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SPATIAL ANALYSIS OF HOUSING MARKET TRANSACTIONS IN SZCZECIN

1. INTRODUCTION

Despite the economic crisis, the housing market remains an area of interest for participants because of the needs it satisfies – both for living but also investment. Active participation in the market requires a study of housing prices. The available analyses and reports usually contain the average housing prices within a particular set of administrative boundaries (district, town, municipality, or province). Most often, official studies concern provincial capitals and the province as a whole, as in the annual publications of the Central Statistical Office (*Real estate...* 2010). However, the preferences of buyers about the location and price of a purchased apartment do not tie in with administrative divisions. These are local decisions. Hence, the need to study the spatial distribution of housing prices and the search for relationships between the characteristics of houses preferred by buyers in urban spaces. Most of this article discusses the spatial autocorrelation in transaction prices (Basu, Thibodeu 1998: 61-85) as well as price indices or spatial models in real estate economics (Barry, Pace, Sirmans 1998: 5–13; Barry, Gilley, Sirmans 2000: 229–246; Palm 1978: 210-221; Wilhelmsson 2002: 92–101).

The aim of this study is a spatial analysis of transactions on the local secondary housing market in Szczecin. This is a continuation of the research undertaken earlier (Batóg, Foryś 2013b: 77-88). The study focused on finding the spatial relationship between transactions in Szczecin, dividing it into four districts and thirty-seven housing estates. The study includes an analysis of

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peripheral settlements in terms of the number of transactions and the average price of housing in the districts. Spatial concentration indices and distributions of housing characteristics were determined.

Information from notarial deeds was used to achieve these objectives. Each transaction is described by a set of quantitative and qualitative variables. The results of the study may be helpful in the decision-making of subjects on the local housing market, including investors who decide to start new construction projects.

2. APPLIED METHODS

The spatial concentration of the number of transactions was computed separately for the sets of housing estates and districts. The Herfindahl-Hirschman index (H) given in Formula (1) was applied (Suchecki 2010: 143-146, Batóg 2008: 19-28):

$$H = \sum_{k=1}^{n} u_k^2 \, , \tag{1}$$

where: n – number of objects (housing estates or districts), k – number of object, u_k – share of the number of transactions for object k in the total number of transactions.

The Herfindahl-Hirschman index does have a maximum value of "1", but the minimum value depends on the number of objects. Therefore, the values of the Herfindahl-Hirschman index were transformed into the interval [0, 1] (relative Herfindahl-Hirschman index). The values of the Herfindahl-Hirschman index close to "1" indicate that the number of transactions for the examined objects were characterised by a strong concentration.

The entropy measure (E) of the number of transactions was also computed separately for the sets of housing estates and districts. The formula of the entropy measure (E) is given in Formula (2):

$$E = -\sum_{k=1}^{n} u_k \log_2 u_k \, , \tag{2}$$

where: n – number of objects (housing estates or districts), k – number of object, u_k – share of the number of transactions for object k in the total number of transactions.

The entropy measure does have a minimum value of "0", but the maximum value depends on the number of objects. Therefore, the values of the entropy measure were transformed into the interval [0, 1] (relative entropy measure). The values of the entropy measure close to "0" indicate that the number of transactions for the examined objects were not characterised by uniform distribution.

In the next step, the similarity measures for housing estates were computed. The Bray-Curtis measure (BC) given in Formula (3) was applied[1] (*Metody…* 2004: 41-42; Markowska 2008: 17-25):

$$d_{ij} = \frac{\sum_{k=1}^{K} |y_{ik} - y_{jk}|}{\sum_{k=1}^{K} y_{ik} + \sum_{k=1}^{K} y_{jk}} , \tag{3}$$

where: i, j – number of objects, k – number of variable, K – number of variables,

$y_{ik} = \dfrac{x_{ik}}{\sum_{k=1}^{K} x_{ik}}$, $y_{jk} = \dfrac{x_{jk}}{\sum_{k=1}^{K} x_{jk}}$, x_{ik}, x_{jk} – values of variable k for objects i and j.

