

THE INFLUENCE OF THE VICINITY OF A NATIONAL ROAD ON HOUSING PRICES

DATA PRZESŁANIA: 15.12.2017, DATA AKCEPTACJI: 15.06.2018, KODY JEL: R31, R41, R42

Maria Trojanek

Uniwersytet Ekonomiczny w Poznaniu
m.trojanek@ue.poznan.pl

Izabela Rącka

Państwowa Wyższa Szkoła Zawodowa w Kaliszu
i.racka@pwsz.kalisz.pl

ABSTRACT

Soundscape is an inseparable element of landscape, thus being a component of the location of a specific property. Noise in the environment represents a serious danger for public health. Often unusual sounds of nature are disrupted, especially in cities, by road noise, which is the main threat to acoustic climate. The aim of this paper is to identify the influence of the vicinity of a national road on housing prices in a selected local market. The log-linear regression to assess the influence of the vicinity of a national road on housing prices was applied. Some other factors which have an impact on the prices of flats were also taken into account. The designed model showed that dwellings located in the zone affected by increased noise were cheaper than those located beyond it. The results of our survey may appear useful in spatial planning and in evaluating the costs of road investments, including the assessment of environmental impact.

KEY WORDS

housing market, prices, roads, road noise

INTRODUCTION

Noise, which is one of the forms of environmental pollution, is an important factor leading to residents' discomfort and contributing to the decreased quality of urban space. Transport noise is a particularly significant form of noise. Studies on the influence of the proximity of roads on acoustic comfort show that its negative impact concerns not only the quality of environment, but also housing prices.

The aim of this paper is to identify the influence of the vicinity of a national road on housing prices in a selected local market. Market transactions concluded in Kalisz in the years 2012–2016

were analyzed. In order to eliminate differences between flats, a group of dwellings located in one of the cadastral districts with homogenous development was distinguished, and then the prices of flats were analyzed, taking into account the proximity of a national road. The research methods included: statistical analysis and multiple regression with the use of log-linear function.

THE INFLUENCE OF LOCATION ON HOUSING PRICES

The price of a property is subject to market laws and changes under the influence of factors resulting directly from the real estate market, as well as from external, macroeconomic factors. Prices inform market participants whether the allocation of resources they perform will enable them to achieve the best possible results; thus, they are a signal indicating the directions of the flow of resources and an incentive to begin or abandon activity (Zaremba, Będzik, 2010, p. 42). Real properties are the only goods the price of which is clearly dependent on the nature of their surroundings, i.e. location (Fanning, 2014; Siemińska, 2012).

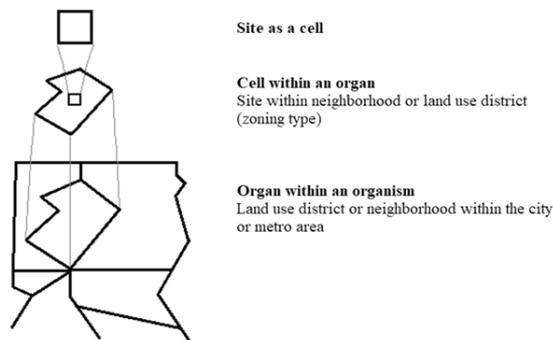


Figure 1. Site as a cell.

Source: based on: (Fanning, 2014).

The influence of location on the price of a real property is discussed by S.F. Fanning (2014), who emphasizes that it is one of the most important price determinants. He views location as a three-level quality, consisting of the purpose of a property (its condition or/and its development potential, landform), the character of its surroundings and its influence on the property, and of the general urban space and mutual relationships in the land use structure of the city, the current ones and those planned or likely in the future. The mutual relations among the three layers of location may be compared to those occurring inside an organism (fig. 1). Just like a cell is linked with neighboring cells and with the whole organism, a real property is connected with its close and distant surroundings, its neighborhood and with the whole city.

Prices in the housing market are determined by a number of factors, such as location, the quality of neighborhood, distance from the city centre, transport accessibility (including public transport), age and materials used for construction. The differentiation of the attributes of dwellings leads to the further segmentation of this market (Ranci, Brandsen, Sabatinelli, 2014, p. 167).

