

USE OF METHODS OF CARTOGRAPHIC REPRESENTATION AND ECONOMETRICS FOR DEFINING THE CORRELATION BETWEEN REAL ESTATE PRICES AND A DISTANCE TO A CITY CENTRE

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Summary

The article presents using methods of cartographic representation and econometrics and statistical description to defining the correlation between unit prices of an undeveloped land property and a distance to a city centre. Sold undeveloped land located within administrative boundaries of the city of Jasło have been the subject of the study.

Keywords

undeveloped land property • correlation “price – distance to a city centre” • cartographic representation • methods of econometrics

1. Introduction

The distance of an appraised real estate to a city centre is one of the elements of a broadly understood feature called location. Objective determination of impact of a distance to a centre on a value of a real estate can improve the quality of its valuation. The coefficient determining a studied correlation should be defined for a specific local market, especially if it determines a value relation of a price to distance. In this article the correlation was studied in the case of undeveloped land properties located within administrative boundaries of the city of Jasło. The correlation of a unit price of land property to a distance to a city centre is obvious. The more distant location of a real estate parcel to a centre, the lower its unit price. The authors will define the correlation quantitatively and visualize it by a cartogram, using the real transaction data.

The issues of defining correlation between price and distance to a city centre have been the subject of many studies. Gawroński and Prus [2005] analysed the influence of chosen factors determining agricultural property prices on the example of the city of Niepołomice. They found that with a decrease of distance to the city, the prices of agricultural properties increased, and that their price is also considerably influenced by the distance to centres of supply and sales. Spatial analyses of land property prices in urban-

ized regions were a subject of works, e.g. by Colwell and Munneke [1997] and Morris and Palumbo [2007]. The use of statistical and econometrics methods [Adamczewski 2011, Anselin 1988, Bitner 2010] in determining the influence of distance to a city centre on a price of residential real estates were presented e.g. in Chen and Hao [2008], Osland [2010] and Ottensmann et al. [2006].

2. The characteristics of the studied area

Jasło is situated in a valley of three rivers: Wisłoka, Jasiołka and Ropa. It was granted municipal rights on 20th of April 1365 by the king Casimir III the Great. Jasło has an area of 37 square kilometres, and has 37 thousand inhabitants. It is located in the south-east part of Poland, in the south-west part of Podkarpackie Voivodeship and is a seat of a district (powiat).



Source: authors' study

Fig. 1. Jasło – administrative map with a division into surveying sections

The Jasło district borders on the east with Krosno and Strzyżów districts and on the south – with Dębica district, and on the west – with Tarnów and Gorlice districts. The south border of the Jasło district is also the border of the Republic of Poland. The area of Jasło has a diverse landscape. Its south and north-east part lies in the Strzyżowskie

Foothills and it is dominated by a landscape cut by basin-like valleys, with a large number of slopes with an irregular gradient, with numerous escarpments, often forested. The areas of Jasło-Krosno Basin have less diverse landscape with gentler slopes of little gradient. Historically the Jasło region is related to oil, gas and glass-making industries. Refining, construction, furniture, chemical and food (mainly fruits and vegetables processing) industries are also well developed. There are 3636 business entities in Jasło. The majority of them are one-man and family companies. But decisive for the region's development are large companies, such as plastics factory Gamrat SA, Lotos Jasło refinery, a flooring panels producer Baltic Wood SA, Oil and Gas Exploration Company in Jasło Ltd., Fabryka Armatur (Factory of Fittings) JAFAR SA, furniture factory "Nowy Styl", and fruit and vegetable processing plant Pektowin – A Naturex Company. There is a growing number of farms geared toward wine growing and production. There are already a dozen or so vineyards, and their number is still growing. Jasło has a good transport connections with Rzeszów, Nowy Sącz and also with border crossings with Slovakia and Ukraine.

The area of Jasło is divided into 24 surveying sections (Figure 1): 01 – Kowalowy, 02 – Ulaszowice, 03 – Błonie, 03A – PGR, 04 – Dzielnica Magazynowo-Przemysłowa, 05 – Hankówka, 06 – Zachód, 07 – Południe, 08 – Centrum, 09 – Górka, 10 – Sobniów I, 11 – Sobniów II, 12 – Gądky, 13 – Wądoły, 14 – Niegłowice, 15 – Żółków, 16 – Kaczorowy, 17 – Bryły, 18 – Gamrat, 19 – Krajowice, 20 – Podzamcze, 21 – Brzyszczy I, 22 – Brzyszczy II, 23 – Warzyce, 24 – Gliniczek.

