Do crime hot spots affect housing prices?

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The study employs hedonic price modelling to estimate the impact of crime hot spots on housing sales, controlling for property, neighbourhood and city characteristics in the Stockholm metropolitan region, Sweden. Using Geographic Information System (GIS), 2013 property sales by coordinates are combined into a single database with locations of crime hot spots detected using Getis-Ord statistics. As suggested by previous research, crime depresses property prices overall, but crime hot spots affect prices of single-family houses more than prices of flats, other factors being equal. Findings show that different types of crime affect housing prices differently and that vandalism is the type of crime that most affects prices for both multi- and single-family housing.

Keywords: *crime clusters, hedonic modelling, spatial analysis, GIS, Sweden, property values.*

Submitted to the Special Issue of Journal of Quantitative Criminology on "The Law of Crime Concentration at Places"

1. Introduction

Where crime rates go up, property prices go down (Thaler, 1978, Naroff et al., 1980, Tita et al., 2006, Rizzo, 1979, Dubin and Goodman, 1982, Clark and Cosgrove, 1990, Munroe, 2007, Ceccato and Wilhelmsson, 2011, Wilhelmsson and Ceccato, 2015, Ceccato and Wilhemsson, 2012). Yet, little is known about what happens to housing values when properties are close to places with high concentrations of crime, often called “hot spots”. Hot spots are “small places in which the occurrence of crime is so frequent that it is highly predictable, at least over a one-year period” (Sherman et al., 1989:30). The aim of this article is to contribute to this knowledge base by assessing how a property’s price is affected when the property is close to a significant crime hot spot.

This topic is relevant to criminological theory and methodology. First, crime hot spots are expected to be generated by specific criminogenic conditions that are particular and highly concentrated in space (Weisburd et al., 2009, Sherman et al., 1989, Andresen and Malleson, 2011, Curman et al., 2014). The more one knows about the nature of these places, the easier it is to predict their effects. Second, studies on the impact of crime on housing prices in recent decades have relied on crime rates, which may be problematic. The use of crime rates implies an assumption that crime risk is uniformly distributed in a particular area, with minor consideration given to potential intra-heterogeneity in the area or surrounding areas. Thus, as the goal is to assess the impact of crime on individual property prices by geographic coordinates of sales, this analytical framework imposes clear limitations.

This analysis takes the central location of crime hot spots as its reference and assesses whether housing prices decline when relatively closer to these statistically significant crime concentrations. Using Getis-Ord statistics, this measure takes into account both crime in the zone and the attributes of its neighbours in space. Hedonic price modelling is then employed to estimate the impact of crime in the neighbourhood (using the distance to the core of hot spots and crime rates), controlling for other factors (property-related characteristics and neighbourhood, city and regional contexts).

This study builds on previous research (Ceccato and Wilhelmsson, 2011, Ceccato and Wilhemsson, 2012, Wilhelmsson and Ceccato, 2015) in Sweden but is set apart by:

i. assessing the effects of both crime hot spots and crime rates on property prices, instead of limiting the analysis to crime rates only,
ii. estimating the effect of crime on both single- and multi-family homes (houses and flats),
iii. extending the study area to the whole Stockholm metropolitan region (consisting of 26 municipalities), while previous results were based on Stockholm municipality or a non-metropolitan municipality (Jönköping) and
iv. using new updated datasets for housing sales and police-recorded crime. The study is based on price data from about 396,100 property sales in 2013.

2. Theory and hypotheses

Crime hotspots are places characterised by high crime frequency. Although levels of crime vary over time in a city, the extent of crime concentrations remains similar (Weisburd and Amram, 2014), constituting hot spots of crime. This stability has attracted the attention of many scholars to the point that some provide clear evidence of the so-called “law of crime concentration at places” (e.g. Weisburd and Amram, 2014, Andresen and Malleson, 2011, Curman et al., 2014). Crime hot spots are different from other places in the city because they have the capacity to attract and/or generate crime (Brantingham and Brantingham 1995) or, for instance, to be crime radiators and/or crime absorbers (Bowers, 2014). Yet, when compared with one another, crime hot spots share a number of commonalities in terms of socio-spatial dynamics (for instance, concentrations of violence in city centres) that can be helpful in crime control. In one of the first studies about hot spots, Sherman et al. (1989) found that only 3.5% of the addresses in Minneapolis, Minnesota, accounted for 50% of all calls to the police. This concentration was even stronger for robbery, criminal sexual conduct and auto theft: only 5% of the 115,000 street addresses and intersections in the city produced 100% of the calls for those, usually stranger-perpetrated, offences (Sherman et al., 1989:30). Fifteen years later, Weisburd et al. (2004) reported that between 4% and 5% of street segments in Seattle, Washington, accounted for 50% of crime incidents for each year during a 14-year period. This criminogenic distinctiveness of crime concentrations affects these areas’ overall quality and is absorbed into the dynamics of the housing market such that property prices are reduced, at least close to such areas. *A property close to a crime hot spot has a price that is lower than if the property had been located in an area far from a crime hot spot.*

