REGIONAL PATTERNS OF THE POPULATION AGEING PROCESS IN ROMANIA (1992–2021)

IONEL MUNTELE[*1], RALUCA-IOANA HOREA-ȘERBAN[**]

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Abstract. Population ageing has become an issue of maximum interest in developed countries. Romania is facing the acceleration of this process in the context of the post-1990 decline in fertility and the post-2000 massive emigration after 2000. The main objective is to outline regional and local disparities, starting from the hypothesis that they are due to the differentiated actions of various factors which can stimulate or slow down demographic ageing. The methodology used proposes a descriptive, typological perspective, coupled with a multivariate one. Several regional patterns of evolution, induced by specific ways of adapting to social, economic and political transition, are thus highlighted. The fast expansion in urban areas and the relative rejuvenation of the population in metropolitan areas, which expresses a population transfer induced by changes in people's lifestyle, relocation of economic activities and increased mobility, generated much interest. At the same time, the prevalence of agricultural activities and the decline of mining shape the context of an unprecedented ageing process in areas threatened by depopulation. The paper concludes that the evolution of the ageing process is similar to that of neighbouring countries and that there are strong rural-urban disparities.

1. INTRODUCTION

Sharp demographic ageing used to be a predominant trend in 20th century Europe, while in the 21st century it has all the prerequisites to worsen (Grundy and Murphy, 2018). Considered one of the most typical features of the second demographic transition (van de Kaa, 1987), this process is a consequence of the changes induced by demographic transition on fertility and death rate patterns, as well as of the impact of population mobility, especially international migration (Káčerová *et al.*, 2014; Naumann and Hess, 2021). It is a huge challenge for social protection systems due to the increase in the dependency rate and the manifestation of an acute labour shortage, and questions the welfare state itself (Galasso and Profeta, 2007). Identifying the causes, evolution patterns and implications of demographic ageing becomes the priority in order to find adaptation solutions (Davies and James, 2011). Resilience is becoming an increasingly important concept in public health, shifting social policies from limiting ageing to actively integrating it through measures meant to increase the quality of life of the elderly (Cosco *et al.*, 2017). The origin of this process is usually sought in past fertility cycles (Reher, 2015) and the trends that define it have been anticipated for a long time (Sauvy, 1948; Laslett, 1987). The evidence of the manifestation of various spatial differentiations, both in the urban and rural environment, underlines the importance of several local and regional factors in explaining the evolution patterns of the structure by age groups (Kashnitsky *et al.*, 2021). Human capital, education level, health status and life expectancy may implicitly lead to the manifestation of a profoundly differentiated dynamics at the territorial level, along with the overall demographic evolution (Balachandran, 2020).

[*] Professor, "Alexandru Ioan Cuza" University, Faculty of Geography, Blvd. Carol I, no. 11, 700506, Iași, Romania; Senior researcher, Romanian Academy, Iași Branch, Blvd. Carol I, no. 8, 700505 Iași, Romania, imuntele@yahoo.fr.

[**] Assistant Professor, "Alexandru Ioan Cuza" University, Faculty of Geography, Blvd. Carol I, no. 11, 700506, Iași, Romania, raluca.serban@uaic.ro.

[1] Corresponding Author

In Romania, the evolution of this process is characterized by the specificities of the demographic transition, and, later on, disrupted by the demographic policy of the communist regime, which occurred prior to 1989. The demographic shock felt after the collapse of this regime quickly changed the population structure by age groups, while the massive post-2000 emigration (initially for labour reasons, and subsequently for lifestyle reasons) triggered an increase in the share of the elderly population (Gheț̆au, 2007). The combination between the decline in fertility, and increased life expectancy at birth and the massive emigration of the young adult population, responsible for the drastic decrease in the population (by more than 4 million inhabitants between 1992 and 2021) make up the main causes of the worsening of the ageing process, which is practically impossible to avoid in the medium term (Bodogai and Cutler, 2014). Public policies are poorly prepared to deal with increasing social demands, both in the rural environment, which is almost completely devoid of means (Kulcsár and Brădăț̆an, 2014), and in the urban one, strongly perturbed by the three decades of transition (Ivan *et al.*, 2020).

