percent. Rizzo's work(1979) which was a similar case

study done in Chicago, provided similar empirical results; crime negatively affects property values. Most importantly, this study received credit for being the first piece of research to point out issues of endogenity as a result of a two-way causal relationship and employ a two-stage least squares model to account for the problem. Using an empirical log-log model, Naroff et al.(1980) also confirmed a high elastic marginal effect of crime on property values and suggested that by reducing crime rates, the city could enjoy increased property values and ultimately larger property tax revenues. Similarly, Buck and his colleagues(1993) also demonstrated that increased policy services result in an increase in property values due to a reduction of uncertainty related to victimization and losses resulting from crime.

Unlike the quite consistent argument related to the effect of crime on property values, the effect of property values on crime still remains mysterious and has yet to occupy 'first fiddle' thus far. Generally, the goal of economic development motivates a variety of urban plans, which thus encourages the introduction of new employers, job creation and increased profits. This fairly typical development process stimulates an influx of population and which in turn stimulates income growth and ultimately produces rising property values in the region. Climbing property values due to economic prosperity and increased amenities, therefore, may positively influence neighborhood environments(Buck et al., 1989). Thus, based on such perspectives, high property values may discourage the occurrence of crime. On the other hand, urban growth tends to be involved in enhancing the instability of urban structure. Such a diverse population and its dynamic mobility may contribute to not only higher property values but also more crime-prone environments when assessing things from the perspective of routine activity theory. In other words, high property values areas could more easily suffer from a convergence in time and space of "suitable targets", "motivated offenders", and "a lack of guardianship"(Cohen and Felson, 1979). So, based on such a perspective, a positive relationship between property values and crime could appear.

Regarding the effects of property value, although not directly addressing questions related to property values, Bowes's work (2007) dealt with causal mechanisms between retail development and crime and tried to discover whether crime is attracted to retail development or discourages such development. Interestingly, empirical results in his research supported a two-way causal relationship, so retail development was found to both attract crime and adversely affect crime. However, this study also demonstrated that violent crime reduces retail development whereas property crime is attracted to it. Thus, it would be necessary to divide the crime into sub-categories since the relationship may vary depending upon the type of crime.

Although some limited studies have con-

sidered endogeneity problems in the empirical research using two-stage least squares models to accurately estimate the effect of crime on property values(for example, Rizzo, 1979; Hellman and Naroff, 1979; Tita et al., 2006), none of them have precisely captured the effect of property values on crime based on the consideration of simultaneous bias. Therefore, unlike prior literature, the present study aims to clarify whether the effect of property values on crime is statistically significant or not, whether the causal effect is positive or negative, and how the effect can differ according to types of both crime and property values.

Ⅲ. Data, Variables, and Measurement

The original crime data obtained from the Dallas Police Department includes the number of crime incidents for each census block group reported through 911 dispatch calls from inside the city limits. Given the assumption that the effect of property values can differ according to types of crime, it seems to be important to categorize crime occurrences based on various types. Two major types of crime, violent crime and property crime, could simplify many complicated types of crime in a relatively convenient way, so they were employed in the present paper. Generally, property crime is associated with the theft of money or property without the use of force whereas violent crime entails the use of force in order to harm the victim. In fact, these categories have been widely used in countless crime papers and based on Part 1 of the Uniform Crime Report provided by the Federal Bureau of Investigation (FBI). Violent crime includes aggravated assault, murder, rape, and robbery whereas arson, burglary, larceny-theft, and vehicle theft belong in the category of property crime. To measure a certain level of crime within a given area, the crime rate should be calculated according to population base due to the necessity of reducing large variations which are driven by local differences of crime occurrence and standardized methods of calculating crime rates. As easily expected, population figure is likely to vary significantly by neighborhood unit. For instance, five census block groups out of a total 928 census block groups within the city limit of Dallas have extremely small populations which are only less than 10. These exceptional observations of small populations may cause severely biased and high crime rates, ultimately resulting in inaccurate as well as misleading statistical results associated with the relationship between explanatory variables for demographic and socio-economic status. Thus, the present study must rule them out in the data analysis. Although traditional measures of crime rates have been challenged by numerous scholars who point out potential problems associated with neighborhood level analysis(for example, Zhang and Peterson, 2007), this paper utilizes population-based crime rates because this index is still more advantageous than other measures in terms of creating the standardized

ratios(e.g., number of crimes per 1,000 residents or per 100,000 residents). The present study focuses on relatively small census block groups which are micro-level geographic units, so crime rates are defined for purposes of the present study as the annual number of crime per 1,000 people.