Moreover, property prices are also vulnerable to factors other than crime that, together with crime, help pull prices down and need to be controlled for (Ceccato and Wilhelmsson, 2011). For instance, high crime areas may also have few environmental amenities and poor accessibility to services, which also affect the perceptions of buyers. Thus, crime hot spots must be taken into account; otherwise the impact of crime on real estate prices may be overstated. However, it is not easy to assess the influence of different land uses on property values. One reason is that certain types of land use may affect a place both positively and negatively, making it difficult to assess. For example, although it is expected that urban parks increase property values, Troy and Grove (2008) show that parks' desirable effects are not incorporated into pricing in the housing market in a homogeneous way and are actually counteracted by crime at the park. The same applies to features such as transport nodes or schools (Kane et al., 2006, Bowes and Ihlanfeldt, 2001). Another reason for this difficulty is that different types of land use attract, generate and/or radiate different types of crime. Some crimes are bound to affect one area more than others. Lynch and Rasmussen (2001), for instance, weighted the seriousness of offences by the cost of crime to victims and showed that, although cost of crime had no impact on house prices overall, properties were cheaper in high-crime areas. In London, vandalism had the strongest impact on prices, while in Stockholm municipality residential burglary seems to have similar effect (Gibbons, 2004, Ceccato and Wilhelmsson, 2011). Vandalism has a significant and independent effect on flat prices in Stockholm municipality even after the impact of fear of crime is controlled for. *Therefore it is hypothesized that effects of crime vary by type of offence and housing type. Based on previous research, it is expected that hot spots of residential burglary and vandalism will have the strongest effect on prices*.

3. The study area

Stockholm's metropolitan area (or Stockholm county, in Swedish, *Storstockholm*), is composed of the municipality of Stockholm (Sweden's capital) and 25 other surrounding municipalities (Figure 1). The region is located on Sweden's south-central east coast, where Lake Mälaren, Sweden's third largest lake, flows into the Baltic Sea. It is the largest of the three metropolitan areas in Sweden, with an area of 6,519 square kilometres and about 2.2 million inhabitants in 2014, half of them residing in Stockholm municipality. The area is served by an extensive public transportation system (three underground lines with more than 100 stations, 2,000 buses, 5,000 taxicabs, dozens of ferryboats and several tram routes) as well as roads, so the archipelago of islands that constitute the metropolitan area is well connected. Many residential areas are also exposed to a variety of environmental amenities, such as plenty of buildings facing bodies of water and forested areas, features that often translate into higher prices in the housing market. The city was recently granted the European green capital award and has been considered one of the most accessible cities in Europe (EC, 2011, EC, 2010). Although other types of housing tenure can also be found, privately or co-operatively owned blocks of flats dominate the most central parts of the metropolitan area. Large sections of Stockholm's inner city have residential land use, where citizens enjoy a good quality of life with high housing standards. The same applies to inner centres in the municipalities that compose the Stockholm metropolitan area. Yet, there are flats built in the 1960s and 1970s throughout the Stockholm region that do not command high prices in the housing market. Some residential areas are often associated with poor architecture, lack of amenities and social problems, including crime.

