



The 9th International Conference “ENVIRONMENTAL ENGINEERING”

22–23 May 2014, Vilnius, Lithuania

SELECTED PAPERS

eISSN 2029-7092 / eISBN 978-609-457-640-9

Available online at <http://enviro.vgtu.lt>

Section: Sustainable Urban Development

Methodology for identification of homogeneous group of housing markets in urban development

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Abstract

Knowledge of the real estate market is crucial for good land management. The question of similarities between local markets is connected with the question of internal variability of the individual markets. We present the results of a project to compare a similarities between local markets in the quantitative and qualitative aspects by creating appropriate integrated indicators for these markets. Such indicators will make it possible to find a similarity of different local markets and present them hierarchically. From the large number of methods available, techniques originating from two spheres of statistical inference were selected: distribution free methods and multivariate analysis methods. For analyses within the distribution free methods, Friedman's test (Friedman's non-parametric variance analysis) and Kendall's test (W. Kendall's compatibility ratio) were selected. For analyses within the multivariate analysis methods, factor analysis was selected, which constitutes a set of statistical methods and procedures allowing for conversion of a large number of variables tested to a significantly smaller number of independent factors or main components which preserve a considerable amount of information conveyed in the primary variables. If this statistical method is applied, it is possible to reduce the number of attributes describing local real estate markets down to a few integrated indicators, which preserve their descriptive qualities, despite the reduction of variables that has taken place.

Keywords: similarity; housing market; land management.

1. Introduction

Proper economic development is dependent on properly organized space, a properly functioning regional economy, properly functioning land management and real estate management. Therefore the regional development and specially urban development including the real estate market development are some of basic stimuli for economic development of any country, which means that proper economic growth is, to a significant degree, contingent upon properly organized and diagnosed space.

The notions of land management and real estate management are defined separately or interdependently, but undoubtedly ambiguously. Generally, it can be stated that land management concerns the entire space and economy in question, although mostly its social, geographic, demographical, political and environmental aspects. However, the real estate management is a spatial, legal, financial and technical dimension of this economy, and specific elements of management can be divided into legal, financial-economic and organizational.

The real estate market is a very important element in the development of a country and market driven economy, as well as a factor influencing society's prosperity and satisfaction [1]. Behaviors on the real estate market are subject to change due to the impact of changing internal and external determinants, thus leading to changes in the individual elements of the system. These changes, as well as the environment itself, constitute a multidimensional plane in which uncertainty occurs. The environment of the real estate market is determined by economic, spatial, social-economic and other surroundings. Even the smallest of changes may result in a random change in other elements of the system, completely altering the relations and dependences occurring in the market [2].

The similarity of the local real estate markets has become an important domain of the regional policy. The analysis of real estate markets necessitates the recognition and evaluation of external determinants not only on the scale of national level but also from the regions or even smaller areas municipalities or only cities. The differences in the development of

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<http://dx.doi.org/10.3846/enviro.2014.107>

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different regions constitute an important problem and a strategic challenge for the regional development policy, land management policy, real estate management policy and urban development policy.

According to [3] most important in the analysis of real market is the selection of adequate research methods and procedures adequate for the specific attributes of the real estate market which make it different from other markets, including capital markets.

It was assessed that useful tools in conducting comparative analyses of various local real estate markets are statistical procedures. From the large number of methods available, techniques originating from two spheres of statistical inference were selected: distribution free methods and multivariate analysis methods. The research analysis was conducted in Warmia and Mazury province, in Poland.

2. Similarity of housing markets

The fulfillment of housing needs is one of the fundamental human needs. According to Maslov's hierarchy of needs, housing satisfies the basic physical requirements for safety and survival, as well as the need for social contact, esteem and self-actualization. Housing fulfills a broad spectrum of needs, which implies that the property market, where housing resources are transferred, affects the behavior of individuals as well as the entire society. Housing markets have multiple interactions with the rest of the economy. The drivers of house prices include income, the housing stock, demography, credit availability, interest rates. That's why the housing market is defined as one where housing services are allocated by the mechanism of supply and demand.

