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Characteristics determining a market value of an agricultural real estate with use of Multiple Correspondence Analysis

Abstract. The paper consider a problem of identify a variables affecting market value of agricultural real estate. Furthermore, in the paper was discussed a problem of identify a homogenous group of agricultural real estate. The purpose of this paper is to determine the possibilities of using of the Multiple Correspondence Analysis in terms of agriculture real estate. This method has a special relevance in situations with a lack of information, large numbers of possible variables, unknown market and a limited number of transactions, as is often in the case with agricultural real estate.

Key words: agricultural real estate, Multiple Correspondence Analysis, valuation

Introduction

In real estate it is important to precisely determine their market value, i.e. the price most likely to be concluded by both buyers and sellers of a property that is available for purchase. Definition of the market value of property is regulated by Real Estate Management Act (Act of 21.08.1997) and Council of Ministers on the valuation property and preparing the appraisal (Act of 21.08.2004). It is also based on recommendation of The International Valuation Standards, European Valuation Standards and EU directives. The market value of real estate is estimated during the valuation process. Rules of valuation of properties are also regulated by Real Estate Management Act (Act of 21.08.1997) and Council of Ministers on the valuation property and preparing the appraisal (Act of 21.08.2004). There are also based on recommendation of The International Valuation Standards, European Valuation Standards and EU directives [Trojanek 2010].

The accuracy in valuation of property (including agricultural property) requires a number of conditions. There is an extensive set of technical, legal and methodological factors which should to be included in the valuation process [Bryx 2006, Dydenko 2006].

First of all, proper estate valuation is executed within local market and it is based on information and transactions from that market. It means that it is based on set of information of properties which were traded on mentioned market during the recent two years [Bryx 2006, Dydenko 2006].

Secondly, each valuation of estate is executed on the basis of the information of properties which are similar to the valued one. The similar agricultural property means, that it is comparable due to the type, shape, soil, location, legal status, method of use, and lots of other characteristics that affect its value [Kucharska–Stasiak 2006, Trojanek 2010].

Moreover, the market value of real estate is determined by a comprehensive set of physical, economic, legal, technical and social attributes (i.e. the characteristics of property). In valuation process, there is not possible (not also necessary) to use all of these

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characteristics of property. However, a prerequisite for correct valuation of real estate is the use of these characteristics that most strongly determine its market value. To carry out such a task, it is needed a large and detailed set of data on properties, which were the subject of the transaction on local real estate market. Unfortunately, in the case of farmland, on the local market there is not always sufficient numbers of transactions that can be used for valuation. Further, values of characteristics of property mostly are intangible. It also does not facilitate the valuation of real estate [Kozioł–Kaczorek 2012].

The purpose of this paper is to determine the possibilities of using of the Multiple Correspondence Analysis (MCA) in terms of agriculture real estate. The Multiple Correspondence Analysis was used to identify relevant explanatory features (i.e. variables) of market value of farmland. Moreover, it was used to identify properties which are similar.

There are several reasons justifying the choice of this method. Firstly, the MCA enables to reduce the large amount of information about objects to the most important category. Let assume that objects are agricultural real estate. In the paper, both terms are used interchangeably. Moreover, the use of MCA enables to obtain homogeneous groups of objects in terms of characteristics. It helps to determine their basic features. Proposed technique allows also to explain the structure of the relationship between the characteristics of the objects [Panek 2009].

The problems with identification of variables affecting the market value of agricultural real estate does not occur, of course, exclusively on the Polish agricultural real estate market. Appraisers in Spain are dealing with the same. Garcia T. and Grande I. presented in their paper such a problem. They also draw attention to the problem of accuracy in valuation and methodological objectivity. The solutions proposed by them is just the use of Multiple Correspondence Analysis. They applied MCA to identify explanatory variables of farmlands located in the two specific localities within the autonomous region of Navarre. One of them was Lerin, second one was Viana. The basic set of variables contained 14 different variables (such as: district, type and class of plot, crop, motive, leasing and rental agreements, soil, climate, geometry, unevenness, access, plot combinations, walls, agricultural buildings). The final set of data, after using of MCA, contained only 3 relevant explanatory variables (district, type and class of plot and crop). Their did not try to identify homogeneous groups in the analyzed set of farmlands.

