IMPACT OF NEIGHBOURHOOD CHARACTERISTICS ON HOUSE PRICES

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ABSTRACT

Urban residential house prices depend on two broad factors: (1) tangible factors - characteristics of the dwelling units and (2) intangible factors - neighbourhood characteristics, services and environment. This study estimates the impact of neighbourhood characteristics, particularly adjacent ravines, amount of public land and incidence of crimes on house prices in the city of Edmonton, Alberta, Canada. Several multiple regression models were estimated using average assessed house prices of 2008 as the dependent variable and a set of neighbourhood characteristics including crime incidences of 2007 as independent variables. Results indicate that household income and adjacency to ravines positively influence house prices. Although adjacency to ravines and household income are positively correlated, they both independently contribute to house prices. In addition the inclusion of an irrelevant variable is less problematic than the exclusion of a relevant variable. Crime variables, in general, have negative impact on house prices but their impacts were negligible, and a model without these variables did not reduce the efficacy of the estimated model.

INTRODUCTION

Urban residential houses are segregated into neighbourhoods identified apparently by geographical locations. Households residing in a neighbourhood have similarity in socio-economic characteristics and preferences, i.e., household income, family size, anticipated services and neighbourhood characteristics including adjacency to ravines, amount of natural areas, and social and property crimes. Such characteristics and preferences, in general, vary from one neighbourhood to another. Recognizing these inter-neighbourhood differences and intra-neighbourhood similarities, Tiebout (1956) presented his theory of local expenditure. He predicted that households with similar interests form nearly-homogeneous neighbourhoods. In urban areas, households in the same neighbourhood have similar demands for services, comparable abilities to pay for those, and analogous aspirations for social, economic and physical environments. Lynch and Rasmussen (2004), building on Tiebout (1956) and using income as a single criterion, asserted that households demanding high quality services have natural incentives to exclude relatively low-income households from the neighbourhood.

Lower income households have less ability to pay for services sought by neighbouring high-income households. The presence of low income households in the neighbourhood is perceived to be associated with social nuisance and less demand for better neighbourhood environment. In addition, high-income households prefer neighbourhoods that are populated with high-income households with stronger desire to have high-quality neighbourhood services and environments. They have both the ability and the willingness to pay premium prices for those services in a sustainable manner.

House prices vary from one neighbourhood to the other depending on neighbourhood characteristics and environments. Brasington and Hite (2005) presented that the price of a house depends on two broad factors. One, the expenditure on a number of characteristics of the dwelling unit itself, such as number of rooms, number of bathrooms, size of dwelling unit and other inner facilities, which constitute the tangible part. The other less tangible component includes neighbourhood services and environment including average income of households in the neighbourhood, house and lot size of the neighbours, accessibility to main arterial roads, adjacency to green spaces and ravines, amount of natural areas, availability of good schools and community centres, and adjacency to nuisances, such as, electric power lines, industrial areas, etc.

Expenditures made on the first set of factors are tangible and are determined easily by observed market conditions, which are primarily impacted by the price of constructional materials and labour. Expenditures on the second set of factors are difficult to obtain as market conditions for these goods and services are difficult to observe. In the absence of direct market prices, measures of willingness to pay, travel costs, hedonic price measurement, household production approach, etc. have been used by different researchers to come up with prices for such variables and ultimately their impact on house prices. For newly constructed houses, these effects are reflected almost entirely within higher lot prices.

House prices do not reflect the arbitrage of tradable divisible commodities and therefore the law of one price does not necessarily hold (Allen et al. 2006). This holds true for both pre-owned and newly-constructed houses. Using data from six major metropolitan areas in Ohio, Brasington and Hite (2005) demonstrated that there are significant spatial effects on house prices – closer the point-source of pollution lower is the house price. Similar studies were conducted to determine the impact of overhead power lines (Sims and Dent, 2005), proximity to public open spaces (Luttik, 2000; Irwin, 2002; Dehring and Dunse, 2006), nearby rail transit (Hsu and Guo, 2005), adjacent subway lines (Lin and Hwang, 2004), cost of crime and crime risk (Lynch and Rasmussen, 2001; Linden and Rockoff, 2008), adjacency to elementary schools (Gibbons and Machin, 2003) and environmental contamination and positive environmental amenities (Brasington and Hite, 2005; Simons and Saginot, 2006) on house prices. However, the impact of adjacent ravines, the amount of natural areas and the amount of social and property crimes along with other common neighbourhood characteristics on house prices are scanty. The principal objective of this study is to estimate the impact of adjacent ravines, the amount of natural areas and different crime rates on the average price of detached residential houses in Edmonton, Alberta, Canada.