The similarity of local housing markets can mean the resemblance of certain features (parameters, attributes), and those features should to a maximum degree reflect current conditions of the market and of its current trends. The real estate market can be described with the use of a significant number of features, and their description should make it possible to use similarity measures not only in the qualitative sense, but also in a quantitative one. The comparison of housing markets according to quality features can be related to an excessively subjective assessment, while using only quantitative features can result in the omission of important features, which cannot be directly translated into numbers. Examples can include fashionable locations, quality of life, residents' safety, social pathologies, etc. Therefore, there appears a problem of market parametrization, i.e. presentation of numerical descriptions of conditions – spatial, economic, demographical, social and others – which cannot be directly presented in a given quantity dimension. A quantity assessment of quality features can be applied directly, i.e. while considering the features which indirectly describe a quality feature, besides their qualitative nature, e.g. the economic activity can be described by the budget revenue of the municipality per inhabitant. Features describing selected local markets should be diagnostic features, i.e. those that to the fullest extent describe the most important – from the point of view of supply and demand– conditions in which real estate transactions occur. Basic general criteria, which can prove the similarity of local markets, include first of all the type of the market, i.e. the type of real estate's that are subjects of sale and their similar features. Among the most important specific criteria, the following can be mentioned: the conformity of factors shaping market prices, the similarity of the scales used for their description, as well as the resemblance in the perception of market features by potential buyers (the same preferences) [4].

The needs and reasons for assessing similarities of local housing markets, in Poland, result, first of all, from legal regulations and standards concerning the assessment of the market value of real estates. Most often, this need is related to situations, in which there is no sufficient information in a given local market as regards transactions of similar objects. In such cases, objects from comparable markets are used for analysis purposes. Such a situation can concern atypical real estates, which are rarely found in the market. In practice, comparable real estate markets are searched for, taking into consideration, first of all, market potential (e.g. the size of the locality, its area and the number of inhabitants), and from among these markets, information is collected on similar real estates, which have recently been the subject of sale. Thus, it is particularly important to determine the criteria of similarity – not only of real estates, but also of the market environment, in which a given real estate is located.

The issue of the similarity of local housing markets, has been the subject of many scientific research. For example, similarities between regions were studied by Bajerowski and Biłozor [5] with the aid of scale-free networks. Kałkowski [6] and Belniak [7] analyzed a number of issues in the dynamics of local markets while Trojanek [8] analyzed local price fluctuations in terms of real estate price indices. Determinants of the development of local housing markets were the subject of research by Foryś [9] using the Hellwing parametric method. The multivariate techniques of principal component analysis and cluster analysis were used Belniak and Głuszak [10] to identify a homogenous group of housing markets that share economic base and are similar in housing market dynamics. Dittmann [11] analyzed the similarity of changes in the real estate's prices and the phenomenon of sigma convergence or divergence.

3. Applied research method

To identify a homogenous group of housing markets in Warmia and Mazury province in Poland, that share economic base and are similar in housing market dynamics, it was assessed, that the useful tools would be the techniques originating from:

- distribution free methods
- multivariate analysis methods.

3.1. Distribution free methods

For comparative analyses within the distribution free methods, Friedman's test (*Friedman's non-parametric variance analysis*) and Kendall's test (*W. Kendall's compatibility ratio*) were selected. Friedman's non-parametric variance analysis is based on ranks – in the case when input data are expressed on an interval or ordinal scale, but the assumption of the normality of the distribution cannot be met, Friedman's test is applied instead of a parametric ANOVA test and variables are transformed to the form of ranks. The lowest observed value of a given feature receives rank 1, the second in the ascending order – rank 2, and the highest – rank k [12]. Afterwards, the number of ranks for each examined feature is summarized. Differences between the sums of ranks are measured with the use of the statistics of Friedman's test. As part of calculating Kendall's test, the so-called Kendall's compatibility ratio is determined, which is a measure of similarity for the examined phenomena. In the computational sense, this ratio is an arithmetic mean of all correlation coefficients of Spearman's ranks.