Ewa Kucharska-Stasiak, Magdalena Załączna and Konrad Żelazowski (2012, pp. 23–25) note that the distribution of prices for the particular attributes of properties in the real estate market has not been identified; moreover, this market imperfectly reflects property attributes in their prices. Due to the scarcity of transactions, the market does not determine the price, but only the range of prices. The level of the transactional price, defined as the average unit price (PLN/m²) in a given period, is determined by – apart from attributes and from the form of sales and its strategy – the negotiation capabilities of market participants, relations between subjects, motivations, emotions, etc.

The real estate market differs from other markets because of its unique character. The study and analysis of the real estate market is difficult since it is an imperfect market (Malienė et al., 2016), which is manifested in its (Brown, 1991, pp. 138–139; Isaac, 2002, pp. 30–31):

- heterogeneity (lack of two identical properties),
- lack of transparency (lack of full information about properties and their prices),
- lack of possibility of the maximization of usefulness and profitability (price is not the only criterion for choice and the attributes and prices of properties are often perceived subjectively, so the behaviour of market participants is irrational),
- few buyers and sellers (the limited number of transactions makes it difficult to value properties),
- barriers to entry and exit (the low liquidity of a property, the necessity of having large capital).

THE RELATION BETWEEN THE PROXIMITY OF A NATIONAL ROAD AND HOUSING PRICES

The development of transport, especially road construction, has a positive impact on the value of real properties, at the same time increasing the level of traffic, noise and air pollution (Levkovich, Rouwendal, van Marwijk, 2016). Martínez and Viegas (2009) studied the connection between the accessibility of transport infrastructure and apartment prices in the urban areas of three Portuguese cities (Amadora, Lisbon and Odivelas). The authors discovered that access to transport infrastructure (underground, railway and roads) has a direct impact on the prices of houses.

External effects are reflected in housing prices. The research concerning road investment carried out in the 1980s by Nelson (1982) in 14 different housing markets showed that the influence of the proximity of a motorway reduces the price of apartments by 8–10%, while Hughes and Sirmans (1992) found out that the vicinity of a busy road causes housing prices to drop by 9.2% in city centres and by half as much in suburbs.

The significant impact of transport infrastructure on the housing market was proven by Mikelbank (2004), who studied relations between road investments and apartment prices in the capital city of Ohio (Columbus). Within the radius of about 6.7 miles, the longer the distance from the motorway exit is, the lower the price of a house becomes – this shows that households appreciate the proximity of a well-developed road network in the region. It was observed, however, that if areas closer to the motorway were taken into account, the more distant from the motorway a dwelling is, the higher its price becomes. External effects connected with the vicinity of a motorway are negative (they reduce the price of a property by 7%).

THE RESEARCH METHOD

Econometric methods are very often used to analyze the phenomena on housing market (Foryś 2014; Meen, 2001; Trojanek, 2013). It is possible to explain the influence of many independent variables on an endogenous variable by using the multiple regression. The multiple regression equation is an equation of a straight line, defined by a general equation:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \dots + \alpha_k X_k + \varepsilon$$

where:

Y – endogenous variable,

X_k – independent variables ($k = 1, 2, \dots, n$),

α_0 – constant,

α_k – structural parameters of the model,

k – the number of independent variables,

ε – random component.

The multiple regression analysis may be performed with the use of the classical method of least squares and conditioned by some assumptions (Baltagi, 2011):

- the model is linear (reduced to linear expression),
- independent variables (market features) are not random size,
- no collinearity between independent variables,
- random component is a random variable the mathematical expectation of which equals zero and the variance is constant,
- the observations are independent,
- random component is not correlated with the independent variables,
- the number of independent variables is smaller than the number of observations,
- there are no correlations between the random components of particular model equations.

In view of the conducted literature research, showing the influence of various factors on housing prices, quantity and quality factors were proposed (table 1).