MODEL AND DATA

House prices in purely residential neighbourhoods and those in mixed residential and commercial neighbourhoods are different. Neighbourhood characteristics and environmental amenities in those types of neighbourhoods are also different and should be modelled separately. For homogeneous residential neighbourhoods, the price of a house and its different characteristics can be depicted in a simple generalized model as: $P = f(H, N, E, O)$ where, ***P*** denotes the price level at a particular time; ***H*** represents a vector of the characteristics of the house – number of rooms, bath-rooms, arrangements, kitchen areas, other rooms, construction materials, etc.; ***N*** is a vector of neighbourhood characteristics – demographic, economic, social and others including neighbourhood crimes; ***E*** is a vector of environmental characteristics – both macro- and micro-environmental qualities including overall air-quality, proximity to schools, community halls, shopping centres, ravines, natural areas, rivers, etc.; and ***O*** denotes a vector of other factors not included in any of the categories.

It is important to note that the actual buying or selling price of a house depends on market conditions, interaction of supply and demand. Both the demand for and the supply of residential housing are affected by several factors. Factors affecting either supply of or demand for or both influence the housing market causing changes in the price level. We also know that housing prices do not represent a divisible tradable market as every house is different. However, we can assume that such factors illustrated above will affect housing prices with the same proportion, and the generalized equation mentioned above to examine the contribution of individual factors on house prices can be used. Another note to this simple model is that every house is unique in its characteristics, and capturing price through characteristics will be subjected to errors. Such errors are assumed to be small for most houses although an outlier containing a large error is not impossible. To further dilute such errors, an average of major characteristics can be used. Many researchers use aggregate data to minimize such uniqueness of individual observations.

Level of aggregation is another point of contention. A seemingly comprehensive study including all neighbourhoods of a city or metropolitan area would be of relatively less value. Separate studies for separate categories of neighbourhoods, residential, commercial, industrial, mixed, etc. would be more appropriate to determine the impact of neighbourhood characteristics on house prices. This study focuses purely on residential neighbourhoods by eliminating all commercial and semi-commercial neighbourhoods from the sample.

The standard residential neighbourhood definition developed and followed by the City of Edmonton was used and spatial data for 192 mature residential neighbourhoods were used. Neighbourhoods with a median construction year of 2000 or later were considered as immature. Immature neighbourhoods were not included in this study for several reasons. First, data on newer neighbourhoods are scanty and often erratic as population, number houses and all other characteristics continuously change. Second, newer neighbourhoods have little or no developed green areas, parks, ravines and natural areas. Third, for new houses, lots and buildings are usually priced separately and adjacency to ravines and the amount of natural areas get included in the lot price. Mature neighbourhoods are usually stable in terms of population, number of property structure and arrangement. Most characteristics of the neighbourhoods do not change over time.

Data on 192 neighbourhoods were obtained from several sources including published reports on the City of Edmonton Community Profiles, the Edmonton Police Service, City of Edmonton Planning and Development department and observed data from the official map of the City of Edmonton. As there are substantial variations among neighbourhoods in different quadrants of the city, the neighbourhoods were categorized into four quadrants, north-east, north-west, south-east and south-west.

The regression equation used to estimate the model is as follows:

$$VAL08 = \beta_0 + \beta_1 RAV + \beta_2 PUBS + \beta_3 INCMN + \beta_4 AGE + \beta_5 PDEN + \beta_6 HHS + \beta_7 HHA + \beta_8 DA + \beta_9 SW + \beta_{10} SE + \beta_{11} NE + \beta_{12} SX07 + \beta_{13} NX07 + \beta_{14} ROB07 + \beta_{15} BE07 + \beta_{16} VT07$$

A description of these variables is provided in the table below:

VAL08	Average value of detached houses in the neighbourhood for 2008 as determined by the City of Edmonton's Assessment and Taxation department
RAV	A dummy variable for adjacency to ravines; 1 having an adjacent ravine area and zero otherwise
SE	A dummy variable for the neighbourhood being in south-east quadrant of the city; 1 if the neighbourhood is in south east and zero otherwise
NE	A dummy variable for the neighbourhood being in north-east quadrant of the city; 1 if