3.2. Multivariate analysis methods

Further stages of comparative analyses involved statistic algorithms from the multivariate analysis methods, which include the following techniques of statistic inference:

- multivariate analysis of variance,
- discriminate analysis,
- factor analysis,
- cluster analysis,
- conjoint analysis,
- canonical correlation analysis,
- multi-dimensional scaling.

For the purposes of comparative analyses, the main aim of which is to describe the smallest possible number of integrated indicators that characterize the market under analysis, a factor analysis has been selected. The fundamental objectives of the classic factor analysis include:

- identification of common factors hidden in a set of variables,
- reduction of the spatial dimensions of variables,
- orthogonalisation of the space in which the tested objects are considered,
- identification of the character of variables,
- transformation of the set of variables into a new set of main components with respect to quality,
- graphic presentation of the set of multidimensional observations.

Factor analysis enables such a conversion of a given mutually correlated set of variables that will result in a new set of variables (*main factors or components*) which would not be mutually correlated, but comparable to the initial set [13]. The application of such a statistical procedure allows for the decrease in the number of attributes describing local real estate markets to a few integrated indicators, which, despite the reduction of variables that has been carried out, do not lose their describing values. It is assumed that specified common factors are the source of interrelations between variables. Additionally, each variable is characterized by some specific features, but they do not imply correlative interdependence of features. Common components are regarded as carriers of the same information, which leads to the conclusion that they can be replaced with new, synthetic, main factors.

4. Data description

Identification of the similarity between local housing markets was conducted in province of Warmia and Mazury voivodeship in northeastern Poland. The voivodeship has an area of 24.192 km² and a population of 174 641. The voivodeship contains 49 cities, the research involved data originating from 30 towns. In table 1 have been defined parameters used in the research. Data (Table 1 – all data from 2012) comes from a polish Main Statistical Office (GUS).

Table 1. Parameters used in research

Symbol	Description
AR	area of the town [km ²]
PE	population of the town
DW	number of new dwellings
IN	budget revenue per inhabitant
UN	employment ratio (relation of the number of the employed to the total number of people in the economically productive age group)
WS	infrastructure related indicator (total length of water supply and sewage lines per km ²),
TR	indicator specifying the role of the town in the transportation system
DI	distance to the capital of the province (Olsztyn)
IM	administrative importance of the town

Source: own study

The value of main used parameters, for identification of the similarity between local housing markets have been presented on Figure 1.

