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The impact of aircraft noise on the value of dwellings – the case of Warsaw Chopin Airport in Poland

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Abstract. The aim of this article is to identify the impact of Warsaw Chopin Airport on dwelling prices in Warsaw. Frederic Chopin Airport in Warsaw is the biggest airport and the main transfer node in Poland, which serviced 10.7 million passengers in 2013. Warsaw Chopin Airport is a city airport, which means that it is located within the borders of the city of Warsaw. The aim of this study is to identify and measure the influence of Warsaw Chopin Airport on the prices of dwellings located within the borders of the limited use area. This research refers only to dwellings located in multi-family buildings. Such choice was determined by two factors. Firstly, the majority of dwellings are located in multi-family residentials (dwelling blocks – up to 90% in big Polish cities). Secondly, houses are characterized by great differentiation regarding both quantitative and qualitative features, which requires the database to include the appropriate information about each property in order to build hedonic models.

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INTRODUCTION

With the growth of market economy in Poland, some markets which played a marginal role in the pre-transition economic system have grown in importance. The housing market is undoubtedly one of them. The role this segment of the real estate market plays in economy is determined by the fact that properties are not only perceived as consumer goods, but also as capital, which makes it possible to create added value for the owner as well as for local and national economy.

The impact of airport noise on dwelling prices is one of the elements of the influence of an airport on its surrounding area and belongs to external effects which indirectly affect the society rather than direct users. This influence is usually reflected in the change of property prices caused by airport activities. These effects very often are negative (the decrease of house prices).

The negative external effects are the result of the activity of airlines using an airport's infrastructure rather than the operations of the airport itself. Airplanes emit noise and pollution, which reduces the comfort of living around the airport. Moreover, there are numerous constraints concerning the use of properties

located near the airport. Those factors result in lower interest in such properties, reduce their value and, consequently, contribute to the drop in house prices.

Changes in real estate prices are determined by general and individual factors. The general factors influencing the property value include, among other things, the increase of the population's disposable income (Trojanek, 2010). The individual factors result from the characteristics of a given kind of land (e.g. property location). In this analysis, the individual factors that are the result of the location of a property within the area influenced by airport operation were taken into consideration.

RESEARCH METHODOLOGY AND THE SOURCES OF DATA

The most frequently used methods of noise cost estimation include: models based on revealed preferences and models based on stated preferences (Levesque 1994; Myles 1997; Salve 2003; McMillen 2004; Baranzini, Ramirez 2005; Cohen, Coughlin 2008; Huderek-Glapska, Trojanek 2012) . Both approaches are based on the theory of consumer choice. Revealed preferences are consumers' actual choices and they are analyzed with the use of historical data. Of all the models based on revealed preferences the hedonic price model is the most frequently used method for analyzing the influence of airport operation on house prices.

The essence of the hedonic method lies in the assumption that the price of heterogeneous goods may be described 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. 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:

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

There are a few reasons for such a choice of function (Malpezzi 2008). Firstly, the log-linear model allows the added value (for example, the value resulting from the higher standard) to change proportionally to changes of the size and other attributes of the dwelling (in case of the linear function, for example, the improvement of the standard will have the same influence on the value of the dwelling with the floor area of 30 m^2 and the one with the surface area of 100 m^2, whereas in case of the log-linear function this influence will be diverse). 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.

In order to estimate the impact of aircraft noise on dwelling prices the information on asking and transaction prices of dwellings in Warsaw in 2010 year 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 deeds are 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, using a specially designed computer program, property descriptions from the catalogue of offers with the actual transactions were matched.

DWELLING PRICES IN DISTRICTS WITH THE LIMITED USE AREA IN 2010

In order to establish the influence of the limited use area on housing prices in Warsaw, the information on transaction prices was collected in the period between the 1st quarter of 2010 to the 4th quarter of 2010. As regards the transaction prices of dwellings in Warsaw, notarial deeds including data about transaction prices of premises in Warsaw served as the source of information. The data covered over five thousand items. They were used for a preliminary analysis of the relations between the limited use area and the housing market in Warsaw in 2010. Data included in notarial deeds concerning dwellings include information on the following cost factors:

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

Such a set of factors does not allow us to use complex methods of the analysis of the impact of factors on the property value – notarial deeds do not include information about strong price components, such as, for example, the standard of completion of a dwelling.