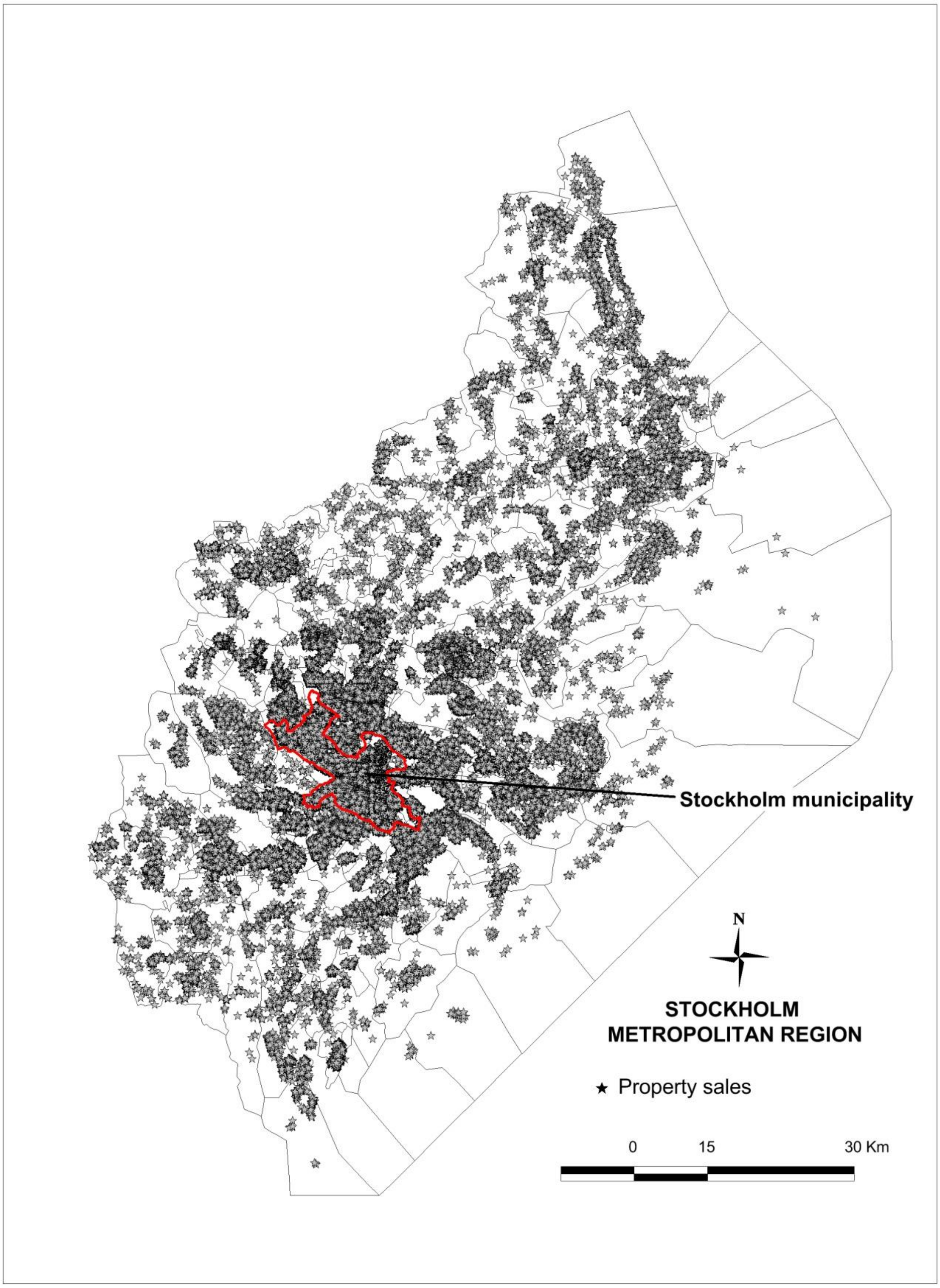

Figure 1 – Stockholm metropolitan area: Study area.

In terms of crime reporting, the metropolitan region follows the national trend of increases in violence (13%) and vandalism (44%) and reduction in thefts, for instance for car-related theft (-66%) (Figure 2). The Swedish Crime Victim Surveys confirm a similar decreasing victimization pattern for the region (from 8.8%, to 6.9% for violence, and from 12.1%, to 10.7% for property crimes) as well as declared perceived safety (from 24%, to 18% of the population declaring themselves afraid of going out in the evenings) between 2005 and 2013. In criminogenic terms, patterns of crime follow the urban/urbanized structure of the region. The geography of crime in the region has been changing since the early 1990s and has varied across space depending on crime type (for examples in Stockholm municipality, see Wikström (1991); Ceccato et al. (2002); Uittenbogaard and Ceccato (2012)). At least for flats, residential burglary, theft, vandalism, assault and robbery individually show a negative effect on prices in Stockholm municipality; a similar impact was confirmed for fear of crime (Ceccato and Wilhelmsson, 2011, Ceccato and Wilhelmsson, 2012).