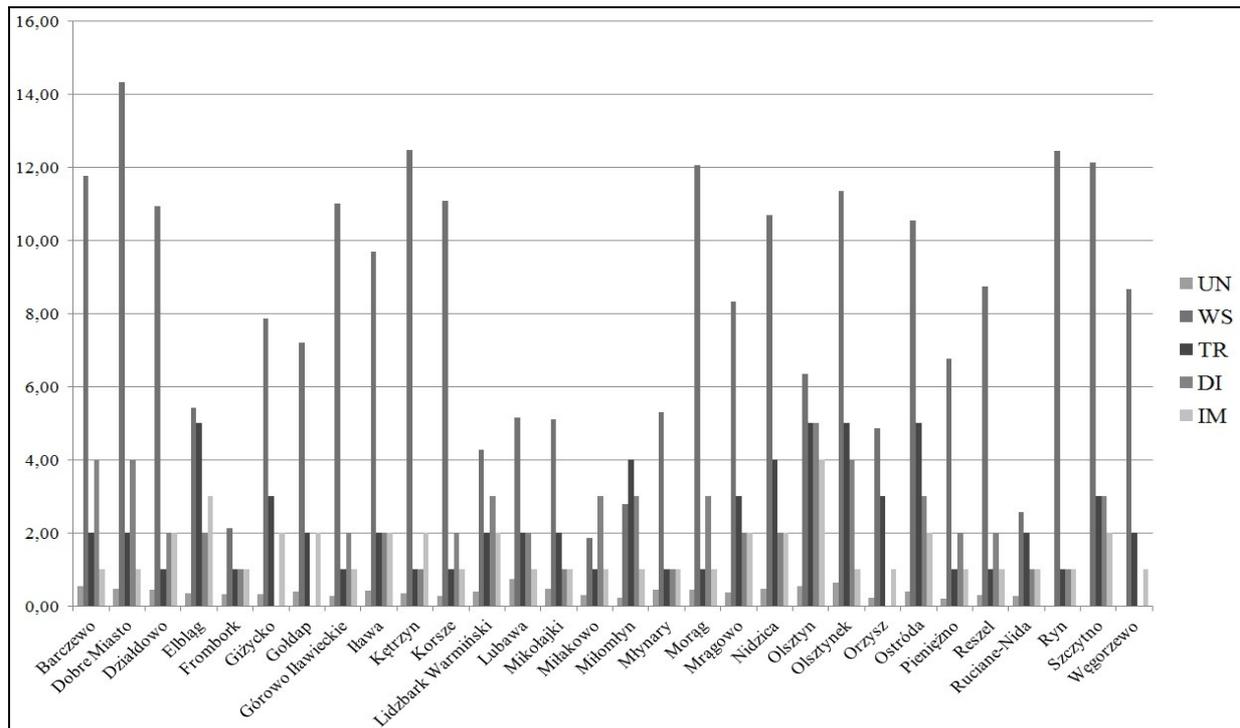


Fig. 1. The value of parameters UN, WS, TR, DI, IM for 30 local housing markets. Source: own study based on GU

The use of selected research methods, requires that the parameters should be presented in the form of ranks. Therefore, appropriate transformation was performed, where the characteristics of the smallest observation was 1, and the largest 30. In order to perform studies has been determined correlation matrix between variables, shown in Table 2.

Table 2. Correlation matrix parameters used in research

	standard deviation	AR	PE	DW	IN	UN	WS	TR	DI	IM
AR	8.775	1.000	0.639	0.689	-0.110	0.189	-0.364	0.591	0.003	0.658
PE	8.803	0.639	1.000	0.833	-0.432	0.356	0.314	0.514	0.187	0.850
DW	8.794	0.689	0.833	1.000	-0.388	0.256	0.156	0.590	0.107	0.685
IN	8.802	-0.110	-0.432	-0.388	1.000	-0.261	-0.389	-0.201	-0.154	-0.165
UN	8.803	0.189	0.356	0.256	-0.261	1.000	0.249	0.279	0.404	0.250
WS	8.803	-0.364	0.314	0.156	-0.389	0.249	1.000	-0.110	0.248	0.085
TR	8.443	0.591	0.514	0.590	-0.201	0.279	-0.110	1.000	0.266	0.478
DI	8.556	0.003	0.187	0.107	-0.154	0.404	0.248	0.266	1.000	0.083
IM	7.612	0.658	0.850	0.685	-0.165	0.250	0.085	0.478	0.083	1.000

Source: own study

5. Identification of homogeneous group of housing markets

5.1. Distribution free methods

Kendall's ratio tests similarities between n arrangements in k categories. This means that, in the discussed example, that statistics may determine the extent of similarities between the rank arrangements in the nine indicators (n), characterising local housing markets in the 30 cities (k). The Kendall's ratio was calculated as an arithmetic average of all indicators of Spearman's correlation of ranks. The value arrived at was $W = 0.28814$, which gave a 29% mutual similarity between 30 cities. The value of that statistic may be explained as follows. The statistic is a quotient of variance of the summed k ranks divided by the maximum possible variance of summed k ranks. If W . Kendall's ratio in this analysis was close to the value of 1, this would mean that the housing markets in Warmia and Mazury province in Poland are identical with respect to the

assumed attributes. Thus, further comparative analysis would be irrelevant. Now, since the result is close to 0.3 the diversity of local markets is true, so there is possibility to find different groups of homogenous housing markets.

In the Friedman's non-parametric variance analysis the basis for determining the similarity is, in this case, an average rank. The calculation results, in the form of hierarchy of cities, have been presented on Figure 2.