The values of the Bray-Curtis measure (BC) lie in the interval [0, 1]. The small values of this measure indicate a strong similarity. The Bray-Curtis measures were calculated on the base of three variables.

At the end, the test, for two means was used in order to compare the average levels of variables in 2009 and 2013. The correlation coefficients between all variables in 2009 and 2013 were also calculated.

3. DATA

The study used information about transactions on secondary housing market in Szczecin in two specific years: 2009 and 2013. The year 2009 is characterised by the fact that it was the first full year of the economic downturn, while 2013 was the last full year before the study, and also in the ongoing economic slump. The examined period is characterised by further housing slowdown on the real estate market.

Every transaction from the notarial deeds is described by a set of variables:

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[1] The Bray-Curtis measure is not a distance one because it does not satisfy all conditions of distance.

- date of sale,
- transaction price,
- apartment area,
- number of rooms,
- floor the apartment is located on.

The study was conducted for thirty-seven housing estates and four districts of Szczecin: Śródmieście, Północ, Zachód i Prawobrzeże (Figure 1). The largest area is Prawobrzeże and the smallest is Śródmieście, while Międzyodrze-Wyspa Pucka is a significant part of an estate including the Oder river backwaters with a low population density.
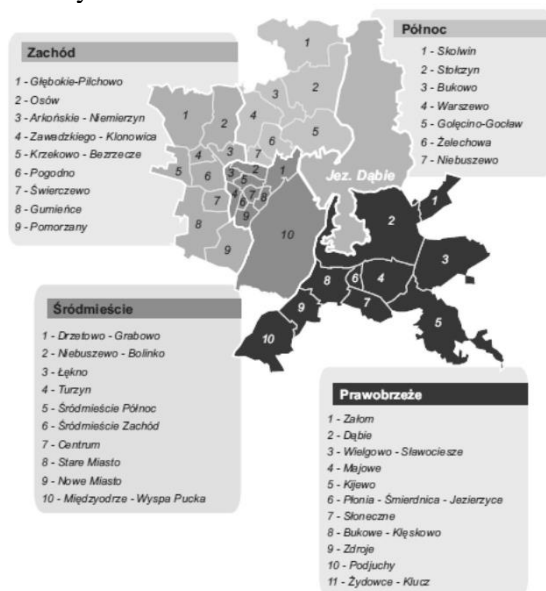

Figure 1. Housing estates and districts in Szczecin

Source: www.szczecin.pl.

Every housing estate and district is described by:
- number of transactions,
- average area of the sold apartments,
- average price for 1 m^2,
- population,
- total sum spent on apartments.

In 2009, data was available from 2 017 transactions on the market (excluding donations, inheritance or no-tender sales) made in the form of notarial acts; in 2013 the number of transactions was 2 242. Throughout these years, a significant increase in the trading house is not visible despite the current government support programme for housing "*Family on its Own*" (Batóg, Foryś 2013: 36-71). The range of available data in the notarial deeds is very limited,

and other real estate databases are not readily available for researchers. Due to incomplete data, the age of the building containing the apartment and the floor on which the apartment is located were abandoned.

4. EMPIRICAL RESULTS

In the first step, the examined variables for 37 housing estates are presented in Figures 2–5. The 2009 values are presented on the *x*-axis and 2013 values are presented on the *y*-axis. In each figure, the symmetry line is also drawn. The 2009 values are greater than 2013 values for points below this line and the 2009 values are lower than 2013 values for points above this line.

As far as the number of transactions in housing estates is concerned (Figure 2), it could be stated that the deviations from symmetry line are greater in the case of greater numbers of transactions in 2013 than in 2009. The number of transactions was greater in 2013 than in 2009 for only one-third of housing estates.
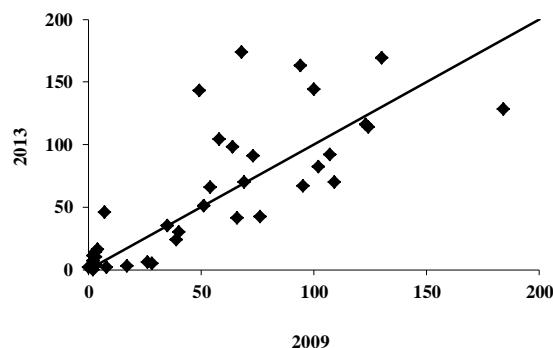

Figure 2. Number of transactions in housing estates in 2009 and 2013

Source: own calculations.

