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The Impact of Green Areas on Dwelling Prices: the Case of Poznań City

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ABSTRACT

Objective: The objective of this paper is to estimate the impact of urban green areas on dwelling prices in Poznań.

Research Design & Methods: In order to identify the influence of the green spaces on dwelling prices, the hedonic method was used. The transactions and offers were matched taking into account the location (name of the street), area of a dwelling, location in the building. As a result a new dataset was created with fewer observations (not in all cases the process of matching succeeded) however with better description of transactions. The final data set contained 1438 geo-coded dwelling transactions for the years 2013 to 2014 in Poznań.

Findings: The application of the log-linear model allows to identify the percentage difference in the price of the same dwelling located with different distances to green areas. In case of this research, the results indicate that increase the distance from green area by one kilometre lowered the price of a dwelling by 3% in Poznań in years 2013-2015.

Implications & Recommendations: It is necessary to conduct research on impact of green areas on other types of properties. Different types of urban green areas may affect property prices in different ways.

Contribution & Value Added: The originality of this work lies in studying some aspects of influence of green areas on dwelling prices in Poland.

Article type:	research paper
Keywords:	dwelling values; hedonic method; GIS; housing market; urban green areas
JEL codes:	C33, F21

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INTRODUCTION

The market value of a dwelling depends mainly on its physical characteristics, out of which the most important is location. In research on factors affecting the value of housing in developed markets, environmental elements are very often taken into account. These factors can be divided, due to the nature of the effect on the value into two groups:

- positive influence (e.g. the neighbourhood of green spaces, water tanks),
- negative influence (e.g. noise, air pollution).

Urban Green Spaces may provide a wide range of benefits to the inhabitants of a given city. The following potential benefits of urban parks have been identified (Konijnendijk et al. 2013):

- human health and wellbeing, i.e. positive impacts of parks and park use on human health (both mental and physical) and wellbeing, either through direct or indirect effects such as recreation and leisure activities,
- social cohesion / identity: the role of urban parks in strengthening social ties, relations and cohesion,
- tourism: leisure visits outside of the own living or working environment, typically longer-term stays. Apart from potentially promoting the health and wellbeing of visitors, tourism is also of interest due to its contributions to the local economy,
- biodiversity: the role of parks in harbouring and promoting biodiversity, and species diversity in particular. Biodiversity has a direct link to human wellbeing (e.g., through nature experience), while it also provides an important base for ecosystem functioning and thus the diversity of an ecosystem,
- air quality and carbon sequestration: positive impacts of urban parks in terms of reducing air pollutant levels and carbon sequestration,
- water management: contributions of parks to stormwater / run off regulation,
- cooling: the role of parks in the cooling of urban areas.

The aim of this article is to identify the impact of urban green areas on dwelling prices in Poznań. In order to estimate the impact of urban green areas on dwelling prices the information on asking and transaction prices of dwellings in Poznań was collected. The use of asking prices is determined by the fact that in Polish conditions, the access to information on features of sold dwellings is limited. The data included in notarial contracts was the most valuable source of information on real estate prices, but they have one drawback – they do not provide a full description of a property. In this study property descriptions from the catalogue of offers with the actual transactions were matched. In this research hedonic method was used. The essence of the hedonic method lies in the assumption that the price of heterogeneous goods may be compared with its attributes.

LITERATURE REVIEW

The value of green space has been the subject of a great deal of research (Crompton, 2001; McConnell & Walls, 2005; Waltert & Schläpfer, 2010). In most cases the results suggest that green spaces have a positive impact on price of dwelling or house (Correll, Lillydahl,

& Singell, 1978; Luttik, 2000; Tyrvainen1997; Kim & Johnson, 2002; Crompton, 2005; Anderson & West, 2006; Herath, Choumert, & Maier, 2015). However, several of the researchers found some contradicting results and state that some factors, such as crime rates or noise, may lower the positive effect of parks on property values (Kong, Yin, & Nakagoshi, 2007; Troy & Grove, 2008, Chen & Jim, 2010).

The most frequently used methods of green space effect on housing prices estimation include: models based on revealed preferences and models based on stated preferences. Both approaches are based on the theory of consumer choice. Revealed preferences are consumers' actual choices and they are analysed with the use of historical data. Of all the models based on revealed preferences the hedonic price model (HPM) is the most frequently used method for analysing the influence of green spaces on house prices.

Application of the hedonic method to value environmental amenities has a long tradition (McConnell & Walls, 2005). In this regard a large literature analyses the effects of open space on property values by using the HPM. Table 1 presents selected recent research is presented along with major findings.

