Analysis of Demographic Change in Romania Using Quantitative Methods

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Abstract

Demographic aging in the European Union will have a major impact and importance in the coming decades. Major changes, such as increased life expectancy and a permanent decrease in natality rates, seen in the structure of the demographic pyramid in the European Union (EU), can lead to one of the most significant demographic changes by reconfiguring the structure of the population in a more aging one, increasingly evident in many EU countries.

To highlight the differences in demographic change between the eight regions of Romania, the dispersion analysis (unifactorial ANOVA) is used. In order to observe the time differences regarding emigration from the regions, data from 2012 and 2016 were used.

Key words: Demographic structure**,** ANOVA, Principal Component Analysis
J.E.L. classification: C38, J11, J14, O11

1. Introduction

Population and the economy were considered relatively independent domains, demographic analyses being made in terms of the economic situation in time and space, until the second half of the 20th century, when the economies' developments pointed out that the demographic evolution cannot be studied outside of the economic one.

The main demographic trends at European level are: population growth aged 65 and over; population growth aged 80 and over; declining active population and aging workforce; the decline of the 15-24 age group. Population aging is already a global phenomenon, and despite the differences in intensity and rhythm, all European societies have or will have to cope with the same trends in decline and demographic aging. As a result of falling natality rate and increasing life expectancy (Harper, Leeson, 2009), will result an aging population emerge globally, a phenomenon with multiple implications in both economic and social sectors.

The paper presents the demographic analysis of the age structure and the evaluation of the aging process in Romania in the European context and the evaluation of the change in age structure of the population. At the same time, the paper aims at identifying the correlations between certain demographic phenomena based on multivariate analysis.

2. Romania in the European context

2.1. Fertility in Romania compared to the countries of Europe

Romania is in the penultimate place among the countries of the EU in 2012 when it comes to the number of children born to a woman (fertility rate). With the national average of 1.25 children / woman, Romania is at a short distance from Hungary (1.23) and far away from the fertility rate that would keep the current level of the population (it would take 2, 1 children / woman). This aspect has not only social but also economic implications from a population perspective that should contribute both to the development of the country and to the support of non-working people.

According to Eurostat data in 2012, Ireland ranks first in the European fertility ranking nationwide, with a score of 2.05, followed by France by 2.01 and the UK by 1.96. There are northern countries (Sweden-1.90, Finland-1.83 and Denmark-1.75), suggesting a direct link between the standard of living and the number of births.

The exception that confirms the rule is the ninth state that completes in 2012 the third of the countries above the EU average to the specific indicator on the number of children, namely Lithuania (1.76). In fact, two other members of the European Economic Space, Iceland (2.02) and Norway (1.88), come to confirm this assertion.

2.2. Population structure

The working-age population is a declining percentage within the European Union and the percentage of those who retire is rising. Because of the aging of generations born in the post-war period, the population will be made up of elderly people in a significantly increased proportion in the coming decades. As is to be expected, this will directly result in an increase in the effort that older workers make in connection with covering the social costs needed to support the aging population.

From the analysis of the demographic structure on the 1st January 2016, we note that 19.1% of the total population of the European Union (estimated at 510.3 million) is the proportion of people aged 65 or over, indicating an increase of 0.3% compared to 2015 and 2.4% compared to 2006. People aged 15-64, 15-64% of the population, while young people under 15 years are in a percentage of 15.6% of the total.

In 2016, the country with the largest proportion of young people in the European Union is Ireland with 21% and the lowest figure in Germany - 13.2%. The weight percentage of older people (aged at 65 years and over) in the total population was high in Italy - 22%, Greece - 21.3% and Germany - 21.1% and the lowest in Ireland - 13.2%. In 2016, Romania was decreasing with the share of young people compared to 2006 (15.5% vs. 16.9%) and that of persons over 65 years of age compared to the same reference year (20.7% vs. 14.7%).