Table 1. The attributes and the variants of attributes of dwellings sold in the area under analysis in the years 2012–2016

Variable	Symbol	Additional description	Notes
1	2	3	4
Year of sale	y1	2012	Five qualitative dummy variables corresponding to the particular years of the period under study were created. If a property was sold in a given year, the variable took value 1, otherwise – 0
	y2	2013	
	y3	2014	
	y4	2015	
	y5	2016	
Period	q1	I quarter 2012	20 qualitative dummy variables corresponding to the particular quarters of the period under study were created. If a property was sold in a given quarter, the variable took value 1, otherwise – 0
	q2	II quarter 2012	
	q3	III quarter 2012	
	
	q20	IV quarter 2016	

1	2	3	4
Location	s_wp s_pw	national road commune road	Two qualitative dummy variables were created, corresponding to the location in the area of a national road (al. Wojska Polskiego), a district road (Prymas Wyszyński street) or a residential street. If a property sold was located near a given road, the variable took value 1, otherwise – 0
Usable area	a_d	-	A qualitative variable with values corresponding to the usable area of a dwelling in square meters
Proprietary area	a_a	-	A qualitative variable with values corresponding to the size of the proprietary area of a dwelling in square meters
Rooms	r	-	A qualitative variable with values corresponding to the number of rooms in a dwelling
Year of construction	c_y	-	A qualitative variable with values corresponding to the years a building was constructed
Time of construction	c_y85 c_y90	until 1985 1986–1990	Two qualitative dummy variables were created, corresponding to the particular periods a building was constructed. If a building was constructed in a given period, the variable took value 1, otherwise – 0
Noise level	LN _{40–45} LN _{45–50} LN _{50–55} LN _{55–60}	40–45 dB 45–50 dB 50–55 dB 55–60 dB	Four qualitative dummy variables were created, corresponding to the subsequent levels of daily road noise. If a dwelling was located in a given noise zone, the variable took value 1, otherwise – 0
Road noise	noise	-	A qualitative variable corresponding to the location in a road noise zone was created. If a dwelling was located in the road noise zone, i.e. the level of road noise exceeded 55 dB during the day and 45 dB at night, the variable took value 1, otherwise – 0
Distance from a national road	dist	-	A qualitative variable with values corresponding to the distance of the building from a national road in meters
Building height	b_h	-	A qualitative variable corresponding to the height of the building was created. If a dwelling was located in a tall building (more than five floors), the variable took value 1, otherwise – 0

Source: own study.

The next step was to eliminate the independent variables with small internal diversity (coefficient of variable $V \leq 0,10$) and the ones which were correlated with the endogenous variable in a statistically insignificant way from the set of grouped factors. Next, a correlation matrix was created to eliminate the mutually strongly correlated independent variables.¹ A model of time series, which presents the influence of independent variables on housing prices in the area and time period under study, was built. The unit price (PLN/m²) is referred to as an endogenous variable in the created model. The creation of econometric models with the use of multiple regression

¹ The strongly correlated variables were eliminated with the use of the graph description method. For the given statistical significance level ($\alpha = 0,01$) and $n-2 = 91$ degrees of freedom (n – the number of observations; $n = 93$), the value of t-Student distribution was calculated, which was 2.6309. Then, the critical value of the correlation coefficient r^* was determined, which was $r^* = 0.2659$. The correlation coefficients above the critical value are considered to be statistically significant. On the basis of such cleared correlation matrix, a graph of correlations between the potential independent variables was developed. A variable not correlated with other variables was put to the model. From the variables included in the knot, the one with the largest number of correlations with other variables within the particular knots was chosen. When there were more such variables, the variable with the highest correlation coefficient with the endogenous variable was chosen. These operations helped to eliminate the collinearity from the set.

led to the hypothesis that there is a linear correlation between the unit price and independent variables. The process of the estimation of model parameters was conducted with the application of the method of least squares.

RESEARCH AREA

The research area is a single cadastral district of the city of Kalisz, marked with number 0073 (Dobrzec housing estate), covering the area of over 63 hectares (fig. 2).



Legend: ■ research area ■ multi-family buildings built in 1980–1991 ■ national road ■ commune road ■ other road
Figure 2. Research area.