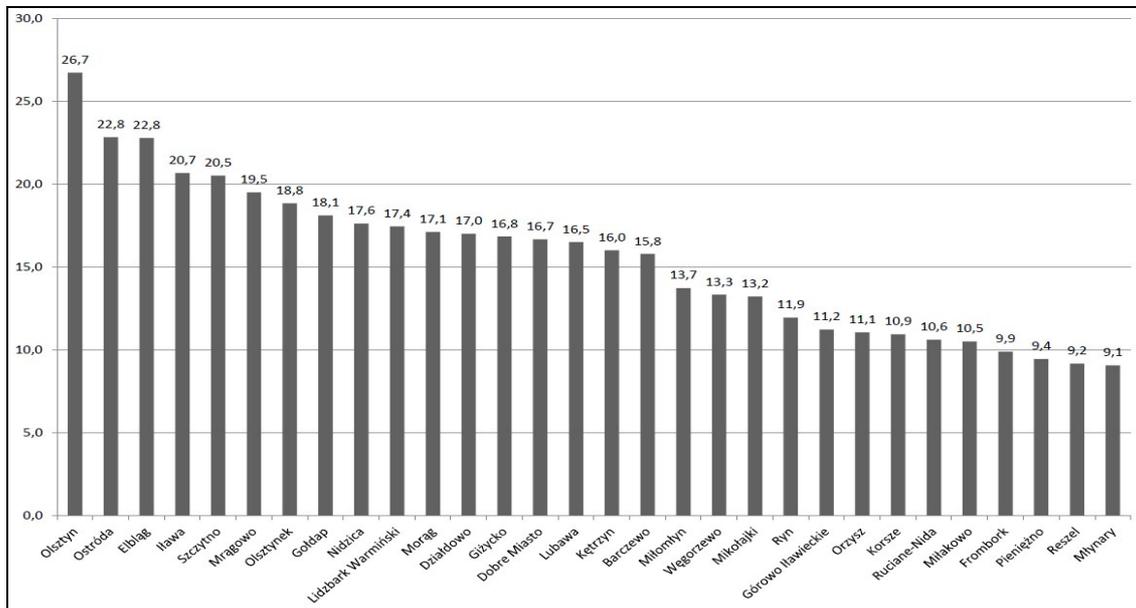


Fig. 2. Hierarchy of towns based on average rank average rank in Friedman's non-parametric variance analysis. Source: own study

The highest average rank, calculated on the basis of nine indicators, was obtained for Olsztyn, as the most important urban centre of the region. This the city achieved the highest average rank (26.72) specifying the dimensions of the market. The lowest average rank was obtained by Młynary (9.05), as a relatively small locality.

The basis for determining the markets similarity is an average rank. A graphical representation of the sum of ranks makes it possible to distinguish groups of objects of a similar sum of ranks. The classification of towns into groups based on average rank average rank in Friedman's non-parametric variance analysis have been presented in Table 3.

Table 3. Classification of towns into groups based on average rank average rank in Friedman's non-parametric variance analysis

GROUP I	GROUP II	GROUP III	GROUP IV
average rank ≥ 22.0	$22.0 > \text{average rank} \geq 18$	$18 > \text{average rank} \geq 12$	average rank < 12.0
Elbląg	Ilawa	Nidzica	Ryn
Olsztyn	Szczytno	Lidzbark Warmiński	Górowo Iławeckie
Ostróda	Mragowo	Morąg	Orzysz
	Olsztynek	Działdowo	Korsze
	Goldap	Giżycko	Ruciane-Nida
		Dobre Miasto	Miłakowo
		Lubawa	Frombork
		Ketrzyn	Pieniężno
		Braczevo	Reszel
		Miłomłyn	Młynary
		Węgorzewo	
		Mikołajki	

Source: own study

5.2. Multivariate analysis methods

In the factor analysis a set of nine parameters (Table 1) characterizing local markets was reduced to two main factors. Those two integrated factors contained approximately 64% of original information (Table 4). The obtained results show that the first factor contained about 44% of the information resource of all nine indicators, while the second factor contained about 20%.