A similar structure of the population to that of the EU can be seen in the European Free Trade Association (EFTA) and candidate countries, with two exceptions: Turkey and Iceland, which have a similar structure to that of Ireland, with a high percentage of young people and a low of people over 65 years. Two other countries with a low elderly population are Albania and the former Yugoslav Republic of Macedonia. Even so, the trend of an aging population is also visible in these countries.

On the 1st January 2016, the age of 42.6 years is the median, meaning that 50% of the European Union population is below this age and we see an increase of 0.3 per year at EU level between 2001 (38.3 years) and 2016 (42.6 years). The EU Member States were median ages with variations between 36.6 years (Ireland) and 45.8 years (Germany), showing relatively young and relatively old structures. Note that the smallest values among all EU states were registered in 2016 in Turkey - 31.1 years and Iceland - 36.1 years. A country that also had a low median age is Albania, a country where in the last 10 years the average age increased by 27.9%, meaning 8 years, from 28.7 in 2006 to 36.7 in 2016.

According to Eurostat, the dependency ratio of the elderly is expressed as a "ratio of the relative size of the younger and / or older population to the working age population". In EU Member States, the rate of dependency of the elderly was 29.3% in 2016, which means that four people - aged between 15 and 65 - offered support to the individual aged 65 or over. In the EU level, Ireland, Luxembourg and Slovakia with low elderly dependency rates (20.4%, 20.5% and 20.6%) are noted. On the opposite side we find Italy with 34.3%, Greece with 34.3%, Finland with 32.4% and Germany with 32,%, which is equivalent to about three people working for each person aged 65 years or over.

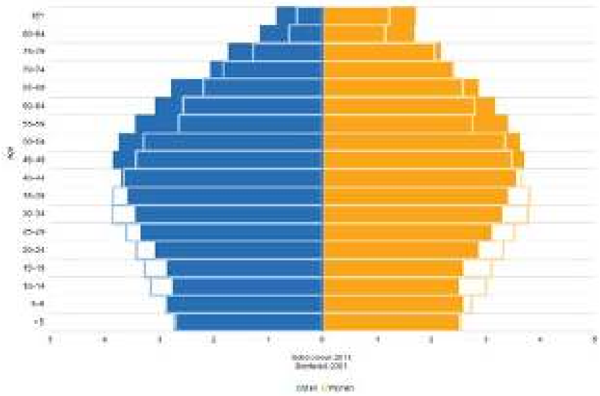
The total dependency ratio was 53.2% in the EU in 2016. This indicates that about two elderly workers correspond to a supported person. In 2016, among all EU Member States, the lowest total dependency ratio of 42.4% was registered in Slovakia, with the highest rate being in France - 59.4%.

At EU level, the overall dependency ratio trend is on the rise. For example, elderly dependency rates have risen 4.3 percentage points over the past decade (or 17.2% of their previous value) from 25% in 2006 to 29.3% in 2016.

As a result of increase the natality rate in the 1960s, the "baby-boom" effect confers a romboid structure on the age pyramid for the European Union (Figure 1, at the 1st January 2016). Compared to 2001, we notice that the first part of the cohort, born over a period of 20-30 years, is very close to retirement age.

The "baby-boom" generation goes forward to the top of the demographic pyramid, so that the bottom of the pyramid, represented by the working-age population and the base, is becoming narrower.

Figure no. 1 Demographic pyramids at EU level, 2001 and 2016



Source: http://ec.europa.eu/eurostat/statistics-explained/index.php/Population_structure_and_ageing/ro

2.3. Trends in population aging in the EU

A decade ago, a long-term population aging trend started in Europe. Analysing the data provided by Eurostat at EU-28 level, for the last 10 years, the population aging process is easily observed in the results of the demographic analysis. Thus, between 2006 and 2016, the population growth is 65 years and over by 2.4 percentage points, while in the 0-14 age group we notice a decrease of 0.4 percentage points of the population share.

The premises underpinning this trend stem from an increase in the share of elderly people - a trend observed in all EU Member States and the European Free Trade Association - coupled with a fall in the share of elderly people (relative to the total population) .

Obviously, there is a variation in the EU countries' increase in the share of people aged 65 and over from 1 percentage point or less in Belgium and Luxembourg to 4.5 (Finland) or 5.2 (Malta) percentage points.