Source: own study on the basis of the Urban Spatial Information System (MSIP, 2017).

It is a part of Dobrzec district, which is quite homogeneous in terms of types of buildings and functions fulfilled: the multi-family residential function dominates here (there are 72 multi-family buildings in total). Additionally, this area includes 30 single-family houses, a school and other educational and sports buildings, retail and service centres, health centres, and a church. Multi-family buildings mostly come from the 1980s; most buildings were built in prefabricated large panel technology. Half of them are four-floor buildings, every third has five floors, and one

in six buildings has more than eight floors. Eight buildings were put in use in the 1990s, and seven after 2000. Moreover, the area under analysis also includes 30 single-family terraced houses – they constitute a gated community. Roads in the area are paved, and the properties are accessible from a commune road, Prymas Wyszyński street, and from national roads, al. Wojska Polskiego and Podmiejska. They are two-way roads with the speed limit of 50 km/h.

Transactions concerning dwellings² in prefabricated large panel buildings, built between 1980 and 1991, concluded in the years 2012–2016, were analyzed. There were a total of over 100 transactions in that period, but all non-market transactions (deeds of donation, inheritance, partition of joint property) were rejected, those characterized by special sale conditions (deferred payment, deferred property release), and the extreme ones, with transactional prices exceeding the so-called three sigma rule in a given market segment.³

RESULTS

The average price of a flat in the secondary market in the area under analysis in the years 2012–2016 was 2654.72 PLN/m², and the average floor area of a flat was 61.4 m². The average transactional price was 210,000 PLN. Other selected statistics were presented in table 2. Most of the proposed independent variables (tab. 1) were strongly correlated. The majority of dwellings were located in the more peaceful part of the estate, near the district road (70%), while the others were close to the national road. Road noise⁴ is strictly correlated with location – the highest level of noise was observed in the vicinity of the national road (compare Szopińska, 2017). The height of buildings exhibited a very similar correlation (high buildings were located mostly next to the district road, while the short ones – near the district road). Because of the identical arrangement of dwellings – resulting from the same construction technology – the number of rooms in a flat was in 98% correlated with its floor area. A link between the time of construction and location was also observed – buildings located next to the national road were put in use earlier than those more distant from it. It is a result of the sequence of land development in the 1980s – beginning with the buildings located closest to the House Factory, i.e. the prefabricated large panel factory.

Table 2. The descriptive statistics of the properties

Independent variables	Median	Min. value	Max. value	Standard deviation
Unit price	2654.72	1954.40	3759.40	323.6414
Transactional price	152000	81000	230000	30882.5611
a_a	3.4	2	5.3	0.8429
a_d	61.4	32.9	74.4	10.1337
dist	220	60	635	172.3480

Source: own study.

² Within the meaning of the Act on the ownership of premises (1994).

³ In case the distribution of transactional prices is a normal distribution or close to a normal distribution, 99.7% observations are in the range ($\bar{x} - 3s$; $\bar{x} + 3s$) where: \bar{x} – mean, s – standard deviation.

⁴ Noise measurements were conducted on the basis of source documentation – the acoustic map of the city of Kalisz for the years 2012–2016, i.e. the period under analysis (SNM, 2017).

The econometric model explaining the prices of dwellings in the secondary market in the analyzed area in the period of time between 2012 and 2016 was prepared after eliminating the factors strongly correlated with each other. Table 3 contains the parameters and basic statistics of estimated models.

Table 3. OLS, the observations used 1-93, dependent variable: $\log(p_trans)$ (p_trans – the residential real estate unit price PLN/m²) on the analyzed area of the secondary market in Kalisz between 2012–2016, $\alpha = 0.05$, $F(2,49) = 87.441$; $p < 0.0000$; Standard residual error: 0.0485.

	Coefficient	Standard error	t-Student	p Value
const	4.726269	0.035854	131.8202	0.000000
a_d	0.008403	0.000636	13.2156	0.000000
noise	-0.000093	0.000037	-2.5228	0.014940

Source: own study.