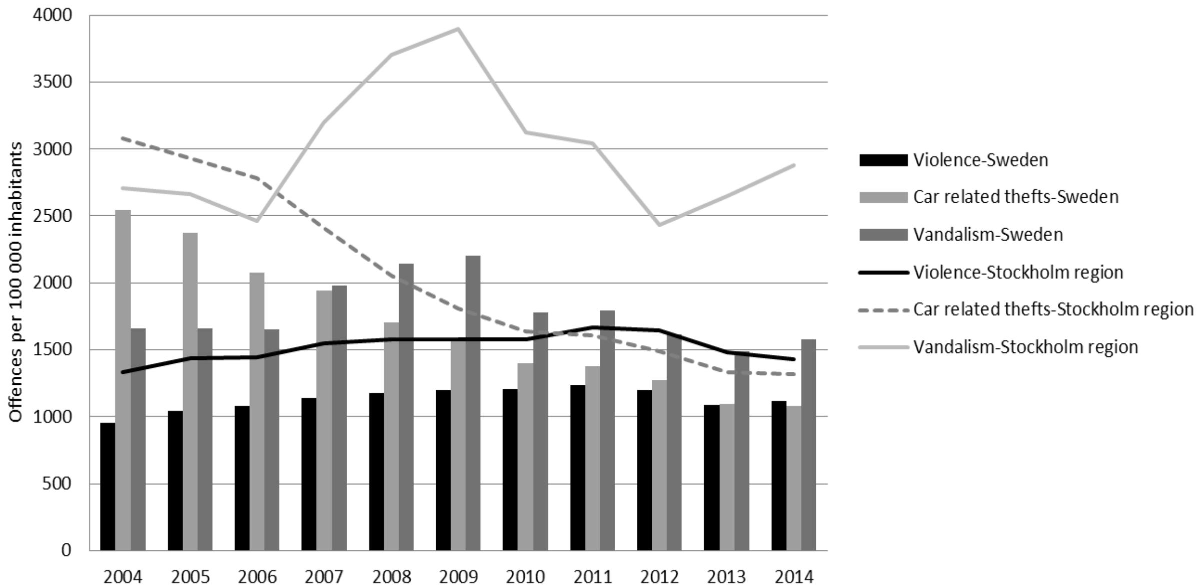

Figure 2 – Police recorded offences, Stockholm metropolitan region and Sweden, 2004–2014. Data source: The Swedish National Council for Crime Prevention (Brå), 2016.

Crime concentrations are found in the city centres of the region's municipalities, in transportation nodes, some shopping malls and retail outlets (e.g. Kista Galleria, Skärholmen centre, Kungens Kurva commercial area), but the largest and most stable hot spots are found in Stockholm's inner city areas (Figure 1), where the main public transport junction is located, as well as areas belonging to the city's Central Business District (CBD). No previous studies have dealt with the specific relationship between crime concentrations and housing prices or, in other words, whether people would be willing to pay more to live far from these hot spots of crime regardless of the municipality in which they live in the metropolitan region.

4. Data and methods

Table 1 below presents the data used to estimate the hedonic price models. The data cover a time span from January 2013 to December 2013 and consist of 396,100 transactions of property sales, both single- and multi-family homes (houses and flats in condominiums). The data come from the company Valueguard, which gathers data on prices and property attributes. The database contains property address, area code, parish code, selling price, living area, year of construction, presence of balcony and elevator, price per square meter, date of contract, monthly fee to the condominium association, number of rooms, date of disposal, number of the floor of the specific flat, total number of floors in building, postal code and x,y coordinates.

Table 1 - Descriptive statistics (average and standard deviation)

	Flats/Condominiums		Single-family houses	
	Mean	Standard deviation	Mean	Standard deviation
Dependent variable				
Transaction price	2 756 114	1 833 382	3 890 844	2 563 779
Property attributes				
Living area	64.89	27.08	114.99	44.94
Other area	-	-	24.23	36.71
Monthly fee	3 476.39	1 450.39	-	-
No. of rooms	2.42	1.12	-	-
Building year	1962	36	1968	25
Quality index	-	-	24.55	10.51
Detached house	-	-	0.17	0.38
Semi-detached house	-	-	0.11	0.32
Waterfront	-	-	0.01	0.12
Water view	-	-	0.05	0.22
Lot size	-	-	1 446.13	8 827.91
Urbanisation				
Share of built area	0.56	0.24	0.42	0.28
Share high-rise buildings	0.48	0.40	0.04	0.11
Share low-rise buildings	0.21	0.32	0.70	0.97
Share single-family houses	0.15	0.28	0.87	0.21
Accessibility				
Public transportation	113.43	7.65	99.21	11.34
Car	115.18	6.75	111.58	10.89
Distance to CBD	9 701	10 190	23 680	17 120
Crime rate				
Total	133.18	709.44	48.31	341.52
Residential burglary	0.90	4.73	0.50	3.55
Violence	0.61	1.49	0.39	1.02
Vandalism	9.79	42.69	3.36	15.11
Car thefts	3.97	42.66	0.53	3.61
Distance to hot spots				
Total	3 840	5 994	12 369	13 317
Residential burglary	3 017	5 504	9 302	10 166
Violence	3 049	5 249	10 031	12 816
Vandalism	3 152	5 520	10 467	12 988
Car thefts				
No. of observations	92 899		25 630	

The cross-sectional data have been merged with land use data from the Stockholm metropolitan area’s database and with police records from Stockholm Police headquarters. Police records were mapped using x,y coordinates for each offence in 2013. The data for some of the control variables (for instance, indicators of urbanization and accessibility) come from the company WSP. The distance between property addresses and the Stockholm CBD has been estimated in GIS. Two types of crime variables were created: crime rates (by resident population) and distance (in meters) to the centroid of a statistically significant crime cluster generated using Getis-Ord statistics (see section 4.1).