Table 4. Own value of integrated factors in factor analysis

	Own value	Percent of variance	Cumulated own value	Cumulated %
1	3.970826	44.12029	3.970826	44.12029
2	1.772639	19.69598	5.743465	63.81627

Source: own study

Another step in factor analysis that is carried out is to determine factor loadings understood as the degree of saturation of a variable with a given factor. This information is subsequently used for subjective identification and then for naming integrated main factors that have been created. The higher is the correlation of a variable with a factor, the more significant is a given variable for a given factor. The results of calculating factor loadings and new own values (after rotation) are presented in Table 5.

Table 5. The results of calculating 2 integrated factors in factor analysis

Symbol	Factor 1	Factor 2
AR	0.907862	-0.205587
PE	0.833583	0.422315
DW	0.854653	0.262197
IN	-0.226221	-0.632936
UN	0.259619	0.588937
WS	-0.160983	0.832184
TR	0.737102	0.091867
DI	0.061416	0.580822
IM	0.839708	0.148737
Common variability resource	3.646201	2.097264
Share in %	0.405133	0.233029

Source: own study

The first factor has the strongest link to the parameters: AR – area of the town, PE – population of the town, DW – number of new dwellings, TR – indicator specifying the role of the town in the transportation system, IM – administrative importance of the town. The second factor is strongly linked to parameters: IN Budget revenue per inhabitant, UN – employment ratio, WS – infrastructure related indicator, DI – distance to the capital of the province (Olsztyn). Specific two integrated factors may be interpreted as two-dimensional co-ordinates of the localisation of housing markets. Thus, based on the calculated values, Figure 3 shows the similarity of towns based on integrated factors in factor analysis.

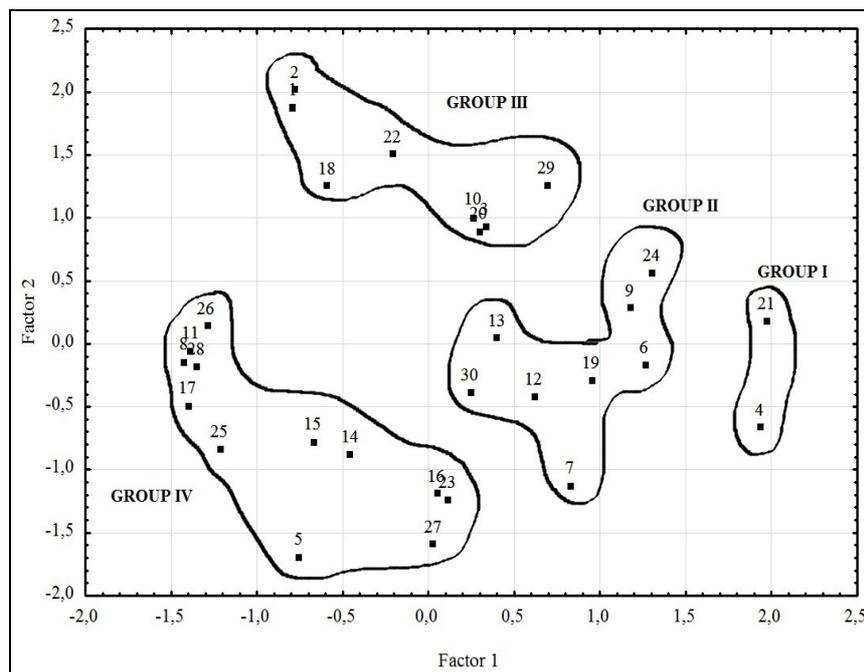


Fig. 3. Similarity of towns based on integrated factors in factor analysis. Source: own study

The classification of towns into groups based on 2 integrated factors in factor analysis have been presented in Table 6.

