ANALYSIS OF ELDERLY FINANCIAL STABILITY IN CENTRAL AND EASTERN EUROPEAN COUNTRIES – CLASSIFICATION APPROACH[1]

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Abstract: The purpose of the paper is to analyze and compare the financial situation of elderly people in Central and Eastern European (CEE) countries. The above countries have gone through similar transformation path to market economy in their socio-economic development and they have been faced similar demographic and economic problems. The financial situation of elderly people in CEE region has been strongly influenced by demographic trends, changes in macroeconomic situation and reforms of existing pension systems. Increasing lifetime, low replacement rate from the public pension systems and little pension savings or even a lack of them cause that increasing number of elderly people can be exposed to financial instability or even poverty risk. Consequently, the examination of the financial standing of the elderly in CEE region seems to be an important scientific and practical issue.

In the analysis, six variables measuring the level of income and expenses, exposure to poverty risk as well as gender differences in disposable income for age group of 65 years or over were included. The data characterizing the financial situation of elderly people in eleven CEE countries was acquired from Eurostat database. The authors applied Ward's method and the *k*-means method in order to classify the examined countries according to the financial standing of elderly people. The obtained results allow to indicate countries with similar financial situation of elderly people in 2007, 2010 and 2014 as well as changes in clusters over the analyzed period. Moreover, the variance analysis was applied to indicate the influence of particular variables on the clustering results. The main findings show that the financial situation of the elderly in CEE countries is very differentiated and changeable, however over the analyzed period financial standing of the elderly seems to be the most similar in Hungary, Poland and Slovenia.

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Keywords: elderly people, poverty, Central and Eastern Europe, cluster analysis

Introduction

Since last few decades European countries have been facing significant demographic changes directly influencing the age structure of the population and determining the directions of further socio-economic development. According to the European Commission (2015), the demographic trends projected over the long term reveal that Europe is 'turning increasingly grey' in the coming decades. Due to the dynamics in fertility, life expectancy and migration, the age structure of the EU population will change strongly in the coming decades including an increasing share of elderly people. In Central and Eastern European countries progressive demographic trends have run parallel to systemic and structural changes that began in the 1990s, however the dynamics of those changes are often higher than in other European countries. For example, until 2060 the largest increases in life expectancy at birth, for both males and females, are projected to take place in Bulgaria, Estonia, Latvia, Lithuania, Hungary and Romania (European Commission, 2015). These trends have resulted in long-term effects on the nationwide situation and the economic growth, what is the most often an area of scientific research. In the narrow context, demographic processes have a significant impact on the financial situation of particular households and individuals.

The purpose of the paper is to analyze and evaluate the financial situation of senior citizens in the selected CEE countries. We decided to focus on Central and Eastern Europe, as the states in this region have gone through similar transformation path to market economy in their socio-economic development and currently they are faced similar demographic and economic problems. The financial situation of the elderly in CEE region has been strongly influenced by demographic trends, changes in macroeconomic situation and reforms of existing pension systems. Increasing lifetime, low replacement rate from the public pension systems and little pension savings or even a lack of them lead to the growing exposure

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of pensioners to poverty risk. Consequently, in our opinion the financial standing of elderly people in CEE region requires comprehensive examination from both scientific and practical point of view.

In the international scientific literature the issues related to financial standing of elderly people are considered from various approaches, however the attention of researchers is mainly focused on the specific changes in consumption and savings profile, which are typical for the considered group of population. Problems related to sources of income in households of pensioners, health care expenses of elderly people and possibilities of accumulation of savings during retirement period have been examined, among others, by Palumbo (1999), Alemayehu & Warner (2004), De Nardi et al. (2010). In Poland, so far relatively few authors have been dealing with the issues concerning the financial situation of the elderly. Ćwiek & Wałęga (2014) carried out the analysis of financial standing of households of elderly people in Poland (in 2000-2012) with the use of regressive modelling, whereas Piekut (2014) examined the consumption of households in Poland compared to other European countries. Much more attention is put on various aspects related to the household financial standing (including, among others, elderly households). For example, saving and investment decisions of households in Poland have been examined recently by Fatuła (2010), Anioła & Gołaś (2013) and Kolasa & Liberda (2014). Świecka (2009) conducted a comprehensive research on indebtedness and insolvency of households in Poland, and Kośny (2013) analyzed the determinants of economic security and its impact on decisions made by the Polish households. Comprehensive studies on the comparison and assessment of the financial situation of elderly people in CEE countries are missing.