Crime rates were calculated by using data by small unit areas (*basområde*, the smallest geographical unit for which statistical data is available in Sweden) in a total of 1,298 units (Figure 1). The procedure was as follows. Rates per small unit area were calculated for total crime, residential burglary, violence, vandalism and car thefts. To link crime rates to the x,y coordinates of each property sale, the Stockholm metropolitan map with 1,298 units was layered over the properties' x,y coordinates. All sales within the boundaries of a small unit area would get that small unit area's crime rates. This procedure was performed using the standard table join function in GIS. For more details, see Ceccato and Wilhelmsson (2011).

4.1 Pre-analysis of the crime data

To identify significantly high crime concentrations taking into account the whole distribution of offences in the Stockholm metropolitan region, a local indicator of spatial association was calculated in GeoDa (Anselin, 2003). Getis-Ord statistics (Getis and Ord, 1992, Anselin, 1995) was applied to the rates of crime per smallest unit of analysis (*basområde*) using resident population as the denominator. This technique is useful to detect local pockets of dependence that may not show up using global measures of spatial association (Getis and Ord, 1992, Karlström and Ceccato, 2002). Getis-Ord statistics can be described as the ratio of the sum of values in a neighbourhood of an area to the sum of all values in the sample. The significance of the z-value of each local indicator can be computed under the assumption that attribute values are distributed at random across the area. The formula is

$$G_i = \frac{\sum_j w_{ij}(d) x_j}{\sum_j x_j} \quad (1)$$

where the *wij(d)* are the elements of the contiguity matrix for distance *d*, in this case, a binary spatial matrix. In a simple 0/1 matrix, "1" indicates that the areas have a common border, "0" otherwise. When the model provides a measure of spatial clustering that includes the observation ($j = i$) under consideration, in other words, when the core area is included, the model is called *Gi**, as it was in this case. To express the spatial configuration of the study area, we used a weight matrix that was row standardised. A column was created to store the results of Gi* statistics by *basområde*. The value of interest was "1", indicating high-high values, namely statistically significant positive Gi* clusters, using randomization (99 permutations, with values smaller than 0.010). We calculated the distance in meters from the coordinates for property sales to the centroid of each hot spot of crime (core polygon). Figure 3 illustrates the dataset used in the analysis: property sales, crime per coordinates and the results of Getis-Ord statistics by *basområde* in the background.

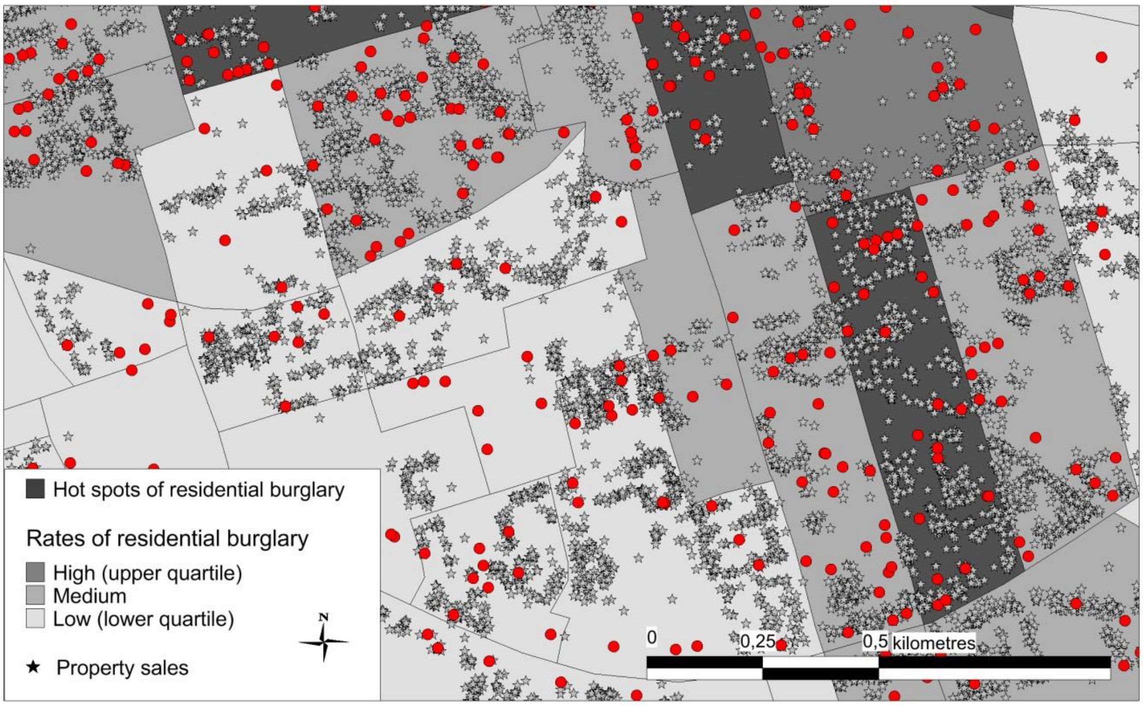

Figure 3 – Sales (stars), Residential burglaries (circles) and hot spots of residential burglary (Getis-Ord statistics by *basområde*).