Table 6. Classification of towns into groups based on 2 integrated factors in factor analysis

GROUP I	GROUP II	GROUP III	GROUP IV
Elbląg [4]	Giżycko [6]	Barczewo [1]	Frombork [5]
Olsztyn [21]	Goldap [7]	Dobre Miasto [2]	Górowo Hławieckie [28]
	Ława [9]	Działdowo [3]	Korsze [11]
	Lidzbark Warmiński [12]	Kętrzyn [10]	Mikołajki [14]
	Lubawa [13]	Morąg [18]	Miłakowo [15]
	Mragowo [19]	Nidzica [20]	Miłomłyn [16]
	Ostróda [24]	Olsztynek [22]	Młynary [17]
	Węgorzewo [30]	Szczytno [29]	Orzysz [23]
			Pieniężno [25]
			Reszel [26]
			Ruciane Nida [27]
			Ryn [28]

Source: own study

An application of factor analysis provides results that are close to the assessment of similarity of objects with the use of average ranks in Friedman's non-parametric variance analysis.

6. Conclusions

The assessment of the similarity of local real estate markets is certainly not easy. The application of analytic procedures used in the course of this research can bring about more credible assessment of similarity, while the extension of the set of diagnostic features of markets could result in obtaining more reliable results. The problem is, in this case, their proper choice. A large number of variables (market features) results, at the same time, in their mutual correlation. Then, theoretically more reliable results can be obtained with the use of factor analysis. The research and analyses conducted indicate that it is possible to practically apply their results in order to analyze real estate markets and general land management

References

- [1] Radzewicz, A. 2013. Real estate market system theory approach phase space, *Real Estate Management and Valuation* 21(4): 87–95. <http://dx.doi.org/10.2478/remav-2013-0040>
- [2] Radzewicz, A.; Renigier-Biłozor, M.; Wisniewski, R. 2011. From uncertainty to the efficiency of the real estate market, in *Conference The European Real Estate Society*. Available from Internet: <http://www.eres.org>
- [3] Renigier-Biłozor, M. 2011. Analysis of real estate markets with the use of the rough set theory, *Studia i Materiały Towarzystwa Naukowego Nieruchomości* 19(3): 107–118.
- [4] Belej, M.; Cellmer, R. 2007. Koncepcja oceny skali podobieństwa lokalnych rynków nieruchomości na potrzeby gospodarki przestrzennej, *Studia i Materiały Towarzystwa Naukowego Nieruchomości* 15(3–4): 23–34.
- [5] Bajerowski, T.; Biłozor, A. 2005. Theory of Barabasi scale-free networks as a new tool in researching the structure and dynamics of regions, *Studia Regionalia* 15: 45–56
- [6] Kalkowski, L. 2003. *Rynek nieruchomości w Polsce*. Warszawa: Twigger.
- [7] Belniak, S. 2001. *Rozwój rynku nieruchomości w Polsce*. Poznań: Wydawnictwo Akademii Ekonomicznej.
- [9] Foryś, I. 2011. *Spoleczno-gospodarcze determinanty rozwoju rynku mieszkaniowego w Polsce*. Szczecin: Wydawnictwo Naukowe Uniwersytetu Szczecińskiego.
- [10] Belniak, S.; Głuszak, M. 2011. Uwarunkowania i zróżnicowania lokalnych rynków mieszkaniowych w Polsce. Stan i tendencje rozwoju rynku nieruchomości, in *Zeszyty naukowe* 192. Poznań: Wydawnictwo Uniwersytetu Ekonomicznego w Poznaniu.
- [11] Dittman, I. 2012. Lokalne rynki mieszkaniowe w Polsce – podobieństwo pod względem zmian cen transakcyjnych oraz dostępności mieszkań, *Studia i Materiały Towarzystwa Naukowego Nieruchomości* 20(1): 71–90.
- [12] Aczel, A. 2000. *Statystyka w zarządzaniu*. Warszawa: Polish Scientific Publishers PWN.
- [13] Sokołowski, A.; Sagan, A. 1999. *Analiza danych w marketingu i badaniach opinii publicznej. Przykłady wnioskowania matematycznego*. Available from Internet: <http://www.statsoft.pl/czytelnia/marketing/adwmarketingu.html>