The average area of the sold apartments in housing estates is presented in Figure 3. On the local market, small apartments (two-room) have been the most popular during the crisis (Foryś 2013: 85-100). The most often sold apartments had an area of around 50 square meters. The average area of the sold apartments was above 70 square meters in one of the examined years for only 7 housing estates.
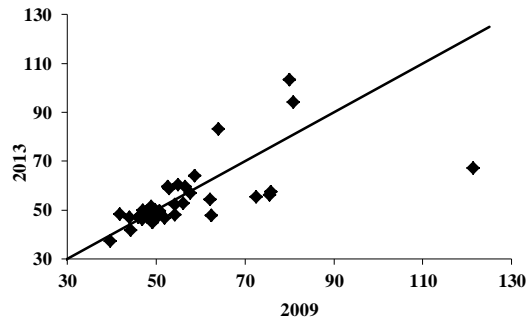
Figure 3. Average area of sold apartments in housing estates in 2009 and 2013

Source: own calculations.

The average price for 1 m^2 in housing estates is presented in Figure 4. This price was greater in 2013 than in 2009 for only 6 housing estates. Additionally, the deviations from the symmetry line are greater in the case of higher average prices in 2009 than in 2013.
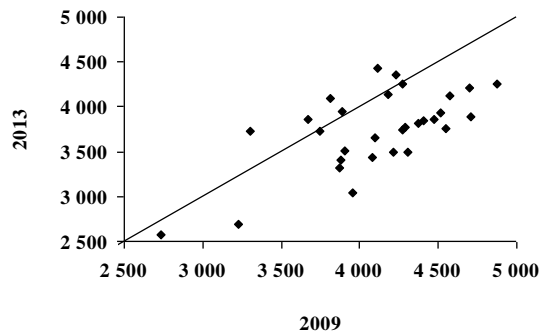

Figure 4. Average price for 1 m^2 in housing estates in 2009 and 2013

Source: own calculations.

The population in the housing estates is presented in Figure 5. It is apparent that the population has dropped in almost every housing estate, but the decreases were very small.
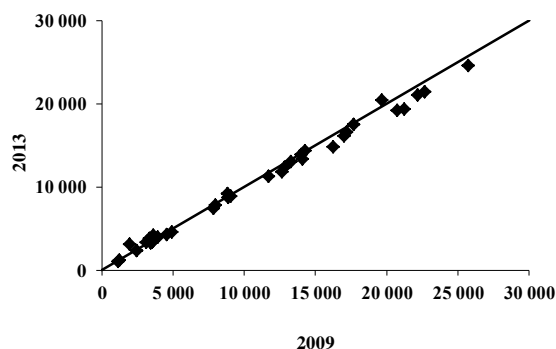
Figure 5. Population in housing estates in 2009 and 2013

Source: own calculations.

In Figure 6, the total sum spent on apartments in housing estates is presented. It could be stated that total sum spent on apartments was bigger in 2013 than in 2009 for almost half of the housing estates in Szczecin. It is also worth mentioning that the price index of dwellings from 2009 to 2013 was equal to about 17%.
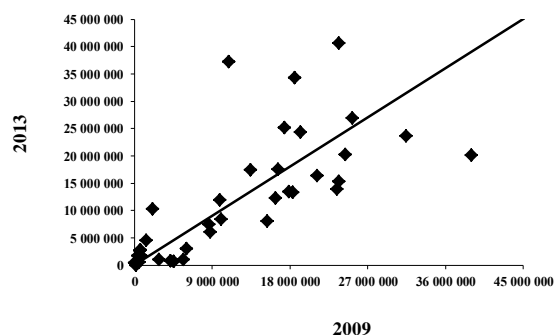
Figure 6. Total sum spent on apartments in housing estates in 2009 and 2013.

Source: own calculations.