- *The hedonic pricing equation*

Hedonic pricing models are used here to assess property value and are based on the fact that, according to Rosen (1974), the prices of goods in a market are affected by their characteristics, which can be implicitly revealed by observed differences in prices. It can also help to estimate the value of a commodity based on people's willingness to pay for the commodity. In the case of housing, preferences for various attributes are revealed through the price one implicitly pays for these attributes. In the case of crime, prices would reveal how much buyers pay to avoid living near a crime hot spot. This can be expressed as:

$$y = \beta x + \varepsilon \qquad (2)$$

where y is a vector of observations of the sale price; X is a matrix of observations on the property attributes, including crime rates and distance to crime hot spots, β is the associated vector of regression coefficients (the marginal implicit price of each attribute) and ε is a vector of random error terms.

Two different data samples were used in this analysis. The first dataset was composed of sales of flats in multi-family dwellings (flats), and the second dataset constitute transactions involving single-family or detached houses. Although flats have on average a lower price than single-family houses, the variation of the transaction prices is relatively high in both samples (Table 1).

As already suggested by previous studies, there is no consensus on which set of relevant characteristics of the city structure and environments should be selected for hedonic modelling (Ceccato and Wilhelmsson, 2011), because it is difficult to control for all possible relevant neighbourhood factors (Can, 1990). Yet, characteristics of the property, characteristics of the property location and features of the neighbourhood are part of the common practice. In this study, five different types of attribute were used that explain the variation in prices. The first set of attributes refers to the dwelling itself, such as size, building year and water view. There is a big difference in size between flats and single-family houses. The average single-family house is nearly twice as big as a flat. It was also observed that the flats were slightly older on average. All variables have a high variation (standard deviation) relative to the average. The second set of attributes refers to the degree of urbanization. Here we use the information about the proportion of built area, the proportion of high-rise and low-rise buildings and the proportion of single-family houses. It is perhaps obvious that flats are located in areas with a higher degree of high-rise buildings and a lower degree of single-family houses. Likewise, the opposite is true for single-family houses. The third set of attributes relates to properties' accessibility, which was measured in three different ways. The first is based on a generalized travel cost for public transportation to work, and the other the same cost but by car. The third variable refers to distance to the Central Business District (CBD). Clearly accessibility in the form of generalized travel costs is lower in the single-family sample, and the distance measured to the CBD is shorter in the sample for flats. The constant time and parish effects (fixed time effects/fixed parish effects) are included in the models but not reported here.

The third set of attributes comprises crime rate as discussed above. On average, crime rates are higher in the sample for flats than in the sample for single-family houses (Table 1). The last set of attributes used in the hedonic model is the distance to crime hot spots. The variable hotspot used in the hedonic model has been defined as the shortest distance between the observations' location (sales) and the centroid of the core of statistically significant hot spots of crime defined by Getis-Ord statistics. The sample of flats is on average closer to a crime hot spot (around 3,000 meters) than the observations in the sample for single-family houses (about 12,000 meters). Note that the testing of a blurred spatial average of crime variable (W_X) as a way to flag for the effect of crime from neighbouring zones as suggested by previous literature (e.g. Ceccato and Wilhelmsson, 2011) was deliberately avoided in this case since the procedure would be counterintuitive to the idea of using hot spots (the spatial average would 'smooth' the hot spot map and be therefore be similar to the original crime rates).

5. Findings

Results are presented in two parts. First, the estimates of the hedonic price equation taking into account the effect of total crime on property prices (rates and distances to hot spots) are reported in Table 2. Second, the estimates when testing the effects of different types of crime on prices are presented in Table 3 for both single-family and multi-family housing.

The model that explains the variation in flat prices in Table 2 has a very high power of explanation, given that it is cross-sectional data, with as much as 90% of the price variation explained by the independent variables. Of primary interest is our estimate of the crime variables. The proportion of crime in the area has a negative impact on the price. If the proportion of crime increases 1%, prices are expected to drop 0.015%. The impact of crime on housing prices in North American cities is greater than the effects found in Stockholm, even after considering differences in crime type and methodology. For instance, Lynch et al. (2000) found an elasticity of 0.05 for violent crimes in Jacksonville, Florida, while Naroff et al. (1980) reported an elasticity of 0.63 for total crimes in Boston. Equally interesting in Stockholm, if the distance to the hotspot increases by 1,000 meters, prices are expected to increase by 0.012%. The significance of the “distance to hotspot” coefficient indicates that crime concentration increase housing price variations even when the total crime rate has already been shown to have a significant price effect. Overall, all coefficients have expected sign, for instance, an increase in flat size increases the price of the dwelling, while the value decreases if the fee to the association increases. Prices will increase by approximately 0.048% if the proportion of developed land (share of built area) in the neighbourhood increases prices by 1%. Compared to medium-sized buildings, both high-rises and low-rises have a negative impact on prices. An increase in the proportion of single-family houses also appears to increase flat prices. All coefficients regarding accessibility have the expected signs and are at a reasonable level.