3. The database and tools of econometrics used in the study

The data used in the study are the price and value of land and property register kept by the District Office (Starostwo Powiatowe) in Jasło and by the Statistical Office in Rzeszów. These are purchase and sales data of undeveloped lands from the first quarter of 2009 till the third quarter of 2011, and so they cover almost three years. The data refer to the area of the Jasło municipality. The following characteristics of undeveloped land properties were taken into account in the analysis:

- transaction price [zloty],
- area [m²],
- seller (individual or legal person, the commune, private investor, State Treasury),
- buyer (individual or legal person, the commune, private investor, State Treasury),
- distance to the city centre [m],
- date of the transaction,
- kind of transaction,
- kind of land property,
- city section,
- class of land,
- additional remarks.

In the studied period 227 transactions of agricultural (mono- and multi-purpose) land properties were carried out. From the database 50 transactions for reasons of an incomplete information and transactions of developed land properties have been removed. The distances to the city centre have been defined by tools of Geoportal website. It was assumed that the centre of Jasło would be the central point of the Hugo Steinhaus Roundabout.

The data analysis began by determining the index of price changes trend. To this purpose the following formula was used [Prystupa 2003, Bitner 2011]:

$$T_r = (C_p - C_w) / C_w t 100\%$$

where:

- T_r – trend index of price changes,
- C_p, C_w – prices of similar properties,
- C_p – price of a property in a later transaction,
- C_w – price of a property in an earlier transaction,
- t – time interval between transactions (in this study: number of days).

The strength of the correlation of unit price of a land property to the city centre was measured by index of correlation coefficient. In order to quantitatively determine the correlation “price – distance to the city centre” the linear regression was used. Moreover elements of descriptive statistics were used to characterize the studied database [Aczel 2000].

4. The results of the analysis

The analysis of price changes trend of undeveloped land properties, carried out with the use of formula (1), showed that in the studied period the market was stable. The prices stayed on pretty much the same level. That is why there was no need to check the prices with regard to a date of the last transaction in the database. The analysis of influence of distances to the city centre on the prices of lands began with the determination of correlation coefficient. The value of the coefficient was -0.24 . Its negative value means that the prices of land properties decrease as the distance to the city centre increases. However the correlation is not strong. The reason for it is e.g. popularity of chosen areas of the town that don't have to be in the city centre. Moreover cities expand more or less concentrically [Batty and Longley 1994].

In order to quantitatively determine the correlation between the unit price of a land and the distance to the city centre, the correlation of linear regression was established. The lines of regression in a formula $y = a + bx$ were adjusted to data by means of the method of least squares [Aczel 2000]. The analysis was carried out for three different ways of grouping data into class ranges. Table 1 shows comparison of the results.

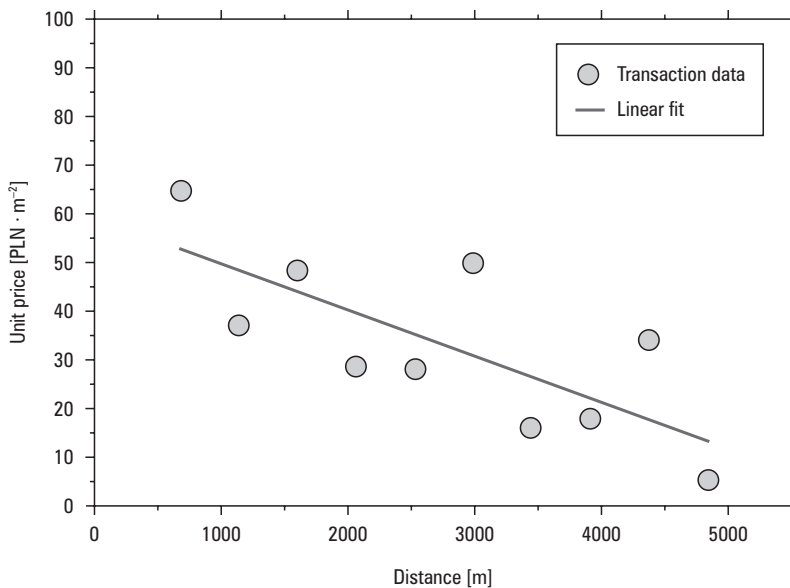
The results presented in Table 1 show that values of regression coefficients, when using different divisions into classes, are comparable. It means that the results do not depend on the division into classes. The negative values of slopes of straight lines