The main contribution of the paper is that we made an attempt to conduct a comprehensive analysis of the financial situation of elderly people in CEE countries with the application of the selected classification methods. The results of the research can be useful for both scientists and practitioners interested in the implementation of social policy solutions as well as financial services addressed to the elderly.

The structure of the paper consists of four main parts. After this introduction, a short description of the applied research methods is presented. Next, the main results of the analysis of the elderly financial standing in CCE countries with the use of Ward's method and the *k*-means method are considered. Moreover, the obtained clustering results are examined with the use of variance analysis. Finally, the main conclusions are presented and discussed.

Research methods

In the first stage of our study, the content-related selection of diagnostic variables was conducted. The set of diagnostic variables consists of the selected ratios characterizing the financial standing of elderly people. The stress is put on measures indicating the adequacy of income and expenditure incurred by the elderly, their exposure to poverty risk as well as gender differences in disposable income. The set of diagnostic variables is formed by the following ratios:

- Expenditure on pensions (X1) – defined as the sum of social benefits such as: disability pension, early retirement benefits due to reduced capacity to work, old-age pension, partial pension, survivor's pension and early retirement benefits for labor market reasons, expressed as a percentage of GDP;
- Severe material deprivation rate 65 years or over (X2) – this indicator expresses the enforced inability to afford some items considered by most people to be desirable or even necessary to lead an adequate life (e.g. to pay their mortgage bills, to face unexpected expenses, to go on holiday, to have a car), measured as a percentage of total population;
- At-risk-of-poverty rate for pensioners (X3) – defined as the share of retired persons with an equivalised disposable income (after social transfer) below the at-risk-of-poverty threshold, which is set at 60% of the national median equivalised disposable income after social transfers, in the total population;
- Relative median income ratio (65+) (X4) – ratio of the median equivalised disposable income of people aged above 65 to the median equivalised disposable income of persons aged below 65;
- Gender differences in the relative median income ratio (65+) (X5) – expressed as relative median income ratio (65+) broken down by group of sex;

- Housing cost overburden rate (65+) (X6) – defined as percentage of persons aged 65 or over (in the total population) living in households where the total housing costs represent more than 40% of disposable income.

Variables X2–X6 represents indicators used in the European Union Statistics of Income and Living Conditions (EU-SILC) survey, whereas X1 is a macroeconomic characteristic referring to the adequacy of pensions by comparing the amount of pension benefits to the level of GDP. All the above-mentioned ratios are expressed in percentages. Moreover, the formal characteristics of selected variables were evaluated using a variation coefficient.

In the next stage of the study, in order to classify the analyzed countries according to the financial situation of the elderly, two research methods, namely Ward's method and the k-means method, were applied. The main advantage of the use of these methods is that they allow to compare the examined objects according to given criteria and to create groups of objects which are characterized with similar values of analyzed variables. We chose exactly these methods, because they belong to different groups of classification methods. Ward's method represents the large group of hierarchical clustering methods, whereas the k-means method is one of the iterative optimization methods. Consequently, Ward's method and the k-means method differ from each other in the grouping scheme.