	the neighbourhood is in north east and zero otherwise
SW	A dummy variable for the neighbourhood being in south-west quadrant of the city; 1 if the neighbourhood is in south west and zero otherwise [A dummy variable for north-west was not included to avoid singularity problem]
INCMN	Average annual household income for 2005 for the neighbourhood as reported in the City of Edmonton's community profile
PDEN	Population density – number of person per hectare as reported in the Federal Census of 2005
BE07	Number of residential break and entry per 1000 people in the neighbourhood for 2007 as reported in the Neighbourhood Crime Statistics by the Edmonton Police Service
SX07	Number of sexual assault per 1000 people in the neighbourhood for 2007 as reported in the Neighbourhood Crime Statistics by the Edmonton Police Service
NX07	Number of non-sexual assault per 1000 people in the neighbourhood for 2007 as reported in the Neighbourhood Crime Statistics by the Edmonton Police Service
ROB07	Number of robbery per 1000 people in the neighbourhood for 2007 as reported in the Neighbourhood Crime Statistics by the Edmonton Police Service
VT07	Number of vehicle theft per 1000 people in the neighbourhood for 2007 as reported in the Neighbourhood Crime Statistics by the Edmonton Police Service
AGE	Mean construction age of the neighbourhood calculated from 2010
HHA	Average area in square feet devoted to each house in the neighbourhood
DA	Average dwelling area in square feet for each house in the neighbourhood
PUBS	Amount of public land available per 1000 people in the neighbourhood

As indicated in the table above, data for this study were obtained from several sources. The dependent variable, pre-owned detached house price, was obtained from the Assessment and Taxation department of the City of Edmonton. This price level is more relevant as it includes prices of all detached houses in the neighbourhood. An alternative would have been to collect the actual sale price from the Edmonton Real Estate Board, which would provide skewed information depending on what category of houses were sold during the period of data collection or the period of study. Also the price level of residential properties in Edmonton has been anything but stable. In this kind of highly inflationary market, actual price data from one time cannot be comparable to that of another time. Data on tangible variables reflecting house characteristics such as average number bedrooms, bathrooms, kitchens, etc. were not available. These, however, should not reduce the quality of information as the size of the dwelling are is highly correlated with the number of bedrooms and bathrooms. In that an assumption has been made that dwelling area contains all such variables.

The set of selected independent variables including dummy variables for residential neighbourhoods in north-east, north-west and south-west (As in many other cities, residential property values in Edmonton differ from one quadrant to the other. A house with same characteristics will typically sell more in south-west than in north-east.). A dummy variable for north-west was not included to avoid perfect multicollinearity and singularity of the matrix. Average annual income, population density, total area allocated to each household, median age of construction, household size, average area of public land and average dwelling area were obtained from the reports on Community Profiles published by the City of Edmonton. Data on the total number of sexual assault, non-sexual assault, robbery, break and entry, and vehicle theft were obtained from Edmonton Police Service. Adjacency of each neighbourhood to ravines was recorded from the official map obtained from the City of Edmonton. Mean values and standard deviations of the variables used in this study are presented in Table 1.

A multiple regression analysis was computed using house price for 2008 as the dependent variable and the set of selected relevant neighbourhood characteristics and environmental amenities including adjacency of ravines and the amount of natural areas as independent variables. These variables were selected from a number of possible contributory variables. The selected relevant independent variables mentioned earlier were identified following three model selection criteria – adjusted R-square values, Akaike Information Criterion and Schwarz Criterion. For the appropriate functional form specification, linear and log-linear models were tried. For the average price level of 2008, the crime variables were used for 2007 as the price variable used was the assessed values reported by the City of Edmonton. The City started assessing the value of houses based on the market value since 1995. It is the valuation of property based upon market value, which is defined as the amount that a property might be expected to realize if sold on the open market by a willing seller to a willing buyer as of July 1 of the previous year. The assessment uses many of the same factors that real estate agents use to determine the value of homes for sale. These include recent home sales statistics, house style (bungalow, bi-level, two-story), lot size, house size, year built, basement development, garage size and type (detached or attached), exterior finish, building condition, roof type, fireplace, air conditioning, swimming pool, and house site or location (nearby golf course, lake, park, ravine, river valley, commercial, institutional, multi-family, traffic, etc.).

Table 1. Mean values of the common variables used in this study

Variable	Mean	Standard Deviation
VAL08	445370	136580
SX07	0.7381	0.8993
NX07	7.0677	10.4190
ROB07	1.7724	2.8843
BE07	8.6809	6.8731
VT07	9.3621	8.3561
PDEN	29.0030	11.6650
RAV	0.2656	0.4428
SW	0.2604	0.4400
SE	0.2083	0.4072
NE	0.2552	0.4371
HHS	2.6021	0.5398
AGE	41.6670	14.264
HHA	8387.6	3552.8
INCMN	64734	27454
DA	1397.0	379.88
PUBS	6.9026	7.4619

Two sets of regressions were run; one using the entire set of variables and the other without using the crime variables, SX07, NX07, ROB07, BE07 and VT07. Although previous studies (Lynch and Rasmussen, 2001; Linden and Rockoff, 2008) show that the house price gets negatively affected by crime variables, this study could not show such a clear-cut evidence.