In the present paper, the use of MCA is presented on the example of analysis of characteristics of agricultural real estate located in the Lublin Province. The set of data contains information about 21 farmlands located in two municipalities in this region. The time range of research data includes the second half of 2014 year.

Agricultural property and its attributes

Agricultural real estate (farmland) are properties that are or may be used for the agricultural production in the field of crop and livestock, horticultural production, orchard production and fish production [The Civil Code, Act of 23.04.1964]. The components of agricultural land involves buildings and facilities of agricultural, residential buildings forming part of farms, sowing and cultivation of crops, perennial crops, trees and shrubs on agricultural land [Dydenko 2006].

Factors determining the market value of agricultural property are divided into two groups depending on the type of agricultural real estate. One of them are features of

undeveloped agricultural land and not intended for development. This group of factors includes, inter alia, location and position, the diversity of the types of ground area (diversity of arable land), soil types, diversity of soil types, the difficulty of cultivation, suitability for the production of certain plants, the possibility of other than agricultural use [Dydenko 2006].

The second group of factors contains, inter alia, shape (geometry), access (distance to the road and quality of the road), the variety of existing buildings and condition of this buildings, possibility of installation new buildings, the occurrence of land suitability for installation, equipment in the network infrastructure, surface area. Although the set of fundamental characteristics is quite extensive, it is sometimes necessary to use a complementary set of characteristics. For agricultural land may be, inter alia, the characteristics such as: the shape of the plot, the distance from the building, the quality of the roads, the risk of soil erosion, the difficulty of the cultivation of soils [Kozioł – Kaczorek at al. 2009]. The set of characteristics of agricultural real estate is very extensive. There is also heterogeneity of the measuring values of these features. This is due to the fact that most of the features are intangible (descriptive).

Therefore, the problem is the identification of such characteristics of the real estate, which substantially determine its market value. The problem is also to determine the impact on market value of descriptive features. For this task, it is needed a large and detailed set of data on properties, which were the subject of the transaction. As mentioned earlier, the real estate market is local, so all the information should come from the local real estate market. In the case of agricultural real estate is quite confusing, as the number of transactions on the local market is often not sufficient.

Multiple Correspondence Analysis

Multiple Correspondence Analysis (MCA) is an extension of correspondence analysis (CA). It is a descriptive and exploration technique that allows studying the association between several qualitative variables. The patterns of relationships of two or more categorical variables is presented in graphical form. MCA enables to put both points representing variables and points representing objects in a same factorial reference system. Thanks to this, it is possible to detect structural relationships between variables, objects, and also variables and objects. The use of the MCA allows to reduce the large amount of information about objects (observations) to the most important category, which may be a subject to further detailed analysis. It also allows to obtain homogeneous groups of objects in terms of characteristics [Greenacre 1984, Panek 2009].

From a technical point of view, MCA is technique of analysis of crosstabulation tables which provides information on the nature of the links between its columns and rows. Its main purpose is to replicate the distance between points which represents the rows and columns of the analysed table within the space with fewer dimensions while preserving as much of the original information. So it is the method of dimension reduction. It quantifies categorical data by assigning numerical values to the objects and categories. Objects within the same category are close together. Objects in different categories are far apart. Each object is as close as possible to the category points of categories that apply to the object. In this way, the categories divide the objects into homogeneous subgroups. Variables are

considered homogeneous when they classify objects in the same categories into the same subgroups [Greenacre 1984, Panek 2009].

The analysis of homogeneity can provide a solution for several dimensions. The maximum number of dimensions equals either the number of categories minus the number of variables or the number of observations minus one. It depends whichever is smaller. A solution with a smaller number of dimensions is easier to interpret, but there is a risk to loss part of information of basic data [Greenacre 1984, Panek 2009].

The main notion of MCA is inertia which is a measure of dispersion of points in multidimensional space. It takes values from 0 to 1. If inertia is equal zero, then the points are close together. It means that there is no relationship between categories of variables. Other words, the categories of variables are not significantly different. If inertia is higher than 0.7 it means that points are not located close to each other. It means that there could be relationship between categories of variables. Other words, the categories of variables are significantly different. The total inertia is decomposed on every final dimension. If inertia of dimension is high it means that this dimension is important in interpreting final results. If inertia is low that this dimension is not important in interpreting final results and can be removed [Greenacre 1984, Panek 2009].