Ward's method is one of the hierarchical methods used for clustering the objects according to their similarities and / or separation of them according to the differences. It belongs to hierarchical agglomerative methods, which are discussed in details in the scientific literature (e.g. (Ward, 1963; Johnson, 1967; Lance & Williams, 1967a, 1967b; Punj & Steward, 1983; Milligan & Cooper, 1987; Rencher, 2002; Zivadinovic et al., 2009; Everitt et al., 2011)). Hierarchical methods assume that a distance matrix of a set of objects is given. The grouping scheme is as follows: it is initially assumed that every object creates a class (cluster) on its own. Afterwards, a pair of classes with the smallest distance is found at each grouping stage. Both classes are combined, as a result of which the number of classes is reduced by one. Then, the distance between the newly created class and other classes is determined. The procedure is repeated $n-1$ times until all classes are combined in one (Mooi & Sarstedt, 2011). In Ward's method, the variance analysis approach is used for estimating the distance between classes. The method aims at minimizing the within-cluster sum of squared variance (Ward, 1963).

The k-means method is a type of iterative optimization method used to "improve" the initial division of a set of objects into k classes from the point of view of a certain defined function of the classification quality criterion. This criterion can be defined e.g. as the sum of the Euclidean distance of objects from the centres of their respective class gravity. Depending on the initial division of the objects into classes, defining the function of the quality classification criterion and the rules of determining the number of resultant groups, there are different versions of the k-means method, with the most commonly used variant having been developed by Hartigan (1975).

The procedure of the k-means method used in the study is as follows:

1. The maximum number of iterations is set as well as the number of k clusters into which the set of objects is to be divided.

2. The initial k clusters are defined; in the applied variant of the method, they consist of objects selected in such a way as to maximize the distances between clusters.

3. The measure of the correctness of division is calculated, which is the sum of the squares of the Euclidean distance between the centres of gravity of the distinguished classes.

4. For the first unallocated object, the distance from each class' gravity centre is calculated and then classified as the nearest grade.

5. The classes' gravity centres are calculated, and the correctness of the division is measured; if the value of the division measure has improved, the object remains in the group, otherwise the change is not made, and the next object is considered.

6. The first iteration of the procedure is closed with the decision on the last unassigned object.

7. Consecutive iterations are carried out until all objects are qualified for a class or until the set number of iterations is carried out.

Variance analysis was used to verify the classification results obtained by application of the *k*-means method. A comparison of the variation within clusters to the variation in the clusters was performed. It is desirable that the variation within the clusters is smaller than the variation between clusters.

Data and results

Data from the Eurostat database for 2007, 2010 and 2014 was used in the conducted study in order to compare the financial situation of elderly people in selected Central and Eastern European countries. The following countries were included in the study: Bulgaria, the Czech Republic (in 2016 the Czech Republic changed into Czechia), Estonia, Croatia (with the exception of 2007), Latvia, Lithuania, Hungary, Poland, Romania, Slovenia, and Slovakia.

The variables described above have been applied for this research, and their statistical characteristics are shown in Table 1. This allows for a comparison of average values and variation of the considered variables in the whole set of Central and Eastern European countries accepted for the study.

Table 1: Statistical characteristics of applied variables in years 2007, 2010, 2014

Variable	2007			2010			2014		
	$\bar{x}$	s	CV	$\bar{x}$	s	CV	$\bar{x}$	s	CV
Expenditure on pensions as percentage of GDP	7.61	2.04	0.268	9.67	1.18	0.121	9.11	1.49	0.164
Severe material deprivation rate 65 years or over	25.37	19.05	0.751	19.68	14.82	0.753	15.9	10.11	0.636
At-risk-of-poverty rate for pensioners	24.73	14.03	0.567	19.23	9.54	0.496	20.54	11.05	0.538
Relative median income ratio (65+)	0.80	0.12	0.155	0.85	0.1	0.106	0.87	0.13	0.146
Gender differences in the relative median income ratio (65+)	0.76	0.13	0.17	0.82	0.13	0.158	0.81	0.11	0.139
Housing cost overburden rate (65+)	14.91	8.31	0.557	10.79	5.45	0.505	10.51	3.57	0.340

Source: Authors' work based on data from Eurostat, http://ec.europa.eu/eurostat/web/income-and-living-conditions/data/database

The criterion for selecting the variables for the study was the variation coefficient. The critical value of the coefficient was assumed as follows $|CV^*| = 0.1$, which lead to all variables being included in the study. The next step in the analysis was application of Ward's method and the *k*-means method in order to classify CEE countries based on the financial situation of senior citizens. Statistica software was used in this part of analysis. The results clearly show that the situation of the elderly in Central and Eastern European states is differentiated.