Table 1. Recent research on UGA and property prices

Authors of research	Place of Research	Type of property	Number of sample, time of research	Findings
Hoshino, Kuriyama (2009)	Setagaya ward, Tokyo	Single room dwellings, for rent	2370 asking rents (05-06 2007)	The effect of parks on property values varies with the park's size: the number of medium-sized neighbourhood parks is positively related to rental prices, while small- and large-neighbourhood parks are not statistically positively influential by rental values.
Bark et al. (2011)	Tucson, Arizona	Single family residence	6676 transactions (1998-2003)	Neighbourhood-level greenness had the largest marginal effect on home values relative to other greenness measures. Results indicate that neighbourhood-level greenness has important external benefits.
Panduro, Veie (2013)	AAlborg, Denmark,	Houses, apartments,	12928 transactions (2000-2007)	Access to green space in cities can be associated with both significantly higher and lower housing prices depending on the type of green space. Differences in the capitalization of different types of green space between apartments and houses.
Kolbe (2015)	Cologne	Apartments	85046 transactions (1995-2012)	A positive price effect of parks, forests and water and an inverse relation between the price variable and the presence of fallow land and farmland was found.
Zygmunt, Głuszak (2015)	Cracow	Undeveloped land	355 transactions (2002-2011)	Strong evidence for positive impact of forest proximity on undeveloped property prices.

Source: own research.

The capitalization of open space in house prices has been investigated by incorporating various variables (Kolbe & Wüstemann, 2014):

- the influence of size of the nearest open space area on housing prices,
- total quantity of surrounding open space areas,
- the visibility of open space,
- distance effects in hedonic studies analysing the impact of open space on house prices.

MATERIAL AND METHODS

In order to establish the influence of the green spaces on housing prices in Poznań, the information on transaction prices and asking prices was collected in the period between the 1st quarter of 2013 to the 4th quarter of 2014. In regard to the transaction prices of dwellings in Poznań, notarial contracts including data about transaction prices of premises in Poznań served as the source of information. The data covered over four thousand items. Data included in notarial contracts concerning dwellings include information on the following cost factors:

- the transaction date,
- the price,
- the area of a dwelling,
- the floor on which a dwelling is located,
- the area of auxiliary premises.

Such set of factors may bias the results of the research – notarial contracts do not include information on strong price components, such as, for example, the standard of completion of a dwelling. Because of that in this research information on dwellings offers was used as well. The transactions and offers were matched with the use of computer software taking into account the location (name of the street), area of a dwelling, location in the building. As a result a new dataset was created with fewer observations (not in all cases the process of matching succeeded) however with better description of transactions. The final data set contained 1438 geo-coded dwelling transactions for the years 2013 to 2014 (Figure 1).

The information on urban green spaces was captured from official site of Poznań city. In case of this research 30 objects (3 forest and 27 parks) were the basis of examination.

In this research the hedonic method was used. The first researcher to use the hedonic method to analyse the real estate market was probably Ridker – he aimed at identifying the influence of pollution reduction on house prices (Coulson, 2008). The theoretical framework of the hedonic method was developed by Lancaster (1966) and Rosen (1974).

The essence of the hedonic method lies in the assumption that the price of heterogeneous goods may be connected with its attributes. In other words, this method may be used for estimating the value of particular attributes of a given product. In order to identify the influence of individual features on the value of a specific good, econometric equations are constructed. The price of a given good is the response variable, whereas its quantitative and qualitative attributes are the explanatory variables.

Figure 1. Urban green spaces and dwelling transactions in Poznań
Source: own study based on Board of Geodesy and Municipal Cadastre GEOPOZ in Poznań.

The equation may be recorded in the following way:

$$P = \beta_0 \sum_{i=1}^{K} \beta_i X_i + u \tag{1}$$

where:

P - price of a good;
β - regression coefficient;
X - attribute of a good (value driver);
u - random error.

The key issue in hedonic methods is to choose the form of the regression function. The log-linear form of the regression function is most frequently used for studying changes in the prices in the real estate market in empirical research:

$$\ln P = \beta_0 \sum_{i=1}^{K} \beta_i X_i + u \tag{2}$$

There are a few reasons for such a choice of function (Malpezzi, 2003). First, the log-linear model allows the added value to change proportionally to changes of the size and other attributes of the dwelling. Secondly, the estimated regression coefficients are easy to interpret. The coefficient of a given variable may be defined as a percentage change of

the value of an dwelling caused by the unit change of a value driver. Thirdly, the log-linear function often eases problems connected with heteroscedasticity or with the variability of a random component.

Dwellings are heterogeneous in nature. This heterogeneity can create heteroscedasticity in the residuals of the estimation of the price function. Indeed, heteroscedasticity was detected in the model (according to White's test). Therefore, we estimate a robust model, employing GLS (a backward stepwise method). Due to the high number of independent variables available, multicollinearity may be a serious concern. Multicollinearity leads to unstable coefficients and inflated standard errors. The Variance Inflation Factors (VIFs) was used to detect it. The VIF values in model do not exceed 3.8 which is in line with the most conservative rules of thumb that the mean of the VIFs should not be considerably larger than 10.