Several different measures of property values have been used to capture the monetary value of socio-economic quality of life. As reviewed in the literature section, a great deal of previous studies related to property values have been inclined to analyze residential property values. Particularly, most of them have used housing values(based on appraisal values) as a proxy of property values in the hedonic price model. However, residential property values might only indicate some aspects of neighborhood economic prosperity due to the fact that economic activities are likely to be frequently involved in commercial developments. It is therefore necessary to consider both types of property values, consequently standardized acre-unit values of both residential property and commercial property are utilized in the present research to measure the property value at the neighborhood-level. These residential and commercial property values are all aggregated by census block group and then divided by land size(acre) of the area. The data is obtained from the Office of Economic Development of the City of Dallas.

The purpose of this study is to demonstrate that changing property values affects variations in crime rates at the neighborhood level. As can be easily expected, both property values and crime are substantially correlated with demographic characteristics in a given neighborhood. Thus, this paper includes basic demographic variables such as population size, median household income, age structure, and racial composition in the analytical models located in the next chapter. Furthermore, community conditions, which are widely referred to as "urban structural covariates" in much criminology or sociology research, have been measured and controlled in various ways. The magnificent work done by Land and his colleagues(1991) pointed out that inconsistent statistical results for demographic and socio-economic variables found in many urban crime studies are largely associated with multi-collinearity issues, so they have suggested an advanced technical process that manipulates composite indices by grouping correlated variables together. Since Land and his colleagues introduced this composite measure approach, several crime studies have continued to conduct the principal components analysis in order to create composite measures(i.e., population structure and resource deprivation) in an attempt to overcome weaknesses related to methodological problems due to multicolinearity (for example, Parker and McCall, 1999; Baller et al., 2001; Wadsworth and Kubrin, 2004). In particular, Sampson and his colleagues(1997) have used factor analysis as a tool of variable reduction process to more specifically measure

Table 1. Factor analysis for neighborhood effects

Factor	Items	Factor Loading
Residential Stability (α=0.87)	Percent stayed +5 years in the same home	0.95
	Percent households without mortgage burden	0.92
	Homeownership rate	0.93
Concentrated Disadvantage (α=0.77)	Percent unemployed	0.81
	Percent people living in poverty	0.90
	Percent single parents households	0.83
Immigration concentration (α=0.92)	Percent foreign born	0.98
	Percent Hispanic	0.93
	Percent Non-citizen	0.98

Note: Maximum Likelihood factor analysis of extraction method and oblique rotated factor pattern with Kaiser Normalization

three community conditions such as "concentrated disadvantage", "immigration concentration", and "residential stability" which had been perceived as typical neighborhood features in urban area by the classical Chicago school scholars such as Wirth(1938) and Shaw and McKay(1942). As such, to extract these critical urban elements, the present study utilized an exploratory factor analysis of 2000 U.S. Census data based on maximum likelihood(ML) extraction with a direct oblimin(oblique) rotation. Technically, Bartlett factor scores need to be calculated for each factor, and each factor has a mean score of 0 and a standard deviation of 1(or close to 1). As shown in Table 1, consistent with Sampson et al.(1997), the result of the factor analysis produced three identified community conditions including residential stability, concentrated disadvantage, and immigration concentration. These three factors are analyzed by three sub-items which can specifically characterize their associated factor.[1] Finally, the reliability coefficients(Cronbach's α) were calculated for each community condition scale, which resulted in a range from 0.77 to 0.92.

