FACTOR ANALYSIS IN DETERMINING THE SIMILARITY OF LOCAL REAL ESTATE MARKETS' CONDITIONS

Mirosław Bełej, Radosław Cellmer, Sabina Źróbek

University of Warmia and Mazury in Olsztyn

Maruska Subic Kovac

University of Ljubljana

Abstract. Interest in research on the issue of real estate market similarity results from many practical problems, especially connected with land management and land administration. The authors assume that factor analysis, as a statistical method among multivariate analysis methods, can be a useful tool for the determining the similarity of local real estate markets' conditions. The authors exploited information from six variables describing local real estate markets to create two new independent main factors that, together, account for 80% of variability of the primary variables. Using factor analysis, it was possible to build a two-dimensional space in which the location of each real estate market can be described using the new main factors as coordinates. Although the practical research was conducted on chosen Polish cities in the Warmia-Masuria Province, the same methodology can be applied to other markets as well.

Key words: similarity, factor analysis, real estate market

INTRODUCTION

The economic development of each country depends largely on the proper development of the real estate market. According to Urbanavičienë et al. [2009], the growth or decline of the real estate sector considerably affects the general growth or decline of a country's economy. Rapid environmental change, globalization and international trade in open markets have an influence on the housing market, especially by affecting housing

Corresponding author: Mirosław Bełej, Faculty of Geodesy and Land Management, University of Warmia and Mazury in Olsztyn, Prawocheńskiego 15, 10-720 Olsztyn, Poland, e-mail: miroslaw.belej@uwm.edu.pl

price level formation. The real estate market share in the global economy suggests the important position of this market in the economic processes of major economies [Venclauskiene and Snieska 2010].

In the classical approach, the real estate market [Dawidowicz et al. 2014] comprises a set of general rules and conditions for transferring property rights and concluding agreements which define the rights and obligations of property owners. This market also varies depending on the behaviors and actions of many actors, including elements of the surroundings. For this reason, it can be considered that the real estate market is a special type of market, with its own rules and far from the definition given by mainstream economics [Brzezicka and Wiśniewski 2013].

Following this view, Bełej [2013] defined the real estate market as a system comprising a set of elements and their attributes, and the set of relations observed between these elements. The set of elements contains all system components which determine all processes on the real estate market. These processes form a set of relations. Interactions between the analyzed set of elements and their attributes with the set of mutual relations take place in a strictly defined period of time. The dynamics of these interactions are determined by the dynamics of changes in the market environment, with varying strength, direction and intensity of such mutual interactions. The real estate market can receive signals from the environment, but, under specific circumstances, such signals can also be transmitted by the market. The above implies that significant changes in the legal, social, economic and political environment are drivers of change in sets of market elements and their attributes. This means that they contribute to real estate market development. Therefore, the market [Foryś 2011], together with its economic and social environment, forms a system of communicating vessels, in which stagnation in any segment and the lack of communication between the segments have a detrimental effect on the entire system.

Typically, a submarket is defined as a set of dwellings that are reasonably close substitutes for one another, but relatively poor substitutes for dwellings in other submarkets [Grigsby et al. 1987]. Some researchers have defined submarkets as specific geographical areas or administrative areas [Goodman 1981]. Others suggested that submarkets comprise all dwellings, irrespective of their location, which possess similar physical characteristics and represent relatively close substitutes to potential purchasers [Grigsby 1963, Dale-Johnson 1982]. Maclennan and Tu [1996] explain that both sectoral (structural) and spatial factors, separately or interactively, may generate submarkets. In the present paper, the authors decided to use the administrative borders of areas to identify the boundaries of submarkets, defined as the local real estate markets.

The analysis of a real estate market represents an important scientific basis for decision-making in spatial planning and real estate management, and designing appropriate public policies. Real estate market analysis provides guidance for the many decision makers involved in real estate development. It is an outgoing process that provides information during the predevelopment, acquisition, development, marketing, and disposition of property. The goal of market analysis is to minimize risks and maximize opportunity for developers and investors by providing analysis that is as timely and accurate as possible. Due to the characteristics of real estate, market analysts should account for the heterogeneity of the real estate market. One important issue in regional

and local development policy has become the identification of heterogeneity (differences) within the real estate markets' conditions and the determination of similarities between areas. National, regional and local economic conditions all affect real estate demand, but the most important factors are local; thus, the study of local economics and demographics should be the main focus of real estate market studies. Therefore, there is a need to identify and consider external factors, not only at the national level but also at the local level, e.g. municipalities or cities. Proper land administration policy, development policy and property management are based on knowledge and reliable information about the differences and similarities of given areas, especially at the local level.