The calculated regression coefficients may be interpreted as the influence of the given variables on the logarithm of a transactional price: by how much will the logarithm price change (increase or decrease) if the independent variable relating to the given coefficient rises by a unit.

The models were verified with the statistical significance of the effect of the independent variables on the dependent variable, the determination coefficient and the adjusted value of the determination coefficient, resistant to increasing the number of explanatory variables.

Based on the model constructed, it is possible to conclude that the (log) prices of flats in the selected area in Kalisz in the secondary market in the years 2012–2016 were influenced by:

- a positive variable: a_d – dwelling area,
- a negative variable: noise – noise zone, strongly correlated to distance from a national road.

The parameters of the regression function showed statistical significance (at the level of $p < 0.05$) and the determination indicator R^2 was 0.7811. This means that the constructed model explained more than 78% of changes of the dependent variable. The value of adjusted R^2 (accounting for the number of independent variables in the model) equalled 0.7722 and did not deviate significantly from the general coefficient (tab. 3).

CONCLUSIONS

The paper presented the results of the research into the influence of the characteristics of a real property on its price, based on the selected local real estate market. The database of prices of flats in Kalisz in the years 2012–2016 was built and the data from a homogeneous estate was analyzed. Next, factors determining the prices of flats were revealed.

An econometric model was built, to describe the prices of flats in the analyzed period. In the course of the research, it was established that the characteristics of a real property explain its price in almost 80%. Housing prices are significantly determined by the level of road noise, strictly connected with location (in the vicinity of a district or national road), the distance from a national

road and acoustic comfort. The analysis of transactional data in the selected area and period has shown that as the level of noise decreases, thus the distance from a national road becomes shorter, the price of a property increases. Transport comfort is also important for the buyers of dwellings, but the direct proximity of a national road is seen as the flat's asset.

The results are similar to the research conducted in other local markets. As Fanning (2014) showed, location of a real property determines its price. Analysis of prices on a homogeneous housing market showed that the proximity of roads affects the level of the unit price negatively, however, this impact is small (0.02%), contrary to the results presented by Hughes and Sirmans (1992), who proved that the vicinity of a busy road causes housing prices to drop by 9.2% in cities.

Road noise is a serious problem, especially when transit roads run through urban areas. One of the reasons for transport noise pollution is improper spatial planning, uncontrolled city growth, or the lack of resources for road investments (ring roads).