One of the reasons that explains the rise in the elder population is the increase in longevity, a trend that has become visible for several decades, as life expectancy has increased.

Often, this evolution is called the "aging peak" of the demographic pyramid.

Another reason would be the steady low levels of fertility over the years that have contributed to the aging of the population, the growing number of births leading to a drop in the proportion of young people in the total population. This process is known as the demographic pyramid's "aging of the base", with a narrow-down in the base of demographic pyramids from the EU-28 over the period 2001-2016.

3. Analysis of demographic changes in Romania using quantitative methods

In order to analyse spatial differences on demographic change and also in order to identify latent links between demographic phenomena, specific methods of data analysis will be used: variance analysis, principal component analysis, multicriterial hierarchy, cluster analysis.

3.1 Identification of regional differences using dispersion analysis

The Anova One-Way method tests the hypothesis that several environments are equal. In order to verify the ANOVA method assumptions, the Levene test was performed and the hypothesis of equal dispersion was accepted, thus the homoscedasticity condition was respected. The null hypothesis for this analysis is that there are no significant differences in the average number of emigrants in the 8 regions of Romania.

Figure no. 2 Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Anul2012	14.728	7	34	.000
Anul2016	5.437	7	34	.000

Source: author's processing based on NSI and Eurostat data

The results of the analysis allow the following conclusions to be drawn:

- in 2012, the highest average rate of emigrants was recorded in the Bucharest-Ilfov area, with an average of 15.09, while in the South-West Oltenia region the lowest rate was 7.93;
- there are no significant differences between the regions surveyed in 2012 regarding the emigration rate for a significance level of 5%;
- in 2016, the highest average rate of emigrants is in the Western region of Romania;
- there are significant differences between the regions surveyed only in 2016 regarding the rate of emigration.

3.2. Analysis of the relationships between demographic phenomena using principal component analysis (ACP)

Analysing the relationships between variables that quantify demographic phenomena will be done to reduce the complexity of data and identify latent variables behind the initial variables. The eight variables that come into the analysis are: *natural growth; birth rate; mortality rate; fertility rate; marriage rate; average life expectancy; average age at first marriage for male; the average age at the first female marriage* was standardized prior to applying the ACP.

Figure no. 3 Correlation Matrix

Correlation Matrix

		Rata natalitate	Sporul natural	Rata nuptialitate	Rata mortalitatii	Durata medie a vietii	Rata fertilitatii	Varsta medie la prima casatorie Masculin	Varsta medie la prima casatorie Feminin
Correlation	Rata natalitate	1,000	,846	,606	-,576	,160	,969	-,035	,125
	Sporul natural	,846	1,000	,586	-,923	,459	,751	,034	,224
	Rata nuptialitate	,606	,585	1,000	-,461	,243	,480	,232	,405
	Rata mortalitatii	-,576	-,923	-,461	1,000	-,589	-,453	-,077	-,253
	Durata medie a vietii	,160	,459	,243	-,589	1,000	,103	,371	,507
	Rata fertilitatii	,969	,751	,480	-,453	,103	1,000	-,108	,023
	Varsta medie la prima casatorie Masculin	-,035	,034	,232	-,077	,371	-,108	1,000	,948
	Varsta medie la prima casatorie Feminin	,125	,224	,405	-,253	,507	,023	,948	1,000

Source: author's processing based on NSI and Eurostat data

The existence of these correlations is at the basis of the PCA, the choice of the main components being done according to Kaiser's criterion (Saporta, Ştefănescu, 1996), meaning those whose own values are greater than ones that were chosen.

Figure no. 4 Total Variance Explained

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4,018	50,229	50,229	4,018	50,229	50,229
2	2,173	27,165	77,394	2,173	27,165	77,394
3	,974	12,176	89,570			
4	,407	6,002	95,652			
5	,311	3,891	99,543			
6	,026	,327	99,870			
7	,010	,130	100,000			
8	-8,327E-017	-1,041E-015	100,000			

Extraction Method: Principal Component Analysis.