Grouping with the use of Ward's method allows to discern four classes of countries in each of the examined years (Figure 1, Figure 2, Figure 3 and Table 2).

Figure 1: Classification of selected CEE countries according to the financial standing of the elderly in 2007 (Ward's method)


Dendogram
Ward's Method 2007
Euclidean distance
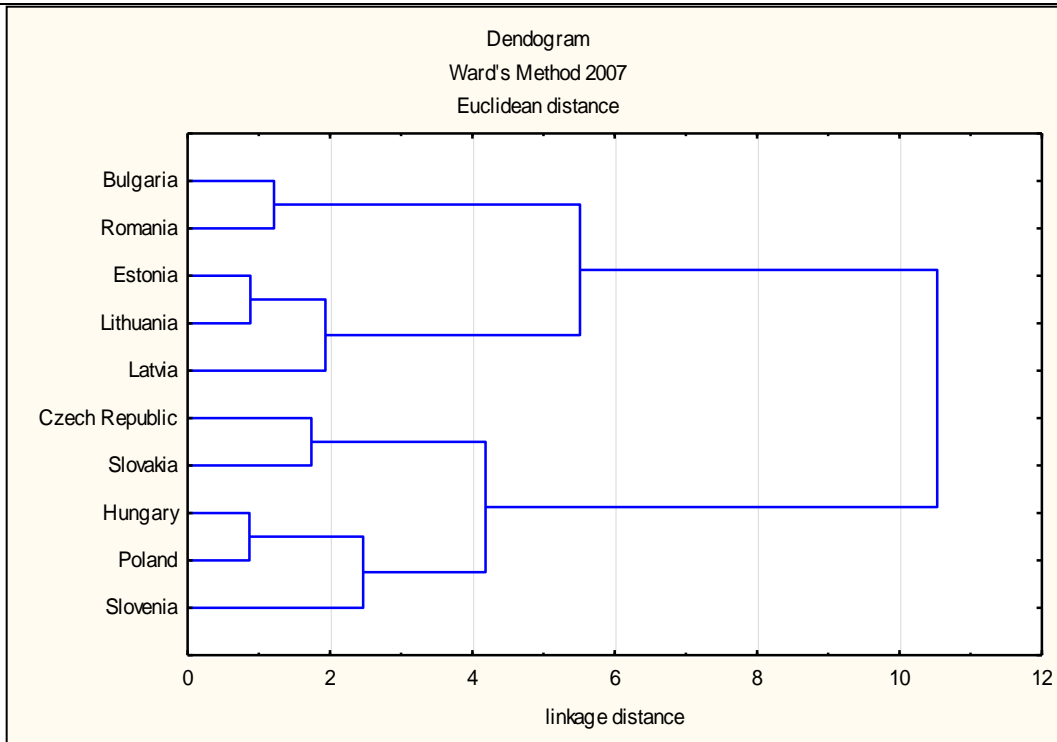
Source: Authors

Figure 2: Classification of selected CEE countries according to the financial standing of the elderly in 2010 (Ward's method)