The article is based on the following assertion: if consideration of local real estate markets is to become a routine component of policy decisions, both by the central government and by regional and sub-regional planning bodies, an easy to understand method that can be applied to any area and frequently updated must be developed. The authors assume factor analysis, as a statistical method among multivariate analysis methods, to be a useful tool for the determining the similarity of local real estate markets' conditions. In our research, we decided to identify homogeneous groups of local real estate markets based on non-pricing local economic factors. In our opinion the real estate market is not only the demand, supply and price, like in the neoclassical economics but it should be analyzed also from the institutional economics and behavioral economics point of view.

LOCAL REAL ESTATE MARKETS

At the local government level, there is a need to use reliable methods for the identification of similar real estate, which arises from many practical issues, especially from land management and land administration, e.g.:
- municipal development strategy planning or zoning plans;
- decision-making by local authorities in the field of housing policy;
- assessment of the condition of local real estate markets in the region;
- strategic management of territorial entities;
- forecasting the development of various areas;
- developing analyses and better decision making by analysts, developers and investors.

The issue of similarity between local real estate markets' conditions is an important area of research. Dittmann [2012] examined the phenomena of convergence and divergence on local markets, and similarities in terms of offer and transaction prices, with Heckman [2008] examining the possibility of using a non-linear causality in multivariable fractional polynomials (MFPs). White [2009] examined the behavior of house prices over a 23-year period in one city, looking at house prices in more and less expensive neighbourhoods and how they change over time, as well as investigating what the most important economic factors that affect house prices in the city are and how they affect different neighbourhoods. The research also examined whether these factors exert long-term or short-term impacts on prices, and the differences in these

price movements across neighbourhoods. McPeake [1998] examined the relationship between religion and choices made by buyers on local markets. The determinants of the development of local markets were examined by Foryś [2011] using Hellwing's parametric method. Źróbek and Grzesik [2013] analyzed the diversity of physical, legal and economic characteristics denoting risk which is specific to local real estate markets in contrast to other sectors of the economy. Scanlon and Whitehead [2011] conducted an analysis on pricing factors and macroeconomic influences in order to identify homogeneous groups of local markets.

MATERIAL AND METHODS

The analysis of local markets requires the simultaneous analysis of multiple variables. It appears that, in such case, it is worth examining factor analysis. This is a useful tool among multivariate methods for understanding the relationships between the variables of complex systems.

According to Cudeck [2000], factor analysis is a collection of methods for explaining the correlations between variables in terms of more fundamental entities called main factors. This means that each new main factor contains partial information from the basic variables. The goals of factor analysis are to determine the number of fundamental influences underlying a domain of variables, to quantify the extent to which each variable is associated with the factors, and to obtain information about their nature from observing which factors contribute to the performance of which variables. Factor analysis [Widaman 1993, Majors and Sedlacek 2001] is often used as a method for grouping variables according to a similar correlation pattern. In this capacity, factor analysis is simply a means for sorting objects. The objective of the analysis is to partition the variables into subsets that are hopefully distinct from those of other groups, and homogeneous within a group.

The key concept of factor analysis is that multiple observed variables have similar patterns of responses because of their association with an underlying latent variable, a factor that cannot be measured easily. One of the main reasons for using factor analysis rather than the more common multiple regression is the problem of multicollinearity amongst variables. The high levels of correlation between many of the variables that can be used to describe a local real estate market pose a problem in creating a stable multiple regression model. Factor analysis has been the subject of several studies [Thompson 2004, Zmarzłowski and Jałowiecki 2008, Lewandowska 2014, Sterev 2014] and more detailed procedures for the use of this method can be found there.

In general, we can say that factor analysis makes it possible to covert correlated variables to obtain new variables, called main factors, which are uncorrelated. Thus, the application of a factor analysis procedure enables the number of primary variables to be reduced to a few new synthetic variables. An important aspect of this procedure is that the new main factors do not lose their descriptive values. The new main factor should clarify the maximum amount of variance of primary variables.