In the paper, the MCA was used to choose the relevant explanatory characteristics of farmland. It was also used to determine the set of properties that may be considered as similar one. The set of data contains information about 21 farmlands located in two municipalities in the Lublin Province. All properties are undeveloped agricultural real estate with an area below 1.5 ha. The original set of features (variables) included such features as: the diversity of the types of ground area (DAL), soil types (SOIL), diversity of soil types (DST), shape of plot (SHAPE), distance to the road and quality of this road (ROAD), the distance from the buildings (ACCESS), surface area (AREA), price per one hectare (PRICE). All of variables are treated as categorical variables.

The result obtained as a result of MCA are as follows. The original number of dimensions is reduced to two dimensions. Its provide an interpretation in terms of distance.

In the Table 1 are presented values of a Cronbach's alpha for all final dimensions. The Cronbach's alpha is a statistic which is generally used as a measure of internal consistency. It is considered to be a measure of scale reliability. Cronbach's alpha takes value between 0 and 1. The higher the value, the greater the reliability of the scale. It is understood that the values above 0.7 indicate the correct scale reliability. In analyzed case, values of Cronbach's alpha for both dimensions are above 0.83. It means that both dimension 1 and dimension 2 has relatively high internal consistency.

Table 1. Model summary

Dimension	Cronbach's Alpha	Inertia
1	0.861	0.506
2	0.839	0.470
Total		0.976

Source: own calculation in IBM SPSS Statistics.

In the Table 1 are also values of inertia. The total inertia (0.976) is a sum of inertia of each dimension. It is easily to see, that the loss of inertia is slight, so the loss of information from basic data is also slight. Moreover, proposed two dimension explain total inertia so there is no need to use more than two dimensions. Other words, nearly all of the variance in

the data is accounted for by the solution, 50.6% by the first dimension and 47.0% by the second dimension.

In the Table 2 and on the Figure 1 are presented discrimination measures, which can be regarded as a squared component loading. The discrimination measures were computed for each variable and for each dimension. It is the variance of the quantified variable in each dimension. The maximal value of discrimination measure is 1. It is in situation, in which the object scores fall into mutually exclusive groups and all object scores within a category are identical. Large discrimination measures correspond to a large spread among the categories of the variable and, consequently, indicate a high degree of discrimination between the categories of a variable along that dimension.

Table 2. Discrimination measures

	Dimension 1	Dimension 2	Mean
ACCES	0.132	0.275	0.204
SHAPE	0.256	0.448	0.352
PRICE	0.338	0.408	0.373
DST	0.493	0.401	0.447
AREA	0.576	0.439	0.508
ROAD	0.602	0.213	0.407
SOIL	0.758	0.725	0.742
DAL	0.894	0.848	0.871

Source: own calculation in IBM SPSS Statistics.

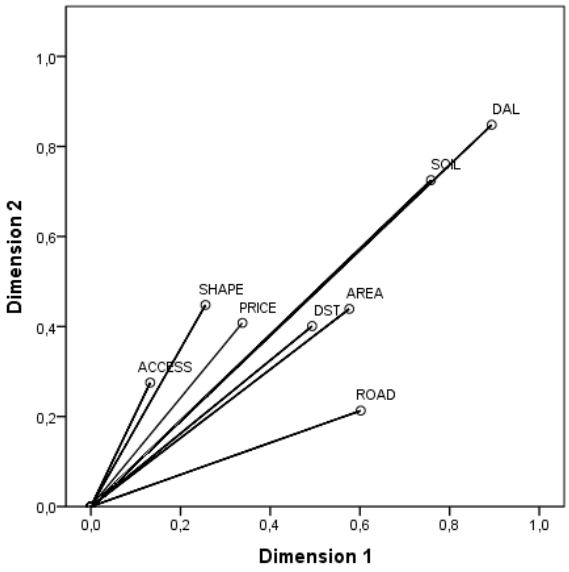

Fig. 1. Discrimination measures

Source: own calculation in IBM SPSS Statistics.