Figure no. 5 Component Matrix

Component Matrix[a]

	Component	
	1	2
Sporul natural	,947	-,206
Rata natalitate	,861	-,392
Rata mortalitatii	-,831	,033
Rata fertilitatii	,766	-,468
Rata nuptialitate	,730	,059
Durata medie a vietii	,545	,472
Varsta medie la prima casatorie Masculin	,260	,896
Varsta medie la prima casatorie Feminin	,453	,852

Extraction Method: Principal Component Analysis.
a. 2 components extracted.

Source: author's processing based on NSI and Eurostat data

The first component explains 50.2% of the variation of the model, and the second component explains 27.2%, the first two main components explaining 77.4% of the variation of the model, as also observed in the scree plot: his slope of the curve changes of its second own value. According to Cattell's criterion, only the first two main components will enter the model's explanation.

Figure 6 shows a strong positive correlation between natural growth and marriage rate and at the same time, a strong negative correlation between marriage rate and mortality rate.

The county's projection at the level determined by the two principal components is based on the hierarchy of counties according to the standard of living (expressed by seventeen indicators), each county having a score of one to forty-two for each indicator considered (1 representing the best value), and then these scores are summed. Depending on the score obtained, the counties were divided into three categories:

- between 100 and 250 points - counties with high living standards;
- between 250 and 450 points - counties with average living standard;
- between 450 and 650 points - counties with low living standards.

Figure no. 6 Correlations between variables

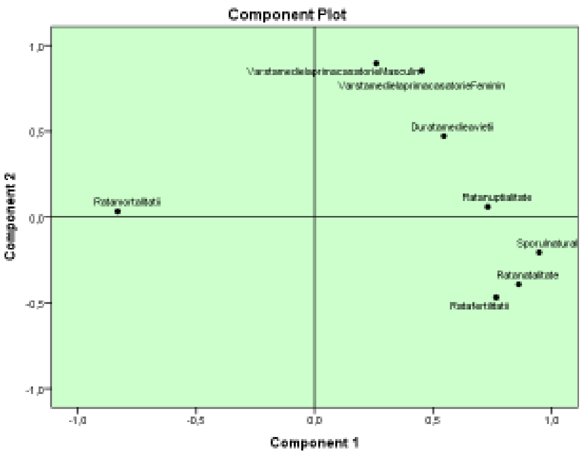
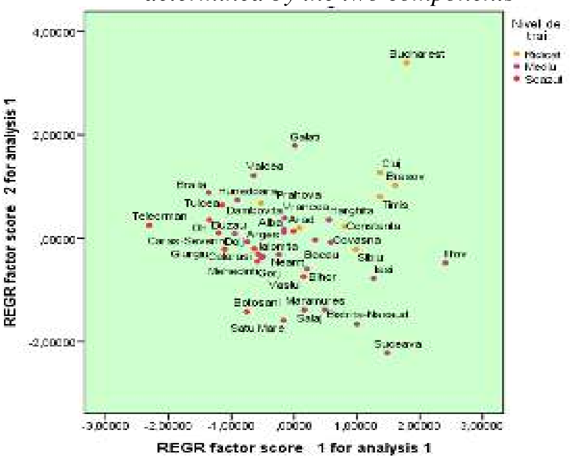


Figure no. 7 Projection of counties on the plane determined by the two components



Source: author's processing based on NSI and Eurostat data

Figure 7 shows that the first axis discriminates well between counties according to the standard of living, the high, low and medium living levels being well differentiated in the projection on the first axis.

Bucharest, as expected, is first in the ranking by living standards. On the graph, it appears separately from the cloud of points, meaning separately of the rest of the counties, and is characterized by high values of both component one and component two.