RESULTS AND DISCUSSION

Data description

The research aimed at evaluating the usefulness of factor analysis for the determining the similarity of local real estate markets' conditions. The study was conducted in the northeastern part of Poland. It was decided to use the cities' administrative borders to distinguish individual submarkets (local real estate markets). The research involved variables originating from 13 cities. Data for the analysis were gathered from the Polish Central Statistical Office (GUS). The study was conducted for two periods, i.e. 2005 and 2012. The reason for selecting these periods is the assumption that research should be carried out during stable periods of real estate market development. In Poland, real estate prices increased slowly and steadily up to 2005, and then, from 2006 to 2007, underwent a rapid increase (by as much as 100% per year). After this time, the real estate market gradually stabilized during a gentle downward trend lasting from 2008 until 2011, and thus 2012 is considered to be the start of a new long-term stable period.

Real estate assets are heterogeneous, which implies that their characteristics vary. Researchers and practitioners have found that hundreds of factors might affect prices in various situations [Liu et al. 2006]. The choice of variables describing local real estate markets is relatively complex seeing as how the selection of factors that determine variations in these markets over time and in space continues to be the subject of debate in scientific publications. For example, Żelazowski [2011] examined economic indicators (GDP, construction costs, household incomes) and demographic factors (population, age structure, migration balance). Kasparowa and White [2001] studied the responsiveness of house prices to macroeconomic forces and found that real estate prices are driven by income growth and interest rates. Ze-bin and Si-wen [2013], in their analysis, used per capita GDP, the average wage of workers, proportion of tertiary industry added value in GDP, urbanization rate, amount of contracted foreign capital, urban domestic consumption of electricity, passenger traffic, per capita road area of the city, number of colleges, number of hospital beds, green coverage of built-up areas, student population, and urban sewage treatment rate. Wit and Dijk [2003] analyzed rents, capital appraisals, total returns, gross domestic product, inflation, unemployment and vacancy rate. Renigier-Biłozor et al. [2014], for rating the methodology of real estate markets in Poland, uses the percent of land covered by zoning plans, unemployment rate, total number of issued construction permits, number of developers on the local market, number of deaths, existing residential areas per resident, population density, number of marriages and population growth. In another study of the Polish housing market, Foryś [2011] examined economic (GDP, performance of construction and assembly markets, unemployment, number of new apartments, availability of loans and state spending on housing) and social (demographic factors, marriage rates, divorce rates, natural population increase and migration balance) drivers of growth.

In Table 1, the following set of diagnostic features was specified for purposes of our analyses.

Table 1.   Description of variables

Symbol	Description
TA	area of the town (km^2)
TP	population of the town (number of inhabitants)
ND	number of new dwellings (number)
TI	budget revenue per inhabitant (PLN)
U	employment ratio – relation of the number of those employed to the total number of people in the economically productive age group (%)
TL	infrastructure indicator (total length of water supply and sewage lines per km^2)

Source: Authors' own study.

The data for the research were gathered from two periods, i.e. 2005 and 2012. Determination of similarities between the cities was conducted independently for these periods. Such implementation of the research procedure gives us the possibility to compare the evolution of the thirteen selected local markets over time. The percentage differences in the selected variables have been shown in Figure 2.

Most of the variables increased significantly from 2005 to 2012, especially (ND) – new dwellings in the town/city – in the case of which the increase was close to 180% in Morąg and close to 100% in Kętrzyn, though much smaller decreases were also observed. The observed changes in the factors in the years 2005 and 2012 could change the classification of local real estate markets (cities) in terms of similarity groups.
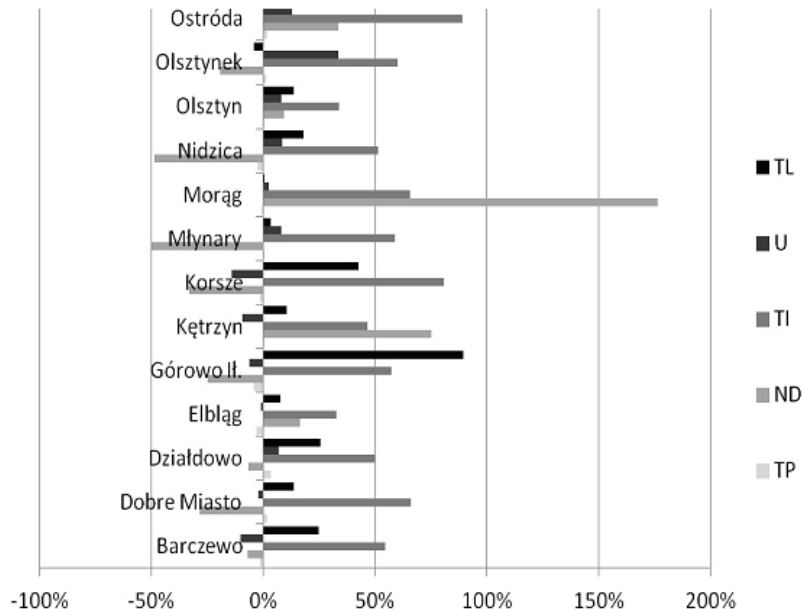

Fig. 1.   The percentage differences in 2005–2012 in selected variables, i.e. TL, U, TI, ND, TP
Source: Authors' own study based on data from the Central Statistical Office of Poland.