According to the routine activity theory, the occurrence of crimes is strongly associated with whether a target is suitable or not. However, much prior literature has struggled to measure major components of target suitability such as accessibility(Cohen and Felson, 1979). For example, the existence of transportation corridors such as a highway or a rail station may contribute to better exposure of crime victims(Bowes, 2007). Like the case of transit sources, accessibility to commercial zones such as shopping malls and retail grocery centers are also expected to stimulate a crime-favorable environ-

1) Sampson and his colleagues' work(1997) also used the same three factors, but sub-items used in the present study are somewhat different. For example, percentage of black residents was one of the sub-items for concentrated disadvantage in the original study. Yet, this particular variable is directly employed in the main regression models of the present study.

Table 2. Variable Descriptions and Data Source

Variable	Description	Source
Dependent variables		
Violent crime rate	Natural log of violent crime rate	Dallas Police Dept
Property crime rate	Natural log of violent crime rate	Dallas Police Dept
Independent variables		
Residential Property Value	Value per acre (unit: $1,000)	City of Dallas
Commercial Property Value	Value per acre (unit: $1,000)	City of Dallas
Basic Demographics		
Population	Natural log of population	2000 Census
Income	Median household income (unit: $1,000)	2000 Census
Black	Percent of Non-Hispanic Black	2000 Census
Age 13-17	Percent of Age 13-17	2000 Census
Age 65+	Percent of Age 65+	2000 Census
Neighborhood Effect		
Residential stability	Bartlett factor scores	2000 Census
Concentrated disadvantage	Bartlett factor scores	2000 Census
Immigration concentration	Bartlett factor scores	2000 Census
Accessibility		
Transportation accessibility	Accessibility index for transit corridors	Digitized map
Commercial accessibility	Accessibility index for commercial zones	Digitized map
Instruments		
New house	Percent of houses built within last 5 years	2000 Census
Big house	Percent of houses with +3 bedrooms	2000 Census
Housing density	Houses per acre	2000 Census
Industrial density	Industrial area per square mile	City of Dallas
Commercial density	Commercial area per square mile	City of Dallas
Office density	Office area per square mile	City of Dallas
Property tax rate	Combined tax rate(county plus school)	Counties and ISDs

ment. To account for the spatial and opportunistic aspects of urban crimes, this paper creates two major accessibility indices and employs them in the analytical models. The present study claims that accessibility is composed of "proximity", indicating the geographic distance, and "opportunity", representing the quantity of accessible targets(for example, highway exits, train stations, shopping malls). Based on this logic, an accessibility index with a range from 0 to 1 is calculated by the formula which evenly weights two aspects.[2)]

2) The formula for accessibility index is as follows.

$$AI_i = \left(\frac{D_M - D_i}{D_M}\right) * \left(\frac{N_i}{N_M}\right)$$

Where AI_i : Accessibility Index for a given area, i
D_i : Distance of i census block group to the nearest accessible target
D_M : The maximum distance among D_i
N_i : The number of accessible targets located within 5 miles from the center of i block group
N_M : The maximum number among N_i

With respect to reciprocal causality between property values and crime rate, the final analytical model in this research employs instrumental variables estimation. Since our research aims to pin down the effect of property values on crime, in order to satisfy the conditions for valid instruments, it is necessary to search for ideal candidates for instrumental variables which are correlated with property values and uncorrelated with crime rates. As a result, a total of seven variables are employed as instruments for property values. The first three variables are percentage of newly built houses, percentage of houses with more than 3 bedrooms, and housing density. Since new and bigger houses tend to be more expensive, the age and volume of houses must be closely associated with property values. Housing density is also likely to affect the housing market structure of demand and supply that leads to changing property value in a neighborhood. Another set of three instruments represent physical features of commercial property. They are industrial building density, retail building density, and office building density. The last instrument is property tax rate which seems to be not only directly related with location decisions of property but also indirectly linked with property value. Table 2 displays data sources and variable descriptions for main variables that are included in the regression models.[3)]

Ⅳ. Model Specification

The unit of analysis for the present research is the census block group, which is a micro-level geographic identifier provided by the Census Bureau. Although the census track is seen as a more popular spatial unit in urban research focusing on neighborhoods, census block groups would be beneficial in terms of providing not only larger numbers of observations with reasonable population sizes for the neighborhood study but also more homogenous patterns of the community.[4)] The target area of the present study is the City of Dallas which has a population of approximately 1.2 million residents(U.S. Census Bureau, 2007), and is the ninth largest city in U.S.