confirm the results obtained by means of correlation coefficient and indicate the fall of the land prices along with growing distance to the city centre. In practical applications one can assume averaged value of regression coefficient, equal to $0.0101 \text{ zloty} \cdot \text{m}^{-2}$ (based on data presented in Table 1). It means that when we get away from the city centre with each kilometre the prices fall by about 10 zloty.

Table 1. Comparison of linear regression coefficients calculated for three ways of division into class ranges

Number of class ranges	Regression coefficient <i>a</i>	Coefficient error <i>a</i>	Regression coefficient <i>b</i>	Coefficient error <i>b</i>
10	59.02	9.2	-0.009486	0.00030
15	61.32	9.5	-0.010058	0.00310
20	60.84	7.2	-0.010619	0.00241

Source: authors' study

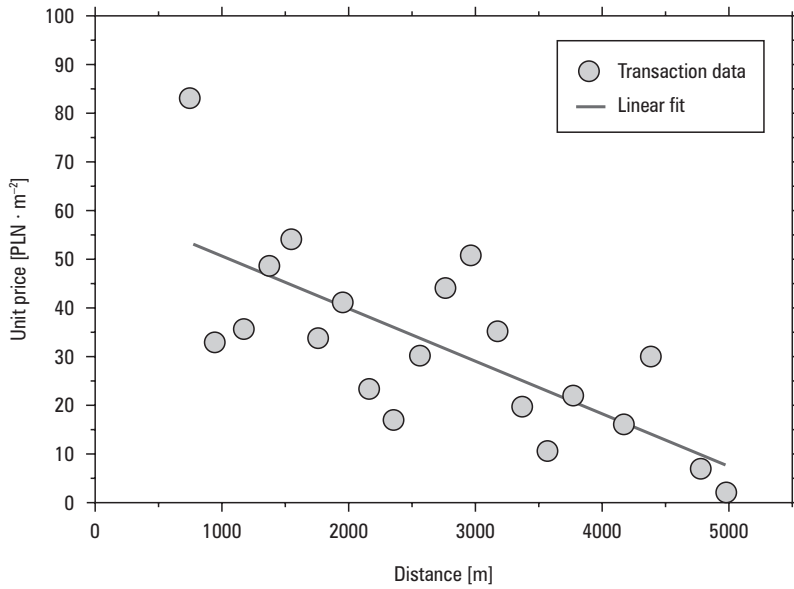


Source: authors' study

Fig. 2. The correlation between a unit price of a land property and the distance to the city centre with 10 class ranges

Figures 2 and 3 show the correlation between the unit price of a land and the distance to the centre of Jasło. As a central point of the city the middle of the Hugon Steinhaus Roundabout has been chosen. A closest was a land situated at 443 m distance from it, and the most remote was a land located at 5060 m from the city centre. The range of

distances of transaction lands to the city centre has been divided into adequately 10 and 20 class ranges. Using method of least squares regression line was adjusted to data. The calculations were made. Coefficients of regression line were shown in Table 1.