Table 2 - Results – Total crime (OLS)

	Flats/Condominiums		Single-family houses	
	Coefficient	t-value	Coefficient	t-value
Property attributes				
Living area	0.0126	244.55	0.0039	93.70
Other area	-	-	0.0008	17.60
Monthly fee	-0.0001	-84.45	-	-
No. of rooms	0.0315	28.53	-	-
Building year	0.0004	18.82	0.0014	21.53
Quality index	-	-	0.0109	32.30
Detached house	-	-	-0.2320	-55.81
Semi-detached house	-	-	-0.1421	-30.51
Waterfront	-	-	0.6630	57.29
Water view	-	-	0.1841	30.74
Lot size 10^{-3}	-	-	0.0387	81.89
Urbanisation				
Share of built area	0.0486	15.60	0.0254	3.09
Share high-rise buildings	-0.0893	-34.61	0.0642	2.86
Share low-rise buildings	-0.0674	-16.92	0.1026	14.87
Share single-family houses	0.0428	8.01	-0.0459	-6.03
Accessibility				
Public transportation	0.0117	34.70	0.0018	4.52
Car	0.0039	12.39	0.0072	9.54
Distance to CBD 10^{-3}	-0.0280	-38.85	-0.0253	-28.52
Crime rate				
Total 10^{-3}	-0.0151	-38.85	0.0059	1.50
Distance to hot spots				
Total 10^{-3}	0.0121	14.86	0.0170	19.09
R-square	0.899		0.877	

Note: Constant time and parish effects are included in the model but not shown in the table.

For the model of single-family houses, the explanation power is also very high for this type of analysis. Almost 88% of the price variation in single-family houses can be explained by the independent variables. In this model, too, all coefficients have expected sign, including crime variables. Dwelling size increases the value of the home, increased quality increases the value, townhouses and semi-detached houses have a lower value relative to detached houses, and locations close to water increase the value. The degree of urbanization appears to increase the value of the home, which probably has to do with the level of urbanization being greater the closer the property is located to the CBD. The value of a single-family house increases with accessibility. Understandably, accessibility in the form of public transportation has a slightly lower effect on single-family house prices than on prices for flats. As initially suggested, crime affects prices differently for single-family houses when compared to the model concerning flat prices. Results suggest that the distance to crime hot spots is the only variable that can explain the price variation. The further a property is from a crime hot spot, the higher the value of the single-family house. For single-family houses, the average crime rates in the area have a minor impact (for burglary) or do not have any impact at all.

Table 3 – Fitting OLS Hedonic Model (Y = Logprice), Results for full sample.

		Rate		Hotspot		R-square	AIC
		Coefficient 10^{-3}	t-value	Coefficient 10^{-5}	t-value		
Burglary	Multi-family	-1.2336	-3.19	1.34	16.70	0.8766	-38548.2
	Single-family	-3.1386	-2.10	0.0148	0.21	0.8766	5494.3
Violence	Multi-family	-0.0236	-7.72	0.0763	1.00	0.8987	-38382.1
	Single-family	0.1216	0.33	1.34	14.37	0.8767	5253.8
Vandalism	Multi-family	-0.2104	-15.34	1.96	26.47	0.8995	-39029.8
	Single-family	0.0117	0.12	1.41	15.04	0.8768	5234.7
Car theft	Multi-family	-2.7826	-21.09	-0.0442	-0.56	0.8992	-38625.5
	Single-family	0.1109	0.29	1.4	16.43	0.8764	5219.4

Note: Property attributes and accessibility variables as well as constant time and parish effects are included in the model but not shown in the table.

Table 3 presents the results of estimations regarding the types of crime separately. The first table reports the results of all observations, the second table the results from a restricted sample. The various types of crime have been estimated separately, i.e., the first regression refers to burglary, the dependent variable referring to flat prices. The model includes all the variables on the type of flat, accessibility and area attributes. Also included are the two crime variables - crime rate, as well as, a variable that measures the shortest distance to a hot spot. The models are thus likely to show whether the distance to a hot spot can better explain the effect of the crime on prices. As expected, the sign of the coefficient for the crime rate is negative, while the distance to the hot spot is anticipated positive. The results indicate that all types of crime have a negative impact on the price, whether for flats or single-family houses. However, crime rates seem to have a clearer impact on flat prices than on the prices for single-family houses. Distance to a hot spot has the expected sign and is statistically significant in many cases though not in all cases.