As hypothesized in the previous sections, the effect of property values on crime depends presumably on the type of property values as well as on crime. In this sense, the present study establishes its hypotheses more specifically in the following ways: (1) high residential property values lead to low(or high) violent crime rates, (2) high commercial property values lead to low(or high) violent crime rates, (3) high residential property values lead to high(or low) property crime rates, (4) high commercial property values lead to high(or low) property crime rates. Based on this assumption, it is necessary for regression

3) To check for any possible multicollinearity problem among three identified factors and other variables, especially the percent black variable, variance inflation factors(VIF) were calculated. The results confirm that there is no serious multicollinearity problem among variables(VIF<4).

4) Census block groups in City of Dallas have roughly 1,300 population on average in 2000 U.S. Census.

models to employ different dependent and independent variables with cross combination. This chapter introduces four analytical models estimating (1) effects of residential property values on both violent and property crime rates, and (2) effects of commercial property values on both violent and property crime rates. Basically, given some demographic, urban structural, and locational characteristics, a certain level of neighborhood crime rates would be expected. Thus, the function of violent crime rates is addressed by the following equation models. Model 1 is a residential property-violent crime(R-V) model and Model 2 is a commercial property-violent crime(C-V) model.

1. R-V model:

$$VC = \alpha_1 + \alpha_2 P_i + \alpha_3 B_i + \alpha_4 A13_i + \alpha_5 A65_i + \alpha_6 IN_i + \alpha_7 RS_i + \alpha_8 CD_i + \alpha_9 IC_i + \alpha_{10} AT_i + \alpha_{11} AC_i + \alpha_{12} RP_i + u_i$$

2. C-V model:

$$VC = \beta_1 + \beta_2 P_i + \beta_3 B_i + \beta_4 A13_i + \beta_5 A65_i + \beta_6 IN_i + \beta_7 RS_i + \beta_8 CD_i + \beta_9 IC_i + \beta_{10} AT_i + \beta_{11} AC_i + \beta_{12} CP_i + \nu_i$$

The dependent variable, VC_i represents violent crime rates of census block group i. Regarding basic demographic variables, P_i is the log of the population, B_i is the percentage of Black residents, $A13_i$ is the percentage of the population that is from 13 to 17 years old, $A65_i$ is the population percentage older than age 65, and IN_i is the median household income. As community condition and location variables, RS_i, CD_i, IC_i, AT_i, and AC_i represent residential stability, concentrated disadvantage, immigrant concentration, accessibility to transportation corridors, and accessibility to commercial zones respectively. RP_i and CP_i are the main independent variables indicating residential property and commercial property. Finally, u_i and ν_i are disturbance terms. In the same manner, regression modes for property crime rates are modeled below in Model 3(residential property-property crime model) and Model 4(commercial property-property crime model) using identical explanatory variables. PC_i is property crime rates of census block group and ϵ_i and η_i represent disturbance terms.

3. R-P model:

$$PC = \gamma_1 + \gamma_2 P_i + \gamma_3 B_i + \gamma_4 A13_i + \gamma_5 A65_i + \gamma_6 IN_i + \gamma_7 RS_i + \gamma_8 CD_i + \gamma_9 IC_i + \gamma_{10} AT_i + \gamma_{11} AC_i + \gamma_{12} RP_i + \epsilon_i$$

4. C-P model:

$$PC = \delta_1 + \delta_2 P_i + \delta_3 B_i + \delta_4 A13_i + \delta_5 A65_i + \delta_6 IN_i + \delta_7 RS_i + \delta_8 CD_i + \delta_9 IC_i + \delta_{10} AT_i + \delta_{11} AC_i + \delta_{12} CP_i + \eta_i$$