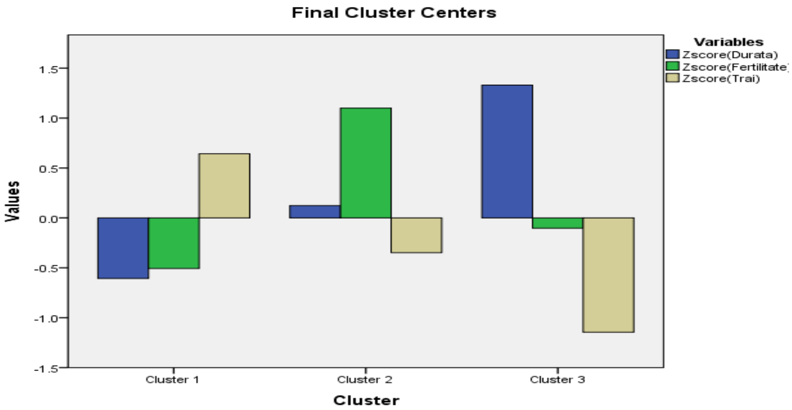
The Cluj, Braşov and Timiş counties occupy the second, third and fourth places in the ranking by living standards and are characterized by high values for *fertility rate, marriage rate, natality rate and natural increase*.

The counties of Teleorman, Giurgiu and Călărași are situated on the last places in the ranking by level of living and is characterized by small values of the first component (*natural increase, mortality rate, natality rate, marriage rate, fertility rate, mean life span and mortality rate*).

3.3. Grouping of counties according to quality of life using cluster analysis

Cluster analysis is a type of multivariate analysis that encompasses several algorithms to classify elements or individuals into homogeneous groups. The groups are formed along the way, and the variables or cases are distributed in clusters so that the greatest similarities are between the members of the same cluster and the weaker similarities between the members of different clusters. To accomplish this goal, we primarily consider choosing the distance between elements in the secondary plan, choosing the grouping algorithm, and finally deciding on the level.

Figure no. 8 Final Cluster Centre



Source: author's processing based on NSI data

The analysis realised has, as individuals, the counties in Romania, and the variables used in setting the clusters are: the average life, the fertility rate and the living standard. These variables can provide a broad picture of the quality of life. After standardization of the variables and after running the K-Means Test in SPSS, three clusters were identified:

- Cluster 1 with 22 counties: Maramureş, Satu Mare, Bacău, Botoșani, Neamţ, Vaslui, Brăila, Buzău, Galați Tulcea, Vrancea, Călărași Dâmbovița, Giurgiu, Ialomița, Teleorman, Dolj, Gorj, Mehedinți, Olt, Caraş-Severin, Hunedoara;
- Cluster 2 with 11 counties: Bihor, Bistrița, Sălaj, Covasna, Harghita, Mureş, Iași, Suceava, Constanța, Ilfov, Arad;
- Cluster 3 with 9 counties: Cluj, Alba, Braşov, Sibiu, Argeş, Prahova, București, Vâlcea, Timiș.

Analysing the graph in Figure 8, we see the characterization of each cluster: Cluster 1 has the lowest average life among of the 3, but the highest living standard, Cluster 2 has a higher fertility rate, and Cluster 3 has the average duration lives greatest.

4. Conclusions

The analysis highlights aspects that characterize the demographic evolutions of Romania in the context of the European Union, as well as their implications at the socio-economic level at the territorial level, from 1990 until present.

The ANOVA analysis highlighted the fact that in 2016, the average emigration rate recorded the highest level for the Western region of Romania, unlike in 2012 when the highest average rate was in the Bucharest-Ilfov region.

Based on the selected variables, APC has led to two principal components; the analysis continued with the projection of the counties on the level determined by the two main components, starting from the ranking of the counties according to the level of living. The results show that the first axis, given by component 1 (in positive sense: natural increase, natality rate, marriage rate, fertility rate, mean life span and in negative sense: mortality rate) discriminates well between counties according to the standard of living, the high, low and medium levels of living are well differentiated in the projection on the first axis.

Bucharest, as expected, is first in the ranking by living standards and is characterized by high values of component 1 and component, followed by the counties of Cluj, Braşov and Timiş. On the opposite side, the counties of Teleorman, Giurgiu and Calarasi are characterized by low values of the first component (natural increase, mortality rate, natality rate, marriage rate, fertility rate, average life expectancy and mortality rate).

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