Factor analyses – practical approach

The primary variables obtained from the Polish Central Statistical Office have been transformed into a rank. The next step was to determine the correlation matrix between the primary variables, as a basis for creating new uncorrelated main factors (Table 2). Further investigation, such as the use of algorithms for identifying hidden factors, depends on the preliminary analysis of this matrix. If the correlation coefficients are low (average correlation coefficients assume values of less than 0.3) or none of the variables are highly correlated with any of the others, a further procedure based on the factor analysis model may lead to unreliable results.

Table 2. Primary variables correlation matrix

2005	SD	TA	TP	ND	TI	U	TL
TA	3.883	1.000	0.956	0.972	−0.055	0.156	−0.052
TP	3.894	0.956	1.000	0.984	−0.071	0.091	−0.016
ND	3.894	0.972	0.984	1.000	−0.027	0.099	−0.055
TI	3.894	−0.055	−0.071	−0.027	1.000	−0.127	−0.747
U	3.884	0.156	0.091	0.099	−0.127	1.000	0.380
TL	3.894	−0.052	−0.016	−0.055	−0.747	0.380	1.000
2012	SD	TA	TP	ND	TI	U	TL
TA	3.884	1.000	0.950	0.967	−0.174	0.121	−0.273
TP	3.894	0.950	1.000	0.978	−0.159	0.000	−0.170
ND	3.894	0.967	0.978	1.000	−0.132	0.044	−0.176
TI	3.894	−0.174	−0.159	−0.132	1.000	−0.291	−0.533
U	3.894	0.121	0.000	0.044	−0.291	1.000	0.082
TL	3.894	−0.273	−0.170	−0.176	−0.533	0.082	1.000

Source: Authors' own study.

The obtained values of correlation coefficients indicate that their average values oscillate within the permissible size of 0.3, and thus the second of the conditions for carrying out further work is satisfied. For example, the variable TA (town area) correlates highly with the variables TP (town population) and ND (new dwellings), i.e. the value is greater than 0.9.

To assess the appropriateness of using factor analysis on the empirical data and to establish how many factors are important, the most commonly used method is the Kaiser criterion. This criterion retains only those factors whose proper values are greater than 1. This means that if the factor does not differentiate at least as much as one original variable, it is rejected. To establish how many factors are significant, graphs of proper values have been presented in Figure 2.
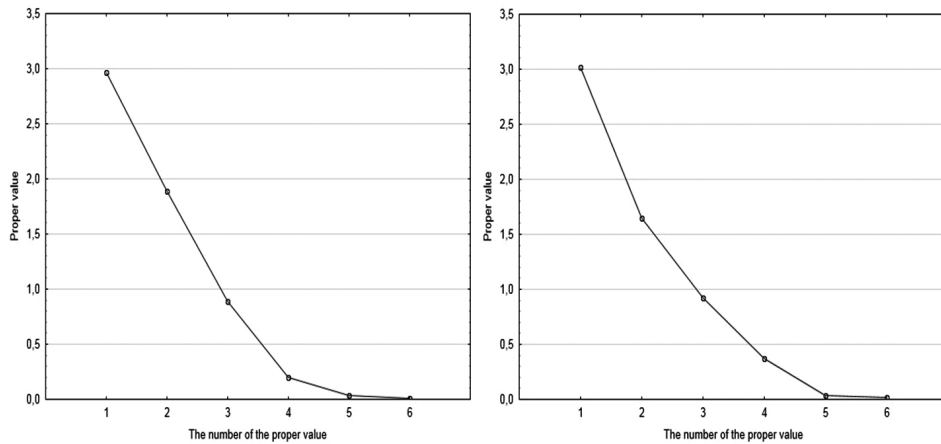
Fig. 2.   Graphs of proper value for 2005 (left) and 2012 (right)

Source: Own study based on data from the Central Statistical Office of Poland.