Geographical research can also contribute to a deeper understanding of the forms of manifestation of this process which, through its specificities, pays special attention to spatial diffusion, territorial differentiation and the manifestation of regional patterns of evolution. Anchored in the interdisciplinary field of gerontology, geographical studies, predominantly descriptive for the longest time, focused on analysing the territorial distribution of the elderly population and, sometimes, the correlations with environmental or well-being issues. They have evolved towards the identification of spatial patterns since the final part of the past century (Rowles, 1986; Sanderson, Scherbow, 2016). At the same time, ideas, concepts and approach models used in gerontology have been assimilated, reinforcing the need for a holistic conceptualization in order to identify the historical bases of this process (Warnes, 1990). The possibility of manipulating detailed databases, along with the use of computer processing means favoured the transition from a descriptive approach to an analytical one (Harper and Laws, 1995), thus developing a genuine "geography of ageing" (Skinner *et al.*, 2015). Partly overlapping traditional geographical subjects (population geography, geography of health, social geography), also named "geographical gerontology", it has increasingly focused on the relationships between the elderly people and the places they frequent (Cutchin, 2009). Three main themes of interest have been settled since 30 years ago: the trends in the spatial evolution of the ageing process, frequently correlated with the mobility of the elderly; the territorial disparities induced by the access to health and social assistance services; the factors which influence the quality of life of the elderly in connection with the quality of the environment. Closely linked to the public policies of "active ageing" and the stimulation of age-friendly communities (Golant, 2014), specialized geographical studies often resort to the principles of sustainable development or of inclusive governance (Han *et al.*, 2021). Along with population growth, international migration and rapid urbanization, ageing is seen as one of the global "megatrends" which are shaping this century (Messerli *et al.*, 2019). Consequently, it is necessary to profoundly revise how society works from a spatial perspective (MacCarthy, 2022), although, as many authors underline, governments are barely aware of the process of demographic ageing and do not have the forethought required to limit its effects (Thumerelle, 2000).

In this disciplinary context, the present study proposes a chrono-spatial analysis of the post-communism evolution of the ageing process of the Romanian population. The beginning of the analysis period is marked by the completion of the demographic transition, postponed by the pro-natalist policy of the Ceaușescu regime, but accelerated by the post-1990 crisis (Rotariu, 2014). Rapidly imposed, especially given the massive emigration of the young population, and a victim of the post-communist restructuring of productive activities, this process has also been sped up by the increase in life expectancy after a long period of stagnation, particularly after the year 2000 (Muntele *et al.*, 2020). The evolution trends of the ageing process of the Romanian population are similar to those noticed in other countries in the central and eastern part of the continent, recording similar gaps, in comparison to western countries, in terms of the public policies on active ageing (Olivera, 2020), the reversal of the

international migration flows which could help mitigate the share of the elderly population (Długosz and Kurek, 2006; Lewandowska-Gwarda and Antczak, 2020), or the incomplete epidemiological transition (Kinsella, 2000).

The specific eastern European context, for which Romania is a prime example, is a dangerous combination between the three acknowledged forms of ageing: at the bottom (caused by fertility decline), median (induced by the significant emigration of the young adult population) and top (triggered by the increase in life expectancy) (Sardon and Calot, 1999). A combination also specific to southern Europe in the past (Marcaletti *et al.*, 2020), it will disrupt demographic balance in the long term. By contrast, the west of the continent has experienced a succession between bottom and top ageing, with a significant time lag (Naumann and Hess, 2021). The aforementioned combination coincided with profound political, economic and social transformations generated by the dissolution of the communist regimes. The elderly generation is often seen as the main loser of the transition to the market economy (Botev, 2012). What is also typical of the Romanian (and eastern-European) pattern, apart from the accelerated ageing rate, is its generalized character, affecting both the rural and urban environment. During the past decades, this has significantly drawn the attention of specialists in the social sciences, who have emphasized its effects on the public social assistance services, poorly prepared to deal with it (Asandului, 2013; Bodogai and Cutler, 2014). The specificity of Romania within the European context has also often been approached in order to identify solutions for the implementation of certain community policies (Gabor *et al.*, 2022). Other studies have focussed on the determining factors, such as international migration (Nemenyi, 2011), the mutations caused by the deepening of the social and economic gaps (Jemna and David, 2021) or the ability of the territorial structures to adapt to this process (Istrate *et al.*, 2015).

The analysis of the previously published papers pointed out a shortage of studies at the national and regional scale and the fact that they only deal with general trends. For this reason, our study opted for a detailed analysis, carried out at the level of the 3,181 basic administrative units in Romania (communes, towns and municipalities). The main objective is to identify the manifestation of some regional evolution patterns of the ageing process, in correlation with a series of socio-economic, cultural and geographical factors. In this context, the key issues that arise are the following:

Is the generalization of the demographic ageing process in Romania a pertinent subject?