The tests for two means were conducted for the average area of the sold apartments and the average price for 1 m^2. The comparison was made for 2009 and 2013. The results are presented in Table 1:

Table 1. Results of the test for two means

Variable	t statistics	p value
Average area of sold apartments	-1.399	0.162
Average price of 1 m^2	15.648	0.000

Source: own calculations.

It turned out that in the case of the average area of the sold apartments, the difference between means in 2009 and 2013 was not statistically significant on a significance level of 0.05 (p value greater than 0.05), whereas in the case of the average price for 1 m^2 the difference between means in 2009 and 2013 was statistically significant on a significance level of 0.05 (p value less than 0.05).

Additionally, the correlation coefficients between the examined variables in 2009 and 2013 were calculated and are presented in Table 2.

In 2009, the strong correlation between the average price for 1 m^2 of the sold apartments and the population of the housing estate could be observed (correlation coefficient 0.784). There is also a significant positive correlation between the number of transactions and average area of the sold apartments (correlation coefficient 0.626). The result suggests that the greater popularity of the housing estate as measured by the number of transactions, the more expensive is the apartment in the location (Foryś 2011: 124-131). This is called the fashion effect for a given location on the one hand, and on the other hand it may arise with the offer on the primary market of a new housing development in specific locations. Apartments on the primary market are usually more expensive than those on the secondary market (Batóg and Foryś 2013: 36-71).

Table 2. Correlation coefficients

	1	2	3	4	5	6	7	8	9	10
1	1.000	0.626	-0.227	-0.172	0.264	0.260	-0.188	-0.175	-0.181	-0.109
2	0.626	1.000	-0.126	-0.109	0.311	0.630	-0.150	-0.134	-0.065	0.005
3	-0.227	-0.126	1.000	0.784	0.388	0.079	0.895	0.894	0.981	0.684
4	-0.172	-0.109	0.784	1.000	0.367	0.173	0.814	0.816	0.801	0.962
5	0.264	0.311	0.388	0.367	1.000	0.387	0.364	0.380	0.428	0.389
6	0.260	0.630	0.079	0.173	0.387	1.000	0.084	0.090	0.127	0.230
7	-0.188	-0.150	0.895	0.814	0.364	0.084	1.000	0.998	0.893	0.722
8	-0.175	-0.134	0.894	0.816	0.380	0.090	0.998	1.000	0.896	0.733
9	-0.181	-0.065	0.981	0.801	0.428	0.127	0.893	0.896	1.000	0.733
10	-0.109	0.005	0.684	0.962	0.389	0.230	0.722	0.733	0.733	1.000

Legend: 1 – number of transactions in 2009, 2 – average area of sold apartments in 2009, 3 – average price for 1 m^2 in 2009, 4 – population in 2009, 5 – total sum spent on apartments in 2009, 6 – number of transactions in 2013, 7 – average area of sold apartments in 2013, 8 – average price for 1 m^2 in 2013, 9 – population in 2013, 10 – total sum spent on apartments in 2013.

Source: own calculations.

In 2013, the strongest positive correlation existed between the average area of the sold apartments and the average unit price (correlation coefficient of 0.998). The population density is significantly positively correlated with both the average unit price and the average area of the apartments

(the correlation coefficients are respectively 0.893 and 0.896), as well as with the total sum spent on the purchase of apartments in Szczecin in the reporting year (correlation coefficient of 0.260).

Comparing the same variables in both years, one can see a low positive correlation between the numbers of transactions in the housing estates of Szczecin (correlation coefficient of 0.260). Also, the relationship between the average area of the sold apartments is low but negative (correlation coefficient of -0.150). In contrast, the relationship between the average unit price, the population and the total sum spent on apartments is positive and high. Demographic processes are long-lasting, but the changes in this subject within five years may also result from the realisation of new investment because of the population increases in the housing estates with these new investments.

In Table 3, the Herfindahl-Hirschman indices for number of transactions are presented for the 4 districts, for 37 housing estates and for housing estates in every district separately.