In both cases, the graphs of proper values indicate that only two factors are significant (Kaiser Criterion). In such cases, there is a possibility to build a two-dimensional space in which the location of each local real estate market can be described using the two new main factors as coordinates.

The next stage was to determine the so-called own value of each of the new main factors. The results have been presented in Table 3. From the six variables describing local real estate markets in 2005, the two new main factors covered approximately 70% of the original information. The first factor covered nearly 50%, while the second factor – nearly 32%. For data from 2012, two new main factors covered approximately 77% of the original information; The first factor covered nearly 50%, while the second factor covered nearly 27%.

The results of calculating factor loadings have been presented in Table 4.

The results are similar for data from 2005 and 2012. Factor 1 is most strongly correlated with: TA – town area, TP – town population, ND – new dwellings. Factor 2 contains further primary variables, i.e. TI – town income per capita, U – unemployment rate, and TL – total length of infrastructure.

Table 3.   Identification of new main factors

2005	Own value	% of variance	Cumulated value	Cumulated value (%)
1	2.967	49.449	2.967	49.449
2	1.889	31.478	4.856	80.927
2012	Own value	% of variance	Cumulated value	Cumulated value (%)
1	3.016	50.265	3.016	50.265
2	1.644	27.408	4.660	77.673

Source: Authors' own study.

Table 4.   Factorial loads for 2005 and 2012

Symbol	2005		2012	
	Factor 1	Factor 2	Factor 1	Factor 2
TA	0.9860	0.0486	0.9897	0.0222
TP	0.9855	0.0563	0.9798	0.0271
ND	0.9939	0.0192	0.9856	0.0232
TI	−0.0040	−0.8610	−0.1524	−0.8825
U	0.1289	0.5188	0.0835	0.4998
TL	−0.0887	0.9399	−0.2723	0.7842
Share (%)	0.4926	0.316657	0.5025	0.2742

Source: Authors' own study.

After this step, the so-called factor loadings for each of the analyzed 13 local real estate markets should be calculated. After the calculation of these factor loadings, there is a possibility to build a two-dimensional space in which the location of each local real estate market can be described using the new main factors as coordinates. The graphical distribution of calculated factor loadings and their affiliation to the specific integrated factor has been presented in Figure 3 for 2005, and Figure 4 for 2012.
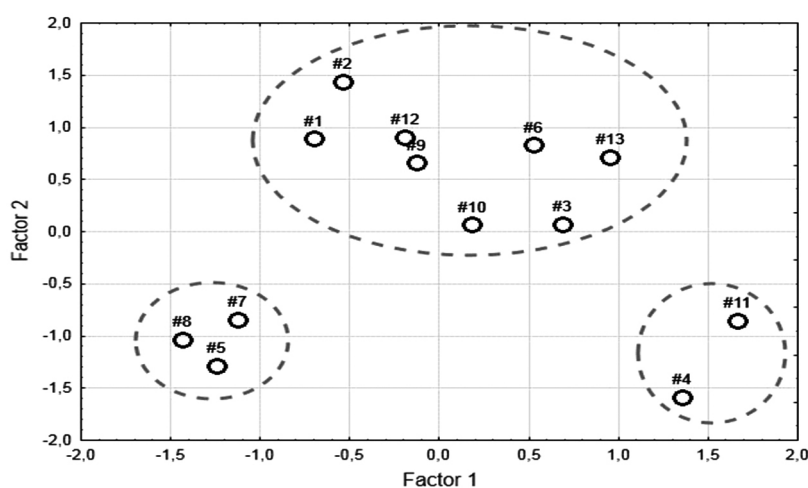

Fig. 3.   Configurations of local real estate markets (numbers 1, 2 etc. – description in Table 5) in reference to the main factors under examination in two-dimensional space in 2005. Circle indicates a group of similar local real estate markets

Source: Authors' own study.