The table 1 presents the number of transactions concerning the purchase of dwellings in the particular districts of Warsaw in 2010 by location in zones Z1, Z2 and LUA (limited use area) and outside these zones.

Table 1

The number of transactions concerning the purchase of dwellings in the particular districts of Warsaw in 2010 by location in zones Z1, Z2 and LUA (limited use area) and outside these zones.

District	Z1	Z2	LUA	outside LUA	Total
1	2	3	4	5	6
Bemowo			83	66	149
Białołęka				147	147
Bielany				120	120
Mokotów			59	399	458
Ochota			50	426	476
Praga Południe				469	469
Praga Północ				141	141
Rembertów				29	29
Śródmieście				722	722

1	2	3	4	5	6
Targówek				251	251
Ursus		26		265	291
Ursynów			558	87	645
Wawer				179	179
Wesoła				52	52
Wilanów				210	210
Włochy			73	67	147
Wola			79	613	692
Żoliborz				112	112
Total		26	902	4,355	5,290

Source: Own calculations.

The analysis of the table shows that none of the transactions took place in zone Z1, 20 were carried out in zone Z2, and over 900 in the LUA.

In order to check whether the location of a dwelling for sale in the LUA or outside the LUA is related to the existence of differences, the median price (zł/m^2) was established in the particular districts in the LUA and outside the LUA in 2010.

Table 2

The median price (PLN/m^2) of properties located in the LUA and outside the LUA in 2010, including the district of Warsaw

District	LUA	outside OOU	Difference between LUA and outside LUA (in %)
Bemowo	7678.63	7630.44	0.63%
Mokotów	8467.48	9000.00	-5.92%
Ochota	8260.16	8112.28	1.82%
Ursynów	8783.81	8851.22	-0.76%
Włochy	7403.08	7388.14	0.20%
Wola	7419.08	7921.38	-6.34%

Source: Own calculations.

There are differences in prices, but they are ambiguous. The price of a square meter for sale in Bemowo, Ochota and Włochy is higher in the LUA than the price for one square meter of a dwelling located outside the LUA. As far as dwellings in Mokotów, Ursynów and Wola, the price of a square meter is lower in the LUA than outside the LUA.

However, we cannot draw any definite conclusions regarding the influence of the LUA on dwelling prices in particular districts on the basis of price differences. This is because the applied measure (the median price) does not take into consideration a number of cost factors determining the value, thus also the price of dwellings.

In order to include the great many factors determining the price of a dwelling, we need to estimate the multi-factorial price function. The most popular method used with regard to real estate prices is the hedonic

method described earlier. Therefore, in order to identify the influence of the LUA on dwelling prices in Warsaw, we used the hedonic regression method.

THE IDENTIFICATION OF THE INFLUENCE OF THE LUA ON DWELLING PRICES IN WARSAW WITH THE APPLICATION OF THE HEDONIC REGRESSION METHOD.

In order to identify the influence of the LUA on dwelling prices, the hedonic method was used. In the analysis, transaction prices of residential units in Warsaw in 2010 were used. As it was already indicated, data included in notarial deeds are 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, using a specially designed computer program, property descriptions from the catalogue of offers with the actual transactions were matched. It was managed to match attributes to the dwelling units being the subject of a transaction in over 2,900 cases.

The choice of qualitative and quantitative data was limited by the availability of information in the database. Table 3 presents variables used in the study.

Table 3

Qualitative and quantitative variables applied in the model

Variable	Symbol	Description
LOCATION	d1-Bemowo, d2-Białołęka, d3-Bielany, d4-Mokotów, d5-Ochota, d6-Praga Południe, d7-Praga Północ, d8-Rembertów, d9-Śródmieście, d10-Targówek, d11-Ursus, d12-Ursynów, d13-Wawer, d14-Wesoła, d15-Wilanów, d16-Włochy, d17-Wola d18-Żoliborz	18 time dummy variables. If the dwelling is located in a given district, it takes the value 1; otherwise it takes 0.
MATERIAL	*M1*-traditional brick *M2*-prefabricated	2 time dummy variables. If the dwelling is located in a building made of a given material, it takes value 1; otherwise it takes 0.
TIME OF CONSTRUCTION	*R1* – before 1939 *R2* – from 1945 to1989 *R3* – between 1990-2000 R4 – after 2000	3 time dummy variables. If the dwelling is placed in a building built in a given period, it takes the value 1; otherwise it takes 0).
FLOOR AREA	area	The floor area of a given dwelling is measured in square meters.
FORM OF OWNERSHIP	Own.	In case of limited right of ownership, the value is 1; otherwise it is 0.
STANDARD	Stand.	It takes value 1 for dwellings with the lowest standard, and 5 for those with the highest.
NUMBER OF ROOMS	No. of rooms	Number of rooms.
LUA zone	st	2 time dummy variables. If the dwelling is locates in the LUA, it takes value 1; otherwise it takes 0.