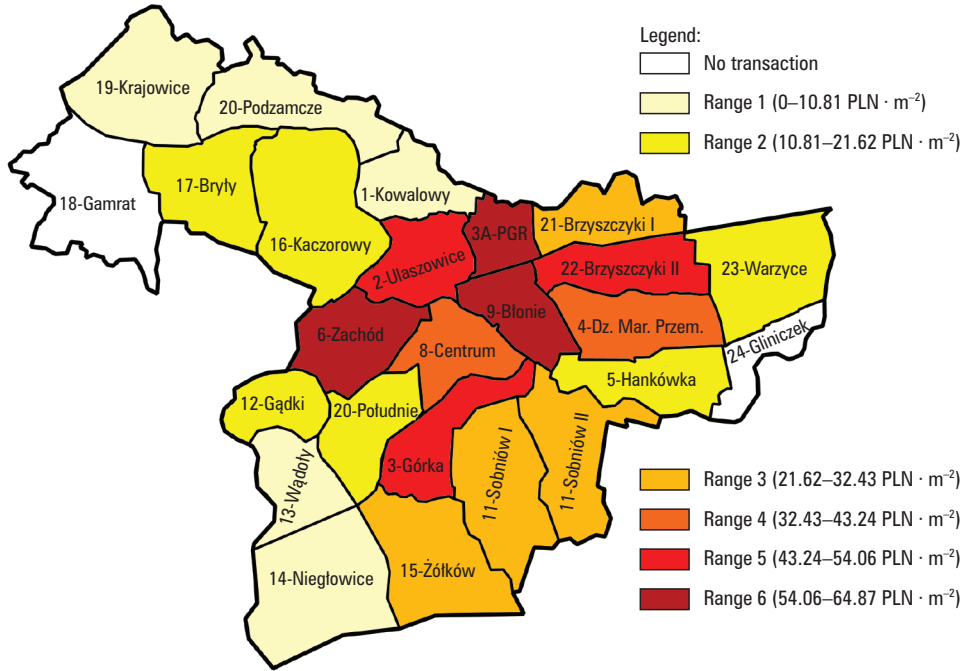
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Fig. 3. The correlation between a unit price of a land property and the distance to the city centre with 20 class ranges

Figure 4 shows, previously quantitatively determined, correlation between of a unit price of an undeveloped land and the distance to the city centre. The highest unit prices occur in the areas near the centre, the lowest – on the outskirts of the town.

The correlation between the number of transaction and distance to the city centre has also been analysed. The results are presented in Table 2 and Figure 5.

Table 2 and Figure 5 show that the highest number of transactions in the studied period was conducted in a ring situated concentrically around the city centre, of around 700 m and 3500 m radii. The distribution of number of transaction in relation to the city centre is positively skewed. At the centre itself and on the outskirts of the city very few transactions of lands have been carried out. Small number of transactions in the centre of the city is related to small supply of lands that can be a subject of transaction. City centres have usually stable ownership structure and owners are reluctant to get rid of attractively located real estates. The high prices of lands in city centres is also an important factor. On the other hand, the small number of transactions on the outskirts of the city results from little interest of purchasers in land located 4 km from the city centre because of e.g. poor transport accessibility.



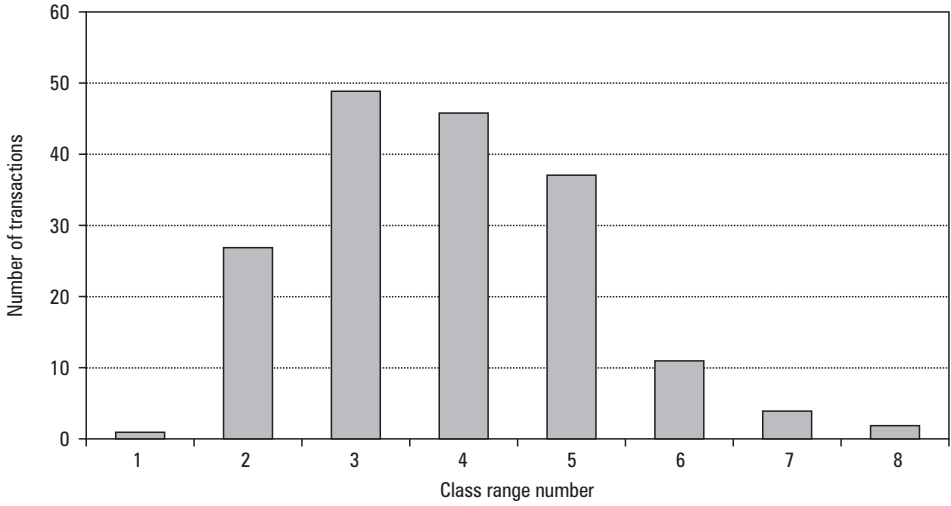
Source: authors' study

Fig. 4. Cartogram of unit prices of undeveloped land properties in Jasło

Table 2. The number of transactions in relation to the distance to the city centre. The second column shows right ends of class ranges