The similarity of local real estate markets' conditions (Figs 3 and 4) can be described by assessing the proximity of selected points representing the local real estate markets under examination, described by coordinates which, at the same time, constitute the value of the main factors. The classifications of local markets into groups have been presented in Table 5 for 2005, and Table 6 for 2012.
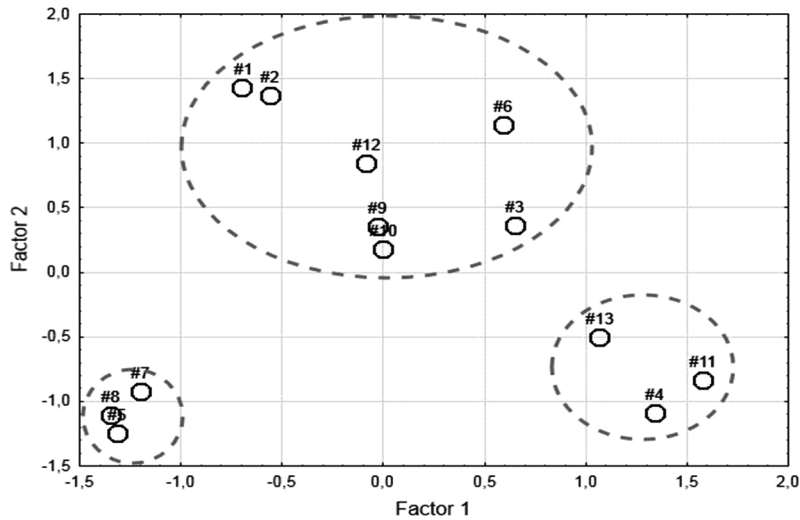
Fig. 4.   Configurations of local real estate markets (numbers 1, 2 etc. – description in Table 5) related to the main factors under examination in two-dimensional space in 2012. Circle indicates a group of similar local real estate markets

Source: Authors' own study.

Table 5.   The classification of local markets in 2005

Cluster I	Cluster II	Cluster III
4_Elbląg 11_Olsztyn	1_Barczewo 2_Dobre Miasto 3_Działdowo 6_Kętrzyn 9_Morąg 10_Nidzica 12_Olsztynek 13_Ostróda	5_Górowo Ił. 7_Korsze 8_Młynary

Source: Authors' own study.

Table 6. The classification of local markets in 2012

Cluster I	Cluster II	Cluster III
4_Elbląg 11_Olsztyn 13_Ostróda	1_Barczewo 2_Dobre Miasto 3_Działdowo 6_Kętrzyn 9_Morąg 10_Nidzica 12_Olsztynek	5_Górowo Ił. 7_Korsze 8_Młynary

Source: Authors' own study.

After applying factor analysis, all 13 cities (local real estate markets) were divided into three clusters of similarity. The results in Tables 5 and 6 are very similar. Between 2005 and 2013 only one local market – Ostróda (13), had the greatest developmental progress taking into account the six parameters, and advanced from Cluster II to Cluster I, which comprises the biggest cities in Warmia-Masuria Province, i.e. Olsztyn (11 – the capital of the province) and Elbląg (4).

CONCLUSION

The paper examines the usefulness of factor analysis for the determining the similarity of local real estate markets' conditions. Using factor analysis, it is possible to reduce the number of variables with little loss of information contained within them. In the presented research, we made use of information from six variables describing local real estate markets to create two new main factors, which together account for 80% of the variability of the primary variables. The conducted research making use of factor analysis indicates that it is possible to find similarities between local real estate markets (cities) and carry out their classification. Almost the same results obtained in the years 2005 and 2012 lead to the conclusion that the real estate market in Poland, after a period of instable evolution (2006–2011) returns to a stable path of evolution.

Although the detailed results refer to local real estate markets in Poland, the applied methodology can be used for other markets. The quality of the results depends directly on the amount and type of data selected for analysis.

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ANALIZA CZYNNIKOWA W OKREŚLANIU PODOBIEŃSTWA UWARUNKOWAŃ LOKALNYCH RYNKÓW NIERUCHOMOŚCI

Streszczenie. Zainteresowanie badaniami w zakresie poszukiwania podobieństwa rynków nieruchomości wynika z wielu praktycznych problemów, zwłaszcza w kontekście gospodarki nieruchomościami. Autorzy uważają, że użytecznym narzędziem do określania podobieństwa uwarunkowań lokalnych rynków nieruchomości jest analiza czynnikowa. Z przyjętych sześciu zmiennych opisujących lokalne rynki nieruchomości dokonano ich transformacji do dwóch nowych niezależnych czynniki głównych, które łącznie zawierają 80% zmienności zmiennych pierwotnych. Stosując analizę czynnikową, zbudowano dwuwymiarową przestrzeń, w której położenie poszczególnych rynków może być opisane za pomocą nowych czynników głównych traktowanych jako współrzędne. Badania empiryczne zostały przeprowadzone na rynkach wybranych miast Polski położonych na terenie województwa warmińsko-mazurskiego. Zaproponowana metodyka może być stosowna także w odniesieniu do rynków dowolnych obszarowo.

Słowa kluczowe: podobieństwo, analiza czynnikowa, rynek nieruchomości