RESULTS AND DISCUSSION

The choice of qualitative and quantitative data was limited by the availability of information in the database. Table 2 presents variables used in the study.

Table 2. Qualitative and quantitative variables applied in the model

variable	symbol	description
location	d1-grunwald, d2-jeżyce, d3-nowe miasto, d4-stare miasto,d5-wilda	5 dummy variables. if the dwelling is located in a given district, it takes the value 1; otherwise it takes 0.
quarter	quarter	1-8 depends on quarter in which transaction took place
construction technology	tech	it takes 1 if the dwelling is located in a building constructed in prefabricated technology, in case of traditional technology it takes 2.
time of construction	tc1 – before 1939 tc2 – from 1945 to1964 tc3– between 1965-1989 tc4– between 1990-2004 tc5 – after 2005	5 dummy variables. if the dwelling is placed in a building built in a given period, it takes the value 1; otherwise it takes 0).
area	area	the area of a given dwelling is measured in square meters.
standard	stand	it takes value 1 for dwellings with the lowest standard, and 4 for those with the highest.
rooms	rooms	number of rooms.
height of building	height	1-buildings up to 5 floors 2-buildings above 5 floors
floor	floor1 - ground and last floor floor 2 - intermediate floors floor3 - first and second floor	3 dummy variables
green area	duga	distance to the edge of nearest green area (in km)

Source: own calculations.

Then, using GRETL software, the parameters of functions in which the log-price1m2 (price of 1 m^2) of a dwelling was the response variable, while the explanatory variables included the location, construction technology, floor, standard, time of construction,

height of building floor space, number of rooms and distance to green area. Table 3 presents the results of the regression function for the equation.

Table 3. The estimates of price1m2 function parameters, heteroskedasticity-corrected, used observations 1-1438, dependent variable: price1m2 log

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	8.72826	0.0355605	245.4485	<0.0001	***
Ddistrict_1	0.0380175	0.0118407	3.2108	0.0014	***
Ddistrict_2	0.0588749	0.012971	4.5390	<0.0001	***
Ddistrict_3	0.0855516	0.0131125	6.5244	<0.0001	***
Ddistrict_4	0.0866749	0.0117985	7.3463	<0.0001	***
Dtc_1	−0.249881	0.0171007	−14.6123	<0.0001	***
Dtc_2	−0.211997	0.012918	−16.4109	<0.0001	***
Dtc_3	−0.183631	0.0127914	−14.3559	<0.0001	***
Dtc_4	−0.0705134	0.0100571	−7.0113	<0.0001	***
Dfloor_1	−0.0309205	0.0087159	−3.5476	0.0004	***
quarter	0.00462746	0.00109394	4.2301	<0.0001	***
rooms	0.0127923	0.00559276	2.2873	0.0223	**
height	−0.0270055	0.00835071	−3.2339	0.0012	***
tech	0.0230272	0.0108067	2.1308	0.0333	**
standard	0.0451113	0.00364427	12.3787	<0.0001	***
area	−0.00587811	0.000337328	−17.4255	<0.0001	***
duga	−0.0331073	0.00407991	−8.1147	<0.0001	***
R-squared		**0.609795**			
Adj R-squared		**0.605402**			
Doornik–Hansen[1]		**10.4039, with p-value 0.00550591**			
Shapiro–Wilk		**0.996729, with p-value 0.00401083**			
Lilliefors		**0.022483, with p-value ~= 0.07**			
Jarque–Bera		**8.4768, with p-value 0.0144307**			

[1]The last four rows present statistical tests for the normality of the residuals' distribution (we reject H0, that the distribution is normal, when $p < 0.01$)
Source: own calculations in GRETL.

On the basis of the obtained results it may be concluded that the explanatory variables used in the equation explain the changes of dwelling prices (price per m^2) in Poznań in 60%. Moreover, most of the variables applied in the model turned out to be statistically relevant.

From research point of view, the statistical relevance of *distance to urban green area* variable is important. The application of the log-linear model allows to identify the percentage difference in the price of $1m^2$ of the same dwelling located with different distances to green areas. In this case, the value of the coefficient with *distance to urban green* variable is -0.033, which indicates that increase the distance from green area by one kilometre should lower the price of $1m^2$ of a dwelling by more than 3%.

CONCLUSIONS

The aim of this article was to identify the impact of urban green area on dwelling prices in the city of Poznań. The application of the log-linear model allowed to identify the percentage difference in the price of the same dwelling located with different distances to green areas. In case of this research, the results indicates that the increase of the distance from green area by one kilometre lowered the price of $1m^2$ of a dwelling by more than 3%. The results are consistent with previous research (urban green areas have a positive influence on the value of dwellings located in multifamily buildings). It is necessary to conduct research on impact of green areas on other types of properties. Also, different types of urban green areas may affect properties in different ways. It would be interesting to examine the influence of parks and forests separately taking into consideration their size as well.

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