Dendogram
Ward's Method 2010
Euclidean distance
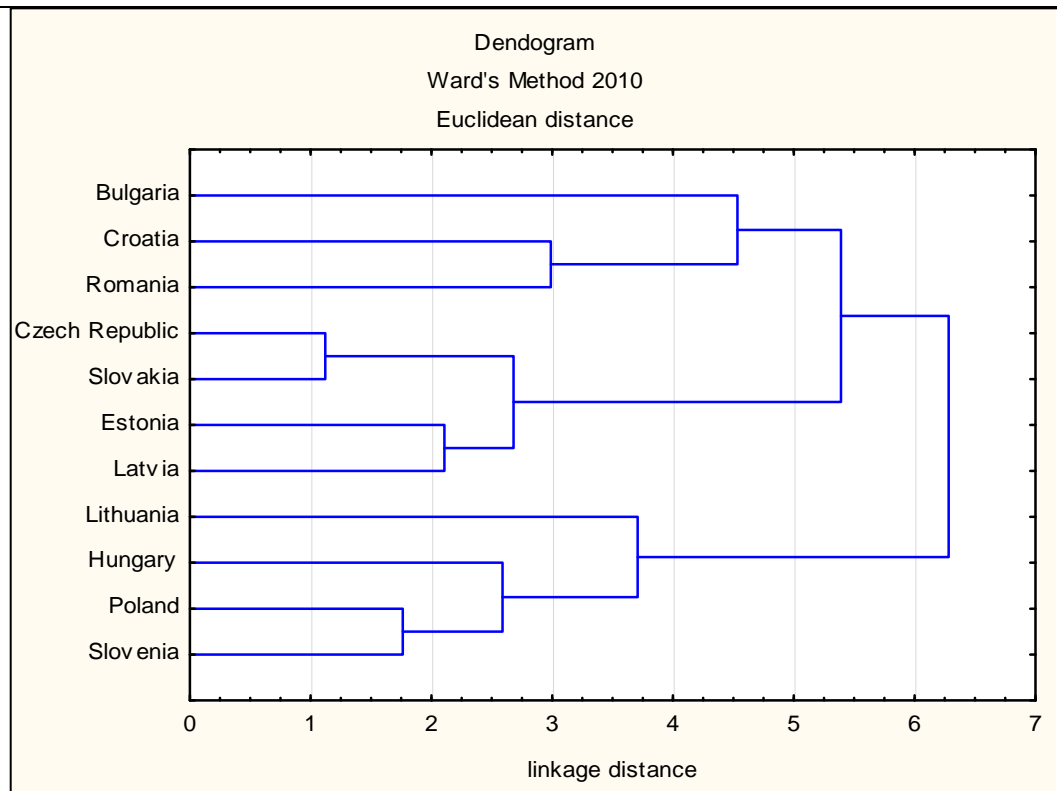
Source: Authors

Figure 3: Classification of selected CEE countries according to the financial standing of the elderly in 2014 (Ward's method)
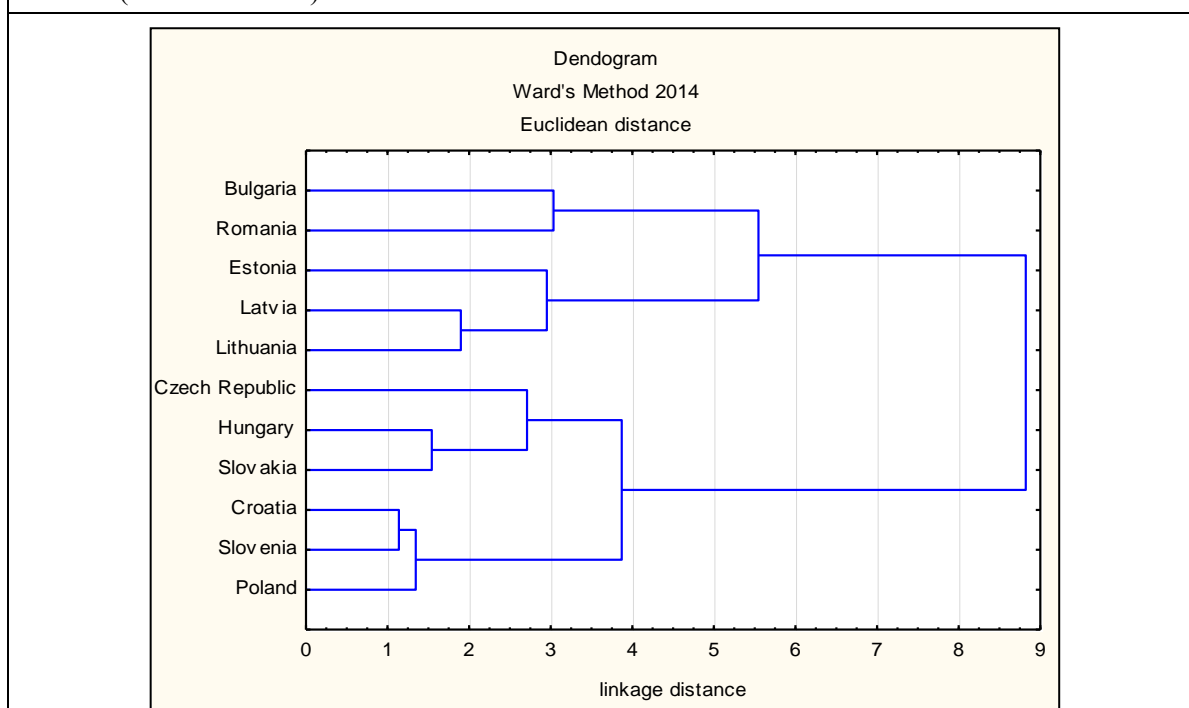
Source: Authors