BIBLIOGRAPHY

- Baltagi, B.H. (2011). *Econometrics. Fifth Edition*. Springer: Heidelberg.
- Brown, G.R. (1991). *Property Investment and the Capital Markets*. E & FN Spon, London.
- Fanning, S.F. (2014). *Market Analysis for Real Estate. Second Edition*. Chicago: Appraisal Institute.
- Foryś, I. (2014). Selected Demographic Aspects of Buyers' Activity on the Local Housing Market. *Real Estate Management and Valuation*, 4 (22), 92–104. DOI: 10.2478/remav-2014-0040.
- Hughes, W.T.J., Sirmans, C.F. (1992). Traffic Externalities and Single-Family House Prices. *Journal of Regional Science*, 4 (32), 487–500. DOI: 10.1111/j.1467-9787.1992.tb00201.x.
- Isaac, D. (2002). *Property Valuation Principles*. London: Palgrave.
- Kucharska-Stasiak, E., Załączna, M., Żelazowski, K. (2012). *Wpływ procesu integracji Polski z Unią Europejską na rozwój rynków nieruchomości*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego.
- Levkovich, O., Rouwendal, J., van Marwijk, R. (2016). The Effects of Highway Development on Housing Prices. *Transportation*, 2 (43), 379–405. DOI: 10.1007/s11116-015-9580-7.
- Malienė, V., Atkinson, I., Šubic Kovač, M., Pödör, A., Nyiri Mizseiné, J., Dixon-Gough, R., Hernik, J., Pazdan, M., Gaudėšius, R., Gurskienė, V. (2016). Property Markets and Real Estate Valuation Practice in Central and Eastern Europe – Slovenia, Hungary, Poland and Lithuania. W: R.T. Abdulai, F. Obeng-Odoom, E. Ochieng, V. Malienė (eds.), *Real Estate, Construction and Economic Development in Emerging Market Economies*. New York: Routledge, 296–357.
- Martínez, L., Viegas, J. (2009). Effects of Transportation Accessibility on Residential Property Values. *Transportation Research Record: Journal of the Transportation Research Board*, 2115, 127–137. DOI: 10.3141/2115-16.
- Meen, G.P. (2001). *Modelling Spatial Housing Markets. Theory, Analysis, and Policy*. New York: Springer Science + Business Media, LLC.
- Mikelbank, B.A. (2004). Spatial Analysis of the Relationship Between Housing Values and Investments in Transportation Infrastructure. *The Annals of Regional Science*, 38, 705–726. DOI: 10.1007/s00168-003-0187-0.
- Nelson, J.P. (1982). Highway Noise and Property Values: A Survey of Recent Evidence. *Journal of Transport Economics and Policy*, 2 (16), 117–138.
- Ranci, C., Brandsen, T., Sabatinelli, S. (ed.). (2014). *Social Vulnerability in European Cities: The Role of Local Welfare in Times of Crisis*. Basingstoke: Palgrave Macmillan.
- Siemińska, E. (2012). Nowe wyzwania inwestowania i finansowania projektów deweloperskich. *Studia i Materiały Towarzystwa Naukowego Nieruchomości*, 3 (20), 17–28.
- SNM (2017). *Strategic Noise Map (Strategiczna mapa akustyczna miasta Kalisza)*, Kalisz City Hall (Urząd Miasta Kalisza). Retrieved from: <http://msip.kalisz.pl/msip/> (access: 10.10.2017).
- Szopińska, K. (2017). *Creation of Theoretical Road Traffic Noise Model with the Help of GIS*. Conference „Environmental Engineering” 10th International Conference Vilnius Gediminas Technical University, Vilnius, Lithuania, 27–28 April, 1–8. DOI: 10.3846/enviro.2017.122.

- Trojanek, R. (2013). Fluctuations of Dwellings' Prices in the Biggest Cities in Poland During 1996–2011. *Actual Problems of Economics*, 2 (1–2), 224–231.
- Zaremba, A., Będzik, B. (2010). Cykle koniunkturalne, popyt i podaż na rynku nieruchomości. W: M.J. Nowak, T. Skotarczak (red.), *Rynek nieruchomości gminnych w czasie kryzysu i po kryzysie* (s. 39–50). Warszawa: CEDEWU.

LEGAL ACTS

Act of 24 June 1994 on the ownership of premises, consolidated text, Journal of Laws no. 0/2015, item 1892, as amended.

WPŁYW BLISKOŚCI DROGI KRAJOWEJ NA CENY NIERUCHOMOŚCI MIESZKANIOWYCH

STRESZCZENIE

Krajobraz dźwiękowy jest nieodłącznym elementem krajobrazu, a tym samym składnikiem lokalizacji szczegółowej nieruchomości. Hałas w środowisku stanowi poważne zagrożenie dla zdrowia publicznego. Szczególnie w miastach dźwięki natury są zakłócone przez hałas drogowy, który jest głównym zagrożeniem dla klimatu akustycznego. Celem artykułu jest rozpoznanie wpływu sąsiedztwa drogi krajowej na ceny lokali mieszkalnych na wybranym rynku lokalnym. Do oszacowania tego wpływu autorki wykorzystały metodę regresji log-liniowej. W analizie uwzględniono także inne czynniki, które warunkują wysokość cen mieszkań. Skonstruowany model wykazał, że mieszkania znajdujące się w strefie podwyższonego hałasu były tańsze niż lokale położone poza tą strefą. Wyniki badań mogą być pomocne w planowaniu przestrzennym i szacowaniu kosztów inwestycji drogowych, w tym w ocenie oddziaływania na środowisko.

SŁOWA KLUCZOWE

rynek nieruchomości mieszkaniowych, ceny, drogi, hałas drogowy