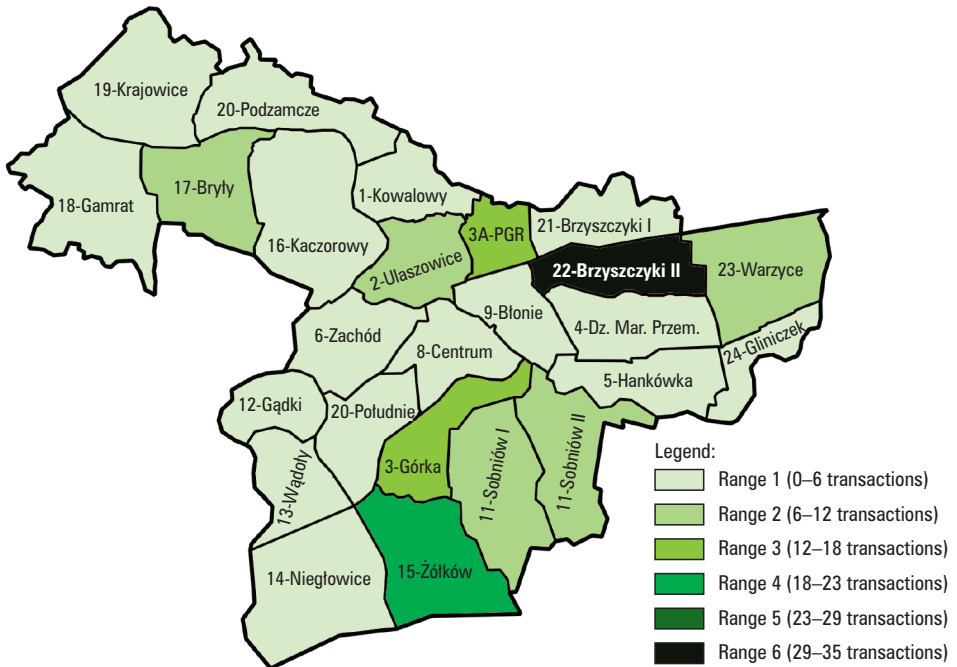
Number of class range	Distance to the city centre [m]	Number of ranges
–	0	–
1	687.5	1
2	1375	27
3	2062.5	49
4	2750	46
5	3437.5	37
6	4125	11
7	4812.5	4
8	5500	2
–		–

Source: authors' study



Source: authors' study

Fig. 5. The number of transactions in relation to the distance to the city centre. Class range numbers on the x-axis correspond to ranges shown in Table 2.

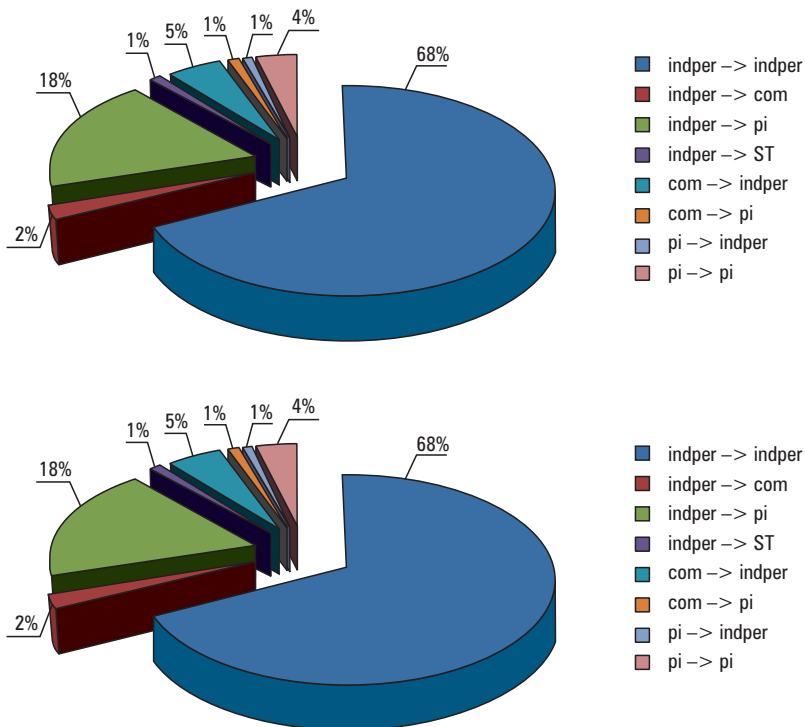


Source: authors' study

Fig. 6. Cartogram of intensity of undeveloped land transactions in Jasło

The intensity of transactions within the borders of Jasło is shown in Figure 6. The largest number of transactions has been noted within the section of Brzyszczyki II, there were 36 of them. It is a section situated by the road Jasło – Krosno. The second in terms of number of transactions is the Żółkowie section. The attractiveness of lands in this section results from its location near the road to a boarder crossing. Within the Gamrat section, an industrial area, no transaction was noted. Little interest in lands was observed in the Gądkki section, situated in the flooded area, and in the Warehouses and Industrial section. In most sections at least 6 transactions were made.