Table 2: Results of Ward's method

		2007	2010	2014	
	Class 1	Bulgaria Romania	Bulgaria	Bulgaria Romania	
	Class 2	Estonia Latvia Lithuania	Romania Croatia	Estonia Latvia Lithuania	
	Class 3	Slovakia Czech Republic	Slovakia Czech Republic Estonia Latvia	Slovakia Hungary Czech Republic	
	Class 4	Slovenia Poland Hungary	Slovenia Poland Hungary Lithuania	Slovenia Poland Croatia	

Source: Authors

The classification results obtained by application of Ward's method indicate that in each of the examined years, the financial situation of elderly people in Slovakia and the Czech Republic, Estonia and Latvia, Poland and Slovenia was very similar, since these three pairs of countries are always in the same group. Slovakia and the Czech Republic are characterized by almost the same values of expenditure on pensions (which are similar to the average values of this indicator presented in Table 1) and relatively low at-risk-of-poverty rates for pensioners (for Slovakia: 2007 – 11.4%, in 2010 – 10%, in 2014 – 7.6%; for the Czech Republic: in 2007 – 7.9%, in 2010 – 10.6%, in 2014 – 9.1%). It should be noted, however, that in all analyzed years the lowest percentage of pensioners who were exposed to the risk of poverty was observed in Hungary. At the same time, the highest values of the at-risk-of-poverty rate for pensioners

were recorded for Estonia and Latvia, in particular in 2007 and 2014. In both years, the value of this indicator was significantly higher than the scores for other countries and four times higher than the value for Slovakia and the Czech Republic (for Estonia: 42.9% in 2007 and 42.2% in 2014; for Latvia 43.7% in 2007 and 35.5% in 2014). This means that in Estonia and Latvia numbers of pensioners who were exposed to the risk of poverty were the highest, although in 2007 Lithuania also had a high indicator, which may be the reason why this country was included in the same class as Estonia and Latvia. The third best-known pair: Poland and Slovenia are characterized by, at the same time, the highest values of expenditure on pensions (a little more than 11%) and relative median income ratio (65+) in 2010 and 2014. It should be emphasized that even though pension expenditure is the largest contributor to GDP, at-risk-of-poverty rates for pensioners are not low. In Slovenia in 2007 and in 2010 more than 25% of retirees were exposed to the risk of poverty.