The Herfindahl-Hirschman indices and the relative Herfindahl-Hirschman indices are all very small and show a very low level of spatial concentration. This kind of situation was true in 2009 and also in 2013. It means that there was no district or housing estate for which the share of the number of transactions was very high in comparison to the shares in other parts of Szczecin. The relative H is mostly higher in 2013 than in 2009, but the differences are quite small. The highest values are for housing estates in the Północ district, but they are still small.

Table 3. Herfindahl-Hirschman index (H) – number of transactions

Districts	2009				2013			
	H	min	max	relative H	H	min	max	relative H
	0.284	0.250	1	0.046	0.288	0.250	1	0.051
Housing estates	0.047	0.028	1	0.019	0.048	0.028	1	0.021
Północ	0.325	0.143	1	0.212	0.262	0.143	1	0.139
Prawobrzeże	0.142	0.100	1	0.047	0.155	0.091	1	0.070
Śródmieście	0.162	0.100	1	0.068	0.170	0.111	1	0.066
Zachód	0.150	0.111	1	0.044	0.158	0.111	1	0.053

Source: own calculations.

In Table 4, the entropy measures for number of transactions are presented for 4 districts, for 37 housing estates and for housing estates in every district separately:

Table 4. Entropy measure (*E*) – number of transactions

Districts	2009				2013			
	E	min	max	relative *E*	*E*	min	max	relative *E*
	1.895	0	2.000	0.948	1.899	0	2.000	0.944
Housing estates	4.642	0	5.170	0.894	4.586	0	5.170	0.887
Północ	1.831	0	2.807	0.652	2.169	0	2.807	0.773
Prawobrzeże	2.981	0	3.322	0.897	2.886	0	3.459	0.834
Śródmieście	2.808	0	3.322	0.845	2.730	0	3.170	0.861
Zachód	2.833	0	3.170	0.894	2.772	0	3.170	0.874

Source: own calculations.

The entropy measures and the relative entropy measures are all large and show a very high level of entropy. This kind of situation was true in 2009 as well as in 2013. Again, it means that there is no district or housing estate for which the share of the number of transactions is very high in comparison to the shares in other parts of Szczecin. The relative *Es* were very similar in 2009 and 2013. The lowest values are also for housing estates in the Północ district, but they are still high.

In the last step, the values of Bray-Curtis measure of similarity of housing estates were calculated. The calculations were based on three variables:
– average area of the sold apartments,
– number of transactions,
– average price for 1 m^2.

The results are presented in Figures 7 and 8. The Bray-Curtis measure was calculated for each pair of housing estates in 2009 and 2013 separately. There is no need to present all of these. The authors decided to present the Bray-Curtis measure in reference to one housing estate in every year.
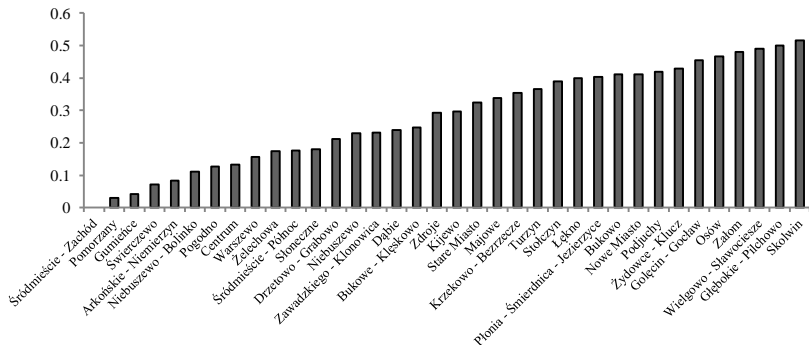

Figure 7. Bray-Curtis measure – Niebuszewo-Bolinko as a base

Source: own calculations.