RESULTS AND DISCUSSION

Results of the regression analysis are presented in Table 2. The two models show nearly identical results. The explanatory power of the models also did not change as reflected by r-square values. The adjusted r-square value went down marginally after elimination of the entire

set of crime variables. This is an indication that crime variables have little influence on the determination of house prices. As expected, income, adjacency to ravines, dwelling area and lot size positively affected detached house prices. But adjacency to ravines, income, dwelling area and lot size are all positively correlated, and without one, the other variables significantly contributed to house price. Once both variables are included in the model, estimated coefficients become smaller and respective standard errors become larger because of multicollinearity problem. As both variables significantly contribute to house prices, avoiding one would cause a biased estimate for not including a relevant variable. The inclusion of an irrelevant variable is less problematic than exclusion of a relevant variable. Ramanathan (2002) presented that omission of a relevant variable from the model will make all other regression coefficients biased and the estimation power will be low. On the other hand, the inclusion of an irrelevant variable will not be able to make any other regression coefficients biased or inconsistent.

The smaller coefficient (1.22) relative to other variables should not be misunderstood as it indicates that for every dollar increase in income, house price afforded by residents go up by $1.22. This makes sense as income increases, people by more and more expensive houses with an increasing proportion. One should also consider the financing option too as hardly anyone would buy a house with cash. Nearly hundred percent of the buyers borrow money from a financial institution and pay it back with interest every month or every two-weeks depending on the payment plan agreed upon between the house buyer and the financier. Therefore, when a buyer makes a decision on purchasing a house, (s)he considers the mortgage payment more than the actual price of the house.

Table 2. Results of the multiple regression analysis using VAL08 as the dependent variable

Variable	All variables			Without crime variables		
	Coefficient	t-value	Elasticity	Coefficient	t-value	Elasticity
Constant	172470	2.6990	0.3873	135240	2.2300	0.3037
PDEN	361.61	0.6698	0.0235	443.02	0.8378	0.0289
RAV	40914	3.5090	0.0244	38598	3.3220	0.0230
SW	11815	0.8459	0.0069	19859	1.4600	0.0116
SE	-11722	0.8976	-0.0055	-3168.6	0.2483	-0.0015
NE	25815	2.2200	-0.0148	-24207	2.0860	-0.0139
HHS	-44701	4.3270	-0.2612	-42201	4.0810	-0.2466
AGE	216.49	0.4989	0.0203	204.69	0.4694	0.0191
HHA	5.92	3.1050	0.1116	6.31	3.3130	0.1188
INCMN	1.60	4.6700	0.2320	1.81	5.3570	0.2626
DA	161.93	6.5170	0.5080	158.88	5.5350	0.4984
PUBS	-316.36	0.5448	-0.0049	-264.54	0.4512	-0.0041
SX07	-9902.30	1.4820	-0.0164			
NX07	-42.76	0.0430	-0.0007			
ROB07	-1797.8	0.5377	-0.0072			
BE07	290.98	0.3109	0.0057			
VT07	-426.26	0.3951	-0.0090			
Adjusted r-square	0.8371			0.8322		

As expected, the dummy variable for SW has positive contribution and the other two have negative contribution to house price. On average, people living in the south-west part of the city have higher income than other quadrants. Average area allocated to each house also has a positive impact indicating that larger the lot size higher the price. The two variables making significant negative contribution to the house price are number of break and entry and proportion of stable residence. The former is expected. The later, however, can be explained that many older