In the analysed real estate database the sides of transaction were various entities, such as, individual person, commune, private investor, the State Treasury. Figure 7 presents percentage share of particular entities taking part in undeveloped land transactions. The following entities were singled out: indper – individual person, com – commune, pi – private investor, ST – State Treasury.



Source: authors' study

Fig. 7. Percentage share of particular entities taking part in undeveloped land transactions

Figure 7 shows that the largest number of transactions was made between individual persons (67%), and 18% are transactions in which a individual person sold a land to a private investor. Some 6% were the transactions in which the commune was the seller.

5. Conclusions

The article presents the methods of using cartographic representation, econometrics and statistical description to define the correlations in the real estate market. As the object of the study an undeveloped land properties market was chosen, located within the administrative borders of Jasło. Transaction data cover almost three years period. In the studied period 227 transactions were made, but only 177 were the subject of the authors' analysis.

In the studied period the market of undeveloped lands in Jasło was stable and the prices stayed on pretty much the same level. Almost 70% of transactions have been carried out between individual persons. The largest number of transactions was noted in sections situated near the road Jasło – Krosno, and to the road leading to a border crossing. The studied correlation between a unit price of a land property and the distance to the city centre showed that along with growing distance to the city centre the unit price of land fall by about 10 złotych with each kilometre. The results of the study can be used directly in evaluation of land properties on the local market or by creating a development strategy of a studied area.

References

- Aczel A.D. 2000. *Statystyka w zarządzaniu*. Wydawnictwo Naukowe PWN, Warszawa.
- Adamczewski Z. 2011. *Elementy modelowania matematycznego w wycenie nieruchomości. Podejście porównawcze*. Oficyna Wydawnicza PW, Warszawa.
- Anselin L. 1988. *Spatial econometrics: methods and models*. Kluwer Academic Publishers, Dordrecht, The Netherlands.
- Batty M., Longley P. 1994. *Fractal cities*. Academic Press, San Diego.
- Bitner A. 2010. O użyteczności metod statystycznych w wycenie nieruchomości, *Infrastr. Ekol. Ter. Wiej.*, 12, 145–158.
- Bitner A. 2011. Jakość wskaźnika zmiany cen nieruchomości wyznaczonego na podstawie analizy par nieruchomości podobnych. *Acta Sci. Pol. Admin. Loc.*, 10, 4, 5–13.
- Chen J., Hao Q. 2008. The impacts of distance to CBD on housing prices in Shanghai: a hedonic analysis. *Journal of Chinese Economic and Business Studies*. Journal of Chinese Economic and Business Studies, Taylor Francis J., 6, 3, 291–302.
- Colwell P., Munneke H. 1997. The Structure of Urban Land Prices. *J. Urban Econ.*, 41, 321–336.
- Morris D., Palumbo M. 2007. The Price of Residential Land in Large U.S. Cities. *J. Urban Econ.*, 63, 352–384.
- Gawroński K., Prus B. 2005. Lokalny rynek nieruchomości oraz wybrane czynniki kształtujące ceny nieruchomości rolnych i działek budowlanych na przykładzie miasta Niepołomice. *Infrastr. Ekol. Ter. Wiej.*, 4, 7–18.
- Osland L. 2010. An Application of Spatial Econometrics in Relation to Hedonic House Price Modeling, *J. Real Estate Res.*, 32, 3, 289–320.
- Ottensmanna J.R., Paytona S., Manb J. 2006. Urban Location and Housing Prices within a Hedonic Model. *J. Reg. Anal. Policy*, 38, 1, 19–35.
- Prystupa M. 2003. *Wycena nieruchomości przy zastosowaniu podejścia porównawczego*. PFSRM, Warszawa.

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