As pointed out in previous chapters, a standard OLS regression model dealing with causal relationships between property values and crime cannot avoid the problematic endogeneity issue. To overcome this potential bias in OLS analytical framework, it is necessary to employ an instrumental variables regression model(IV regression). Technically, this particular model is very useful in obtaining a consistent estimator of the unknown coefficients of the population regression function when the regressor, X, is correlated with the error term. A valid IV regression model has to satisfy the certain

condition that an instrumental variable must be correlated with the regressor, but not correlated with the error term. Firstly, the present study utilizes the Durbin-Wu-Hausman tests to determine whether any endogeneity is present in the regressions(Hausman, 1978). For these particular tests, the null hypothesis indicates that the tested regressors are exogenous. The testing results demonstrate that the null hypotheses were rejected at the 0.05 level based on Durbin-Wu-Hausman χ^2 statistics. Therefore, the endogenous regressors' effects on the estimates appear to be important, thus necessitating the application of instrumental variables techniques. Next, the Sargan tests were also conducted in order to test the validity of instrumental variables(Sargan, 1964). The null hypothesis is that the instruments are valid instruments, so a rejection casts doubt on the validity of the instruments. The results from Sargan tests fail to reject the null and confirm that all instrument variables were statistically valid.

Thus, the effect of property value is estimated by instrumental variables in the IV regression like following updated equation models:

1-1.

$$VC = \theta_1 + \theta_2 P_i + \theta_3 B_i + \theta_4 A13_i + \theta_5 A65_i + \theta_6 IN_i + \theta_7 RS_i + \theta_8 CD_i + \theta_9 IC_i + \theta_{10} AT_i + \theta_{11} AC_i + \theta_{12} \widetilde{RP}_i + u_{2i}$$

2-1.

$$VC = \phi_1 + \phi_2 P_i + \phi_3 B_i + \phi_4 A13_i + \phi_5 A65_i + \phi_6 IN_i + \phi_7 RS_i + \phi_8 CD_i + \phi_9 IC_i + \phi_{10} AT_i + \phi_{11} AC_i + \phi_{12} \widetilde{CP}_i + \nu_{2i}$$

3-1.

$$PC = \lambda_1 + \lambda_2 P_i + \lambda_3 B_i + \lambda_4 A13_i + \lambda_5 A65_i + \lambda_6 IN_i + \lambda_7 RS_i + \lambda_8 CD_i + \lambda_9 IC_i + \lambda_{10} AT_i + \lambda_{11} AC_i + \lambda_{12} \widetilde{RP}_i + \epsilon_{2i}$$

4-1.

$$PC = \chi_1 + \chi_2 P_i + \chi_3 B_i + \chi_4 A13_i + \chi_5 A65_i + \chi_6 IN_i + \chi_7 RS_i + \chi_8 CD_i + \chi_9 IC_i + \chi_{10} AT_i + \chi_{11} AC_i + \chi_{12} \widetilde{CP}_i + \eta_{2i}$$

where $\widetilde{RP}$ and $\widetilde{CP}$ represent the residential and commercial property values instrumented with the variables described in the previous section. All models are weighted by population of census block groups to address the heterosckedasticty since block group areas are expected to have different error variances depending on the size.

V. Findings

Table 3 presents empirical results in simple OLS regression models focusing on four distinct types of effects between property values and crime such as (1) effects of residential property values on violent crime and property crime, and (2) effects of commercial property values on both violent crime and property crime. The RV model and CV model display the results for the violent crime rate as dependent variable whereas the RP model and CP model show the regression outputs for the property crime rate as dependent variable. However, as the previous sections continued to point out, the endogeneity of property value may plague the above results obtained in OLS models, so the results from the two-stage least squares model in Table 4 need to be reinforced. The instrumental regression

Table 3. The Results of OLS Regression Models for Crime Rate

	DV=Violent Crime				DV=Property Crime			
	IV=Residential Prop.		IV=Commercial Prop.		IV=Residential Prop.		IV=Commercial Prop.	
	b	S.E	b	S.E	b	S.E	b	S.E
Residential property	-0.0014**	0.0002			-0.0004*	0.0002		
Commercial property			0.0004**	0.0001			0.0005**	0.0001
Income	-0.010**	0.002	-0.014**	0.002	-0.002	0.0014	-0.003*	0.001
Population(Log)	-0.042	0.085	-0.028	0.088	-0.224**	0.076	-0.193**	0.076
Black	0.849**	0.250	1.008**	0.256	0.321	0.223	0.347	0.221
Age 13~17	-1.449	2.262	1.439	2.304	-3.259	2.015	-2.121	1.987
Age 65 more	-1.212	0.823	-1.729*	0.847	0.365	0.733	0.072	0.730
Residential stability	-0.202**	0.074	-0.021	0.077	-0.210**	0.066	-0.112	0.066
Concentrated disadvantage	0.107	0.084	0.248**	0.086	0.029	0.075	0.091	0.074
Immigration concentration	-0.050	0.075	-0.017	0.077	-0.125	0.067	-0.127	0.067
Access to transit	-0.458**	0.169	-0.337*	0.173	-0.327*	0.150	-0.298	0.149
Access to commerce	1.015**	0.252	0.754**	0.257	1.241**	0.224	1.136**	0.222
R^2 Adjusted	0.36		0.33		0.11		0.12	
F	48.47**		41.60**		11.31**		12.36**	
N	923		923		923		923	

* P≤.05, ** P≤.01

models employ seven instruments for property values: physical features of residential property(percent of newly built house, percent of houses with more than 3 bedrooms, housing density), densities of commercial property (industrial building density, retail building density, office building density), and property tax rate.

In the violent crime models(both RV and CV models), several demographic and economic factors are statistically significant. "Black" is positive and statistically significant, so higher percentages of Black are associated with higher violent crime rates. "Income" is negatively significant, as expected. Of the age variables, only "Age65 more" is significant at $\alpha = 0.05$ in CV model, with a negative coefficient. This result shows that percentage of elderly in the population may possibly turn out to be a mitigating factor for crime. With respect to

Table 4. The Results of 2 Stage Least Square(IV Regression) Models for Crime Rate

	DV=Violent Crime				DV=Property Crime			
	IV=Residential Prop.		IV=Commercial Prop.		IV=Residential Prop.		IV=Commercial Prop.	
	b	S.E	b	S.E	b	S.E	b	S.E
Residential property	-0.001**	0.0003			-0.001**	0.0002		
Commercial property			0.001**	0.0002			0.001**	0.0002
Income	-0.010**	0.002	-0.014**	0.002	-0.00001	0.001	-0.004**	0.001
Population(Log)	-0.046	0.085	0.019	0.091	-0.214**	0.077	-0.135	0.079
Black	0.881**	0.252	0.975**	0.259	0.220	0.227	0.306	0.226
Age 13~17	-1.021	2.301	1.994	2.337	-4.624*	2.073	-1.428	2.038
Age 65 more	-1.269	0.826	-1.983*	0.860	0.547	0.744	-0.245	0.750
Residential stability	-0.181*	0.077	0.061	0.082	-0.277**	0.069	-0.010	0.072
Concentrated disadvantage	0.126	0.086	0.286**	0.088	-0.034	0.078	0.138	0.076
Immigration concentration	-0.042	0.076	-0.035	0.078	-0.151*	0.068	-0.150*	0.068
Access to transit	-0.436**	0.170	-0.346*	0.175	-0.397**	0.154	-0.309*	0.152
Access to commerce	0.977**	0.255	0.700**	0.261	1.363**	0.230	1.069**	0.228
R^2 Adjusted	0.36		0.32		0.10		0.09	
F	44.26**		41.40**		12.29**		13.33**	
N	923		923		923		923	

* P≤.05, ** P≤.01

+ The IV regression model employs seven instruments: percent of newly built house, percent of houses with more than 3 bedrooms, housing density, industrial building density, retail building density, office building density, and tax rate.

community condition variables, "Residential stability" in RV model is negatively significant and "Concentrated disadvantage" in CV model is positively significant. Two accessibility indices in both models are statistically significant, but signs appear totally opposite, so transit accessibility is negatively significant whereas the coefficient for commercial accessibility is positive. Thus, these results imply that while higher accessibility to transit corridors leads to lower violent crime rates, higher accessibility to commercial zone is associated with higher

violent crime rates. The result for commercial accessibility seems to be consistent with the argument supported by opportunity theories of criminal victimization assuming that a potential target and offender must converge in time and space for a crime to occur. Yet, a negative relationship between transportation accessibility and violent crime is unexpected and hard to be explained by traditional criminal theories. Finally, the main independent variable, residential property values in RV model are negatively significant indicating high residential property values lead to a lower violent crime rate. On the contrary, commercial property values in the CV model have positive coefficient with statistical significance, so the result demonstrates that higher violent crime rates are caused by the increase of commercial property values. Thus, two distinct regression outputs emphasize that the effect of property values on violent crime could be substantially varied according to the property type.

Unlike a series of results presented in violent crime models, some explanatory variables in property crime models(both RP and CP models) display quite a different pattern. For instance, while "Population" is insignificant in violent crime models, it is negatively significant in RP model. Thus, more populous areas are likely to enjoy lower property crime rates. Although a significant number of previous studies have analyzed relationships between population density and crime, there has been no consistently overwhelming argument related to it(Jargowsky and Park 2009). Yet, this negative relationship between population and property crime could be supported by Jane Jacobs' contradictory argument that crowed city streets and sidewalks could be effective deterrents to criminal behavior. "Black" variable fails to be statistically significant in both RP and CP models and Income" has a significant coefficient in only the CP model. In addition, only "residential stability" in the RP model is statistically significant at $\alpha = 0.01$ among the three community condition variables. Two accessibility indices in property crime models are statistically significant as well as consistent with the results for same variables in violent crime models. Lastly, both residential and commercial property values are statistically significant and have the same signs as violent crime models.

As shown in Table 4, the coefficients of the instrumented property value variables in four models that must be the most important are all statistically significant at $\alpha = 0.01$. The result for the residential property variable in the IV model(R-P model) is more robust alleviating significance level compared to $\alpha = 0.05$ in the OLS model. Residential property values are negatively significant in both violent and property crime models, so it is expected that higher residential property values may discourage crime occurrences. Yet, commercial property values are positively significant in both crime models, implying higher commercial property value could result in higher crime rates.

Consequently, regression outputs address ideas that higher residential property values lead to lower crime rates whereas higher commercial property values stimulate occurrences of crime regardless of type of crime. These results in IV models appear to be consistent with OLS model outputs, but the magnitude of coefficients of instrumental regression models is much bigger than the one of coefficients in OLS models. Thus, the results from IV regression model in Table 4 support more strongly the conflicting effects between residential property values and commercial property values on crime rates.

Ⅵ. Conclusion and Discussions

Urban crime is so complex that it is difficult to investigate its important determinants as well as the impacted variables. Urban researchers have long paid attention to the causality between crime and its related socio-economic phenomena, but a majority of prior literature has focused solely on the negative impacts of urban crime on property values. The primary purpose of the present study is to investigate the causal effect of property values on crime rates by using the case study of the city of Dallas, Texas. This paper reveals that the effect of property values on urban crime tends to be presumably indirect and must be strongly associated with ecological aspects of neighborhoods. For instance, high property values may positively impact neighborhood conditions, which could therefore deter the occurrence of crime. However, high property values may possibly contribute to providing target space for potential criminals. On the other hand, low property values are likely to affect neighborhood conditions negatively, so poor neighborhoods tend to be easily associated with crime-prone environments. Based on these assumptions, this paper explicitly pointed out that highly complicated causal mechanisms between property values and urban crime could be captured by not only dividing both property values and crime rates into two major types respectively but also by utilizing instrumental variable regression framework due to endogeneity issues.

The regressions in Tables 3 and 4 provide support for the hypothesis that property values influence on urban crime rates. More specifically, the results demonstrate that the impact of property values on crime rates may differ by the type of property values rather than the type of crime. Regardless of the crime type, higher residential property values lead to lower crime rates, whereas higher commercial property values cause higher crime rates. This finding could be explained by various theoretical aspects. The majority of urban scholars of Chicago school have continued to emphasize the ecological effects of the neighborhood on crime rates. Assuming that the housing values are likely to be associated with the community prosperity or neighborhood quality, residential property values could affect urban crime through various neighborhood effects. Thus, the positive effect

that higher residential property values might have in discouraging criminal activities would be sufficiently addressed through the social disorganization theory initially suggested by Shaw and McKay(1942). Unlike residential property values, the positive impacts of commercial property values on crime could be supported by the routine activity theory developed by Cohen and Felson(1979). According to the theory, in order for a crime to occur, there must be a convergence in time and space of a suitable target, a motivated offender, and a lack of capable guardians. These three ingredients need to come together in time and space to create an opportunity for a criminal offence. As commercial property values increase, neighborhoods are likely to be more involved in commercial and economic activities at various locations where the convergence of three crime-prone elements can easily take place. Thus, crime rates for potential offenders who target communities with higher commercial property values may tend to increase.

This paper provides useful a policy discussion about the argument that rising property values, induced mainly from rapid urban development, can either deter, or stimulate urban crime. When urban development plans are expected in commercial areas, we can easily predict, and frequently observe that commercial property values solidly increase. This change in property values should be conceived of as a strong warning sign for high crime rates in a given development area. On the contrary, since the rise in residential property values does not undermine a certain level of community safety, urban policy makers might need to pay more attention to the other potential side effects caused by urban residential developments.

Although the empirical evidence used in this study is based on American data, this research might be able to provide useful policy implications to urban developments in Korea. One issue in particular, related to Korean urban policy, is rapidly rising in importance and raises concerns about a series of new town projects, not only in Seoul, but also at adjacent locations which fall into the Seoul metropolitan area. According to Gu and his colleagues' research(2009) dealing with the effects of new town projects on neighborhood housing prices in Seoul, it is very difficult to generalize public preconceptions, which assert that new town projects lead to positive externalities in surrounding areas and ultimately result in rising property values. Yet, many believe that these urban renewal projects might contribute to increasing property values in the target regions, where low or middle-income classes have previously suffered from a variety of urban problems. Thus, the assumption that urban redevelopment, change in property values, and the occurrence of crime are related, needs to be more accurately analyzed in terms of improving quality of life in neighborhoods and preliminary measures that discourage high crime rates caused by the change in property values should be carefully considered with respect to policy implications.

Three issues appear to warrant further investigation. First, this particular research is likely to suffer from omitted variable bias. A variety of regional factors such as time of construction, topography, and uniqueness of neighborhood housing market could influence property values as well as urban crime. In addition, both property values and crime are highly time-variant concepts and cannot be well addressed by cross-sectional cutting point analysis. To control these factors, which are related to regional and historical features, future research will need to incorporate a fixed effect model which is widely used for panel data analysis. Second, the present study only relies on two major categories of violent and property crime, but this classification is likely to neglect a wide range of variation and dynamics that various criminal activities may contain. Thus, a further analysis based on more specific crime categorizations could produce more useful implications such as how each specific type of crime is influenced by change in property values. Finally, better ways to measure levels of crime need to be considered for the reason that traditional crime rates are generally calculated based on the number of residents, which oftentimes can result in misleading or inappropriate conclusions. In general, population-based crime rates tend to work properly when applying them to larger areas such as metropolitan cities. However, if this particular index is used at the neighborhood level of research, using small units of analysis such as census tracts or census block-groups, it would be no trouble to consider strong mobility and continuous population flows hanging between boundaries. Therefore, the residential population fails to reflect the dynamic redistribution of population according to human activities such as commuting and population based crime rates which may consequently result in misleading information related to real crime trends. Despite some limitations that the present paper will need to overcome in future research, the findings presented here explicitly establish the causal effect of property value on crime that past research has ignored so far.

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