neighbourhoods with smaller lots and smaller house sizes are stable. It can be concluded that the adjacency of houses to ravines and natural areas increase house price as those are inhabited by high income households. The analytical power of the model clearly indicates that crime variables play almost no role in determining house prices. This sounds counter-intuitive. The demand for houses in a neighbourhood that has high crime level should definitely be low and as such should be reflected in lower market value. Buck et al (1993) examined the impact of increased tax to increase security and reduced crime rate and found a substantial positive impact in Atlantic City. Reduced crime rates as a result of increased security increased demand for houses leading to increased price level. They also found a crowding out effect on demand due to increased tax rates. However, the crowding out effect was relatively minor and the net result was on higher house prices. Thaler (1978) in an earlier study even concluded a definitive quantitative impact. He observed that for every standard deviation increase of crime rate, the house values drop by three percent. Hellman and Naroff (1979) and Rizzo (1979) used census tract data from Boston and Chicago respectively and confirmed that crime had a significant impact on house prices. Gibbons (2004) in more recent study reported this figures to 10 percent. Linden and Rockoff (2008) upon reviewing several papers and estimating their own results concluded that the impact of crime rate on house prices is extremely localized and dissipates with the distance. A house next to a sex offender's residence may lose as much 12% of its property values but a house couple block from the residence will not notice any difference. However, before digging into the causes, we need to examine with more certainty that impact of crime variables on house prices is purely localized and in an overall sense the impacts are not significant. This study attempts a different approach. Using cross-section and time-series data on house prices and crime rates for at least five consecutive years and using different lag periods, the overall impacts of crime rates are insignificant although localized effects are definitely noteworthy and substantial (Table 3). It is apparent that robbery and vehicle theft were contributing factors if those happen during the past year. Sexual assault and non-sexual assault showed no impact on house prices. Surprisingly, break and entry showed a positive impact on house prices, which may be due to the fact that break and entry happens in high priced neighbourhoods.

Table 3: Results of multiple regression analysis using the value of five consecutive years as the dependent variable and the crime values of one-year, two-year and three-year lags

Variable	One-year lag		Two-year lag		Three-year lag	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Constant	328780	62.14	294160	66.26	355760	62.08
SX	714.57	0.12	15081	3.23	-32145	4.27
NX	1033.2	0.99	1563.8	1.93	3099.8	3.18
ROB	-9601.1	3.11	-16854	7.30	-15567	6.05
BE	5437.1	7.38	2043.3	3.14	701.13	0.91
VT	-3762.9	6.83	-877.03	2.55	64.253	0.16
Adjusted r-square	0.0981		0.0783		0.0690	

The explanatory power of all the crime variables together is small as expressed in the adjusted R-square values in the table above. Since no consistent impact of crime variables on house price was noticed, it may be a good idea to find out the inter-relationships among different crime variables. The following table (Tabele 4) shows correlation coefficients among different crime variables, income and some other common variables that have impacts on house prices. It is interesting that no consistent relationship can be found between different variables relevant to crime although consistently negative correlation coefficient is obtained between each and every variable with income. This is consistent with the conventional hypothesis that social crimes are more prevalent in low income households. Population density and robbery exhibited negative correlation with all the major variables although the relationships are not very powerful. Strong

correlations were noticed between robbery and non-sexual assault. Vehicle theft was also found positively correlated with non-sexual assault, robbery and break and entry, an intuitive result.

Table 4. Correlation coefficients among some relevant variables

	HHS	AGE	HHA	DA	PUBS	PDEN	INCMN	SX07	NX07	ROB07	BE07	VT07
RAV	0.05	-0.03	0.27	0.44	0.07	-0.20	0.51	-0.20	-0.11	-0.15	-0.16	-0.17
HHS		-0.51	0.05	0.32	-0.03	-0.08	0.44	-0.25	-0.29	-0.26	-0.29	-0.35
AGE			-0.10	-0.53	-0.18	-0.03	-0.35	0.23	0.15	0.17	0.27	0.29
HHA				0.37	0.20	-0.73	0.50	-0.21	-0.19	-0.17	-0.08	-0.16
DA					0.02	-0.24	0.81	-0.36	-0.23	-0.22	-0.30	-0.39
PUBS						-0.15	-0.02	-0.01	0.03	-0.01	0.05	-0.00
PDEN							-0.40	0.11	0.10	0.13	-0.10	0.05
INCMN								-0.41	-0.37	-0.36	-0.31	-0.47
SX07									0.69	0.63	0.32	0.56
NX07										0.87	0.56	0.79
ROB07											0.40	0.78
BE07												0.68

CONCLUSION

House prices are significantly affected by several variables, i.e., adjacency of ravines, size of the household (total number of people living in the household), size of the lot, area of the house and income of the household. All these variables have significant positive impact except the number of people in the household. Although adjacency to ravines and household income are positively correlated, they both independently contribute to house prices, and as such inclusion of both variables are relevant and multicollinearity problem is expected to be minor. In addition the inclusion of an irrelevant variable is less problematic than the exclusion of a relevant variable as the exclusion of a relevant variable makes the estimation problem biased and the estimated coefficients become less efficient. Crime variables, in general, have negative impact on house prices but their impacts were negligible. The estimation of a model without crime variables did not reduce the efficacy of the estimated coefficients. In this case, the crime variables are less relevant in determining the price of the house.

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