The housing estate bases were characterised by the greatest number of transactions. And it turned out that in 2009 the greatest number of transactions was in the Niebuszewo-Bolinko housing estate, whereas in 2013 the greatest number of transactions was in the Śródmieście-Zachód housing estate.
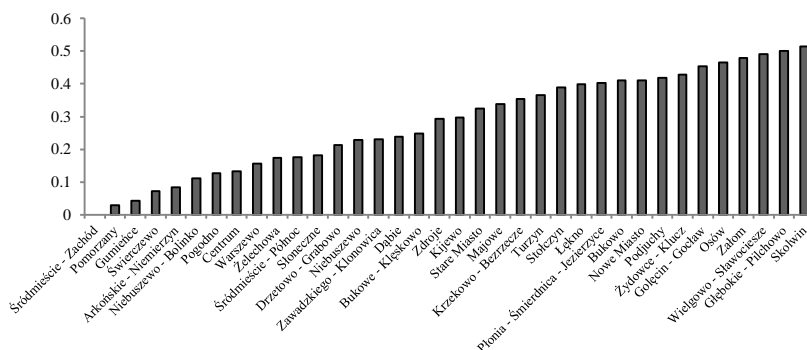

Figure 8. Bray-Curtis measure – Śródmieście-Zachód as a base

Source: own calculations.

In 2013, it could be observed that most transactions were concluded in the largest housing estates of the Zachód district such as Pomorzany, Gumieńce and Świerczewo. These housing estates are characterised by high population density resulting from a great number of high-rise residential buildings from the '70s and '80s. Additionally, it is worth mentioning that in 2013, in contrast to 2009, the Centrum housing estate (central location in the city) was not included in the first three housing estates which had the highest number of transactions. The Pomorzany housing estate had a significant position in both years – it has high-intensity multi-family buildings, including new investments. Pomorzany has a large number of small apartments, sought both for lease and purchase. The attractiveness of this location is also affected by its proximity to three universities.

In the examined years, the smallest number of transactions in reference to base housing estate was noted in estates with mainly single-family houses or low multi-family ones, as well as in housing estates distant from the centre.

5. CONCLUSIONS

The changes in the number of transactions, prices and other analysed variables for apartments sold in Szczecin in the examined years were affected

by the downturn. After five years of the persistence of negative trends, significant changes can be expected in the housing market, especially spatial changes. The obtained results did not confirm this supposition.

There is no district or housing estate for which the share of the number of transactions is very high in comparison to the shares in other parts of Szczecin.

The number of transactions was greater in 2013 than in 2009 for only one-third of housing estates. This is the effect of the concentration of transactions in Szczecin's inner-city housing estates and in those locations where new investments arise. It also shows the mobility of Szczecin's residential population (Foryś, 2011: 197-211, Foryś, 2010: 71-81), which is not uniformly distributed in space.

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ABSTRACT

The housing market is very important even in the period of crisis because people always have welfare and investment needs. Therefore the spatial analysis of secondary market (prices, attributes of apartments) is of interest. The aim of the paper is spatial analysis of transactions on the secondary housing market in housing estates and quarters in Szczecin. The peripheral quarters will be assigned and concentration indices will be calculated. The data come from notarial deeds referring to the transaction on the secondary housing market in Szczecin. Each transaction is described by a set of variables – the date of sale, transaction price, apartment area, the number of rooms or the level the apartment is located on.

PRZESTRZENNA ANALIZA TRANSAKCJI NA SZCZECIŃSKIM RYNKU MIESZKANIOWYM

ABSTRAKT

Mimo kryzysu gospodarczego rynek mieszkaniowy pozostaje obszarem zainteresowań jego uczestników z uwagi na potrzeby jakie zaspokaja: bytowe, ale również inwestycyjne. Aktywne uczestnictwo na rynku wymaga przestrzennego badania tego rynku (cen oraz cech mieszkań). Celem badania jest przestrzenna analiza transakcji mieszkaniami, zawartych na wtórnym rynku w Szczecinie z podziałem na dzielnice i osiedla. Obejmuje ono analizę peryferyjności osiedli pod względem liczby zawieranych transakcji oraz średniej ceny mieszkań w dzielnicy. Wyznaczono również indeksy koncentracji przestrzennej oraz rozkłady cech mieszkań w przestrzeni. Do realizacji powyższego celu wykorzystano informacje zawarte w aktach notarialnych, w których każda transakcja opisana jest zestawem zmiennych ilościowych i jakościowych, w tym datą sprzedaży, ceną transakcyjną, powierzchnią lokalu, liczbą pokoi, charakterystyką budynku, w którym znajduje się lokal czy kondygnacją budynku, na której jest położony.