The lowest discrimination measure is for ACCESS on both dimensions. It means that, there is small dispersion of the categories of this variable and low degree of discrimination

between the categories of a variable along these dimensions. ROAD has a larger value of discrimination measure on the second dimension then on the first dimension. Thus, the categories of ROAD are spread a little further apart along the first dimension than the second dimension. The variables SHAPE, PRICE, DST and AREA have similar values of discrimination measure on second dimension, so there is similar dispersion of the categories of these variables. SOIL and DAL have large values on both dimensions, indicating discrimination in both the first and second dimensions.

On the Figure 2 are presented object scores plot labelled by object. The distance from an object (farmland) to the origin reflects variation from the average pattern of results. It means, that the pattern of results is the pattern of values of variables. This average results pattern corresponds to the most frequent category for each variable. Objects (farmlands) with many characteristics corresponding to the most frequent categories lie near the origin. In contrast, objects with unique characteristics are located far from the origin. Objects which are located nearby each other has the similar categories of characteristics. Those objects can be treated as similar and they belong to the same homogenous group.

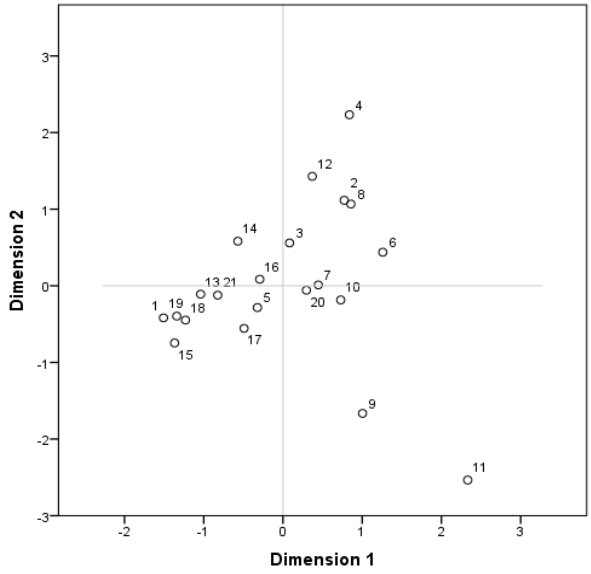

Fig. 2. Object scores plot labelled by object

Source: own calculation in IBM SPSS Statistics.

It is easily to see, that two objects (no. 9 and no.11) are outliers. Both of them lies far from origin, so they are the objects with the unique characteristics. The object no. 11 is discriminated in same way by the two dimensions. The object no. 9 is also discriminated by the two dimensions although somewhat lesser degree. Another outlier is the object no.4 which is discriminated mostly by the dimension 2.

On the other hand, there are also homogeneity groups of objects in terms of characteristics. One of such group formed, for example, objects no. 1, 18, 19, 13, 21, 15. The objects no. 7, 20, 10 formed another homogenous group.

Conclusions

The Multiple Correspondence Analysis was presented in the paper. This method has a special relevance in situations with a lack of information, unknown market and a limited number of transactions, as is often in the case with agricultural valuation. The using of MCA enable to choose relevant explanatory variables. It also allows to find homogeneous groups of analyzed objects. Moreover, MCA avoids the problem of the appraiser subjectivity with selection of real estate's features used in the valuation of the property and in establishing a set of similar properties.

In the example described shortly below were 21 farmlands located in Lublin Province. The basic set of characteristics of agricultural real estate included such characteristics as: the diversity of the types of ground area (DAL), soil types (SOIL), diversity of soil types (DST), shape of plot (SHAPE), distance to the road and quality of this road (ROAD), the distance from the buildings (ACCESS), surface area (AREA), price per one hectare (PRICE). All of variables are categorical variables.

After applying MCA it turned out that there is small dispersion of the categories of the distance from the buildings and of distance to the road and quality of this road. Middle dispersion is of the categories of diversity of soil types, shape of plot, price per hectare and surface area. The largest dispersion is of the categories of soil types and the diversity of the types of ground area. In summary, all variables are important. However, the greatest significance should be attributed to soil types and the diversity of the types of ground area. The smallest significance should be attributed to the distance from the buildings and of distance to the road and quality of this road.

The use of MCA allowed also to isolate both subsets of similar farmlands and individual significantly different farmlands.

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