Countries that stand out and where at the same time the financial situation of elderly people is the most difficult are Bulgaria and Romania. Both recorded significantly higher rates of severe material deprivation in people aged 65 or over (for Bulgaria: 67.2% in 2007, 58.1% in 2010 and 40.3% in 2014; for Romania: in 2007 - 50%, in 2010 - 32% and in 2014 - 26%). Such high values indicate that a very large group of people aged 65 and over was unable meet at least a couple of basic needs due to financial reasons. The only positive in this situation is that in the subsequent years the value of this indicator declined, suggesting an improvement in the financial standing of elderly people. The lowest values for this indicator, i.e. 6.5% in 2007, 4.3% in 2010 and 5.1% in 2014, were recorded in the Czech Republic.

Table 3: Results of the *k*-mean method

		2007	2010	2014	
	Class 1	Czech Republic Hungary Poland Slovenia Slovakia	Bulgaria Croatia Latvia	Bulgaria Romania	
	Class 2	Latvia	Romania Lithuania	Estonia Latvia Lithuania	
	Class 3	Bulgaria Romania	Slovakia Czech Republic Estonia	Slovakia Hungary Czech Republic	
	Class 4	Estonia Lithuania	Slovenia Poland Hungary	Slovenia Poland Croatia	

Source: Authors

The *k*-means method classification results presented in Table 3 correspond to those obtained using Ward's method. Romania and Bulgaria represent a separate class in 2007 and in 2014. Analysis of average values for their cluster in both years clearly indicates the significantly higher values of housing cost overburden rate and severe material deprivation rate for people aged 65 years or over. This confirms the earlier conclusion that the financial situation of elderly people in Romania and Bulgaria was the worst.

In 2007 the best financial situation had the elderly in the Czech Republic, Hungary, Poland, Slovenia and Slovakia (class 1). Analysis of average values of indicators for this class indicates the highest values of the ratios (relative to the average values of indicators in other classes): expenditure on pensions, relative median income ratio (65+) and gender differences in relative median income ratio (65+) and the lowest values (relative to the average values of indicators in other classes) of: at-risk-of-poverty rate for pensioners and severe material deprivation rate for people aged 65 years or over.

In 2010, the elderly living in Hungary, Poland and Slovenia (class 4) had the best financial situation. In 2014 it was similar because the analysis of average values of indicators for each clusters indicated that the elderly living in countries belonging to class 4 were in the best financial situation.

It should also be stressed that the performed variance analysis indicates the correctness of the classification carried out using the *k*-means method. The variances within the classes were usually smaller than the variances between classes. At the same time it points out which variables constituted the main criterion determining the obtained clustering results. These were respectively: in 2007 – gender differences in relative median income ratio (65+), at-risk-of-poverty rate for senior citizens, and severe material deprivation rate, while in 2010 – relative median income ratio (65+) and expenditure on pensions, and in 2014 – expenditure on pensions and at-risk-of-poverty rate for pensioners.

Conclusion

Examining the financial standing of elderly people is a very important issue in the face of both demographic and economic changes in Central and Eastern Europe. According to Eurostat forecasts (until 2060), life expectancy will be the greatest in developing countries, especially in Latvia, Lithuania, Romania and Bulgaria (European Commission, 2015). Taking this into account, the aforementioned research findings become even more worrying. In particular, Romania and Bulgaria face a very serious challenge, because in Central and Eastern Europe they are the countries where the financial situation of elderly people is already the most difficult.

Comparing the financial standing of older people in developing countries is not an easy task, especially over the longer term. There is no complete, detailed data, mainly due to the different moments of accession to the European Union and the need to provide relevant data. However, the results of classification with the use of Ward's method and *k*-means method presented in the paper allow formulating relevant conclusions. In addition to the aforementioned countries with the most difficult financial situation of senior citizens, it should be emphasized that the financial standing of the retirees seems to be similar in Slovenia and Poland and in the Czech Republic and Slovakia (these countries belonged to the same groups in each of the analyzed years for both applied research methods). The results of Ward's method also point that the financial situation of elderly people in Estonia and Latvia is similar.

This study contributes to the development of the silver economy and constitutes a part of a greater research on the financial standing of elderly people in Europe.

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