Do the chronology of the manifestation and the development speed of this process produce regional gaps?

Can the differential evolution of the demographic transition explain the features of the regional patterns of evolution?

What role did the strong shrinking of the urban population and the building-up of metropolitan agglomerations play in the manifestation of divergent trends in the ageing process?

Is there, locally or regionally, a manifestation of a resistance to this process? What are the factors that can explain these forms of adaptation?

The working hypothesis that emerges from these issues is the following: leaving aside the general trends outlined by various papers, when analysing the ageing process in Romania significant territorial disparities (generated by the differentiated action of the factors that favour or limit it) can be noticed.

In order to test this hypothesis, the present study takes a double approach: a descriptive analysis, aimed at identifying some typologies of the evolution of the ageing process, using the structure by age groups and the average age as variables; a multivariate analysis of the explanatory role of a series of demographic, socio-economic and geographical variables, the average age being the dependent variable.

We believe that this approach helps with understanding the demographic crisis Romania is going through (the population dropped from 22.8 million in 1992 to 19 million in 2021, one of the most serious declines in Europe) and clarifies the particularities of the aging process for each of the four moments analysed.

2. MATERIALS AND METHODS

The information needed for the two analyses was collected from the databases of the National Institute of Statistics. Two distinct sets of information were created: one relating to the population structure by age groups, gender combined; the other one containing derived information illustrative of variables with an explanatory role in the evolution of the ageing process.

For the descriptive analysis, the share of each age group (*Px*) in the total population *Pt* (*Px/Pt*100*) was calculated for each of the four censuses conducted in Romania after 1990 (1992, 2002, 2011 and 2021). The four percentage datasets derived were then subjected to a hierarchical agglomerative clustering (AHC) typological analysis in the XLSTAT software (Addinsoft, v. 2015). Using Euclidian distance and grouping statistical units by their degree of similarity (Ward's method of clustering), the typology aimed to keep the values of intra-class dispersion coefficients at a minimal level compared to inter-class dispersion coefficients, thus ensuring class homogeneity. Eight classes with a distinct profile were selected and then mapped with the help of the Adobe Illustrator CS12 program. The class profiles were compiled in Excel. For comparison purposes, the average profile was also illustrated.

A total of 14 explanatory variables were selected for the factorial analysis. The average age was chosen as a dependent variable, after previously testing its correlation with the ageing index, more dependent on the share of extreme age groups. For all four time series, the correlation coefficient of the two indicators exceeded 0.9. The average age was preferred because it expresses the ageing phenomenon in a more synthetic manner, taking into account all age groups. It was calculated as follows: $X = \frac{\sum(x+0.5)Px}{\sum Px}$, where *X* represents the average age, *Px* is the number of people of age *x* and 0.5 is the average equivalent of the variation of the deviations from the exact date of turning a certain age.

The description of the explanatory variables, the source of the information they were based on and how the derived values were standardized appear in Table 1. Four of these variables were regarded as constant for the whole analysis period, while the others were calculated for each time series. The choice of these variables is consistent with various studies which analyse the main factors that trigger the process of structural ageing (the population's demographic history - Preston *et al.*, 1989; fertility, mortality and migration - Hoff, 2011; mortality improvement, especially in low-fertility countries – Murphy, 2017; geographical drivers - McCann, 2017; fertility decline and net migration - Smailes *et al.*, 2019; per capita GNI, urbanization rate and life expectancy - Wang, 2020, etc.).

Table 1

Variables used in the factorial analysis – description and source of information

Type of variable	Variable	Acronym	Description	Information source	Standardization
Dependent variable	Ageing Index	AI	Ratio between the population aged 65 and the population aged 0−14	Romania's population censuses of 1992, 2002, 2011 and 2022	Z scores, outliers removed
Explanatory variables	Bottom ageing	BA	Ratio between the average birth rate of the last intercensal period and that of the penultimate period	Tempo Online database of the INS (1966-2021), www.insse.ro	
	Median ageing	MA	Average migratory balance in the last intercensal periods	Tempo Online database of the INS (1966-2021), www.insse.ro	
	Top ageing	TA	Ratio between the 50−64 and +65 age groups	Romania's population censuses of 1992, 2002, 2011 and 2022	

Table 1 (continued)

Oldest old	OO	Share of +80-year-old population in the total of +65-year-olds	Romania's population censuses of 1992, 2002, 2011 and 2022	
Average altitude of habitat	ALT	Considered for main localities	Topographic map 1:100 000, Military Topographic Directorate https://www.geomil.ro/Descarcare	
Habitat fragmentation	