Then, using GRETL software, we estimated the parameters of functions in which the price of a dwelling was the response variable, while the explanatory variables included the location, construction material,

standard, type of ownership, time of construction, floor space, number of rooms and the location in the LUA. Table 4 presents the results of the regression function for the equation.

Table 4

The estimates of price function parameters, used observations 1-130324, dependent variable: price log.

	Coefficient	Standard error	Student's t-distribution	p-value	
const	12.21	0.0266115	458.9435	<0.00001	***
d1	-0.197173	0.0279	-7.0671	<0.00001	***
d2	-0.460304	0.0266922	-17.2449	<0.00001	***
d3	-0.217726	0.0268452	-8.1104	<0.00001	***
d4	-0.04542	0.022915	-1.9821	0.04756	**
d5	-0.120103	0.0228845	-5.2482	<0.00001	***
d6	-0.215495	0.0230277	-9.3581	<0.00001	***
d7	-0.272443	0.026615	-10.2364	<0.00001	***
d8	-0.386506	0.0526246	-7.3446	<0.00001	***
d9	0.0371242	0.0223011	1.6647	0.09608	*
d10	-0.318919	0.024511	-13.0112	<0.00001	***
d11	-0.308365	0.0248106	-12.4287	<0.00001	***
d12	-0.0661671	0.0242393	-2.7297	0.00638	***
d13	-0.337257	0.0276062	-12.2167	<0.00001	***
d14	-0.415184	0.0352526	-11.7774	<0.00001	***
d15	-0.257623	0.0259839	-9.9148	<0.00001	***
d16	-0.248237	0.0284587	-8.7227	<0.00001	***
d17	-0.182441	0.0223515	-8.1624	<0.00001	***
floor area	0.0141234	0.000240681	58.6810	<0.00001	***
brick	0.0307277	0.00865474	3.5504	0.00039	***
limited right of ownership	-0.0232668	0.0071471	-3.2554	0.00115	***
standard	0.0223702	0.00186085	12.0215	<0.00001	***
R1	-0.0905441	0.0122908	-7.3668	<0.00001	***
R2	-0.184466	0.00858428	-21.4888	<0.00001	***
R3	-0.0697871	0.0108778	-6.4156	<0.00001	***
number of rooms	0.0430514	0.00539011	7.9871	<0.00001	***
ST1	-0.0409051	0.0102738	-3.9815	0.00007	***

Source: Own calculations.

On the basis of the obtained results it may be concluded that the explanatory variables used in the equation explain the fluctuations of dwelling prices in Warsaw in 2010 in 88%. Moreover, all the variables applied in the model turned out to be statistically relevant.

From the analytical point of view, the statistical relevance of ST1 variable is extremely important. The application of the log-linear model helps us to identify the percentage difference in the price of the same dwelling located within the LUA and outside this zone. In our case, the value of the coefficient with ST1 variable is -0.04, which indicates that a dwelling located in the LUA was about 4% cheaper than the same dwelling located beyond this area in Warsaw in 2010.

Thus, it may be concluded that the location of a dwelling within the LUA reduces its value by 4% on average.

CONCLUSION

The aim of this article was to identify the impact of aircraft noise created by Warsaw Chopin Airport on dwelling prices in Warsaw. Hedonic regression method was used to estimate the impact of aircraft noise on dwelling prices. The application of the log-linear model let to identify the percentage difference in the price of the same dwelling located within the LUA and outside this zone. In case of this research, the value of the coefficient with ST1 variable is -0.04, which indicates that an dwelling located in the LUA was about 4% cheaper than the same dwelling located beyond this area in Warsaw in 2010 year. Earlier studies (Huderek-Glapska, Trojanek 2012) indicated that the impact of aircraft noise on dwelling prices in Warsaw was lower (about 1%), however it must be stated that the previous research was conducted on asking prices (supply side).

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