Vandalism is the type of crime that increases the coefficient most in both the multi-family model and the single-family model. The distance to the hot spot in both models has the expected effect, that is, the farther from a hot spot a home is located, the higher the price, all other factors being equal. The effect in magnitude of distance to the hot spot is similar for the two housing types. However, note that vandalism rates do not have a negative impact on prices of single-family houses, only on flat prices.

6. Conclusions

Previous research has shown that properties are more discounted in areas with high crime rates. Instead of using crime rates, this study assesses the relationship between housing prices and the location of crime hot spots detected using Getis-Ord statistics. Two main hypotheses were tested in this study. The first relates to crime impact on flat prices after controlling for attributes of the property and neighbourhood characteristics, whether crime is indicated by using crime rates or distance to crime hot spots. Findings show that being close to crime concentrations has a depressive effect on the housing market independent of crime rates, but this effect is particular for single-family houses. One explanation of this is that the areas in which single-family houses are located have crime rates that are lower than the areas with flats. Thus, if a crime hot spot is close to single-family houses, it should be perceived by buyers more negatively than in areas where there are many crime hot spots.

Second, it was hypothesized that the impact of crime varies by type of offence and housing type. Results show that vandalism is the type of crime that most affects prices for both multi- and single-family housing. These results corroborate other findings found elsewhere in the recent international literature, for instance, for the case of vandalism in London (Gibbons 2004) and partially in Stockholm municipality (Ceccato and Wilhemsson, 2012, Ceccato and Wilhelmsson, 2011). Vandalism impacts an area in different ways. First, it affects the appearance. House buyers read vandalism and incivilities as a sign that nobody is in control of the area, an indicator of neighbourhood decline (Wilson and Kelling, 1982), so they avoid these areas if they can. Moreover, events of vandalism impact on property prices, because they induce fear of crime. Previous research suggests that fear of crime is highly affected by physical damage (for example, Killias and Clerici (2000)), a crime common in many municipalities of the Stockholm region. Second, as stated by Sampson et al. (1999:609), “vandalism may not directly ‘cause’ other more serious crimes but they do share the same explanatory processes, with the difference that vandalism can be observed by everybody in the area: residents, visitors and potential offenders” as well as property buyers. In Stockholm (but not in London), evidence shows that vandalism is associated with other crimes. The highest correlation is found between hot spots of vandalism and high concentrations of violence and car theft (r = 0.72** and r = 0.40**); for residential burglary, the correlation is r = 0.12**. This suggests the link between vandalism and other types of crime are present throughout the Stockholm metropolitan region.

The current study is not without its limitations. First, it remains to be tested whether estimates of property prices substantially diminish as other features of neighbourhoods are controlled for. Another issue is the causal relationship between housing prices and residential burglary that seems to go in both directions, introducing the problem of endogeneity. Thus, areas with high property prices may attract residential burglary, and therefore the number of burglaries will be high in high-priced neighbourhoods. One way forward is to add an instrumental variable to crime by purging its correlation with unobservable influences on flat prices, using variables that are correlated with hot spots of residential burglary but not with flat prices. Previous research indicates that robbery, car theft, violence and vandalism may be more exogenous and thereby less complicated when it comes to the estimation of the hedonic price equation (Ceccato and Wilhelmsson, 2011). Something that is also missing in this study is a test of the potential effects of crime "cold spots" (instead of hot spots), on the housing market, something not yet tested in the international literature.

Future research should assess whether crime effects are consistent across space. This is because the prices of different property attributes are a function of many different demand and supply factors. Ceccato and Wilhelmsson (2011) suggest that if the average income among households is higher in one area, it could be expected that the price of having a property not close to a crime hot spot is higher than in an area where household incomes are lower. Moreover, even if all demand factors do not vary in space, the implicit price may fluctuate with the supply of attributes. The relative scarcity of properties far from a crime hot spot in the inner city would suggest the price of properties is high compared to the suburbs, where hot spots of crime are fewer and dispersed (places far from crime hot spots are abundant). Future studies should investigate whether the price of a property far from a hot spot of crime is higher in the inner central areas as a result of higher income and relative scarcity of residential areas far from a crime hot spot.

What are the implications of these results for policy? If crime pulls down housing prices and its occurrence is fairly predictable over time, at least in these hot spots, we take the view that public policies should focus on these particular places to better tackle safety problems, strengthen housing markets and consequently improve residents' quality of life. This is particularly relevant to many relevant stake holders (for example, police, urban planners, housing companies) in areas with single-family houses where hot spots of crime have the strongest impact on buyers' appreciation of the areas. For police officers, this information has potential to help defining better policing strategies directed to these particular places and at particular times, as it has been previously suggested by hot spots policing in the North American context (see e.g. Braga, 2007:1, Weisburd et al., 2011). For urban planners and experts from housing companies, this information can guide their long term work in 'cooling down' these crime hot spots. First, by investigating what make these spots "hot" and then by making the necessary changes in the environment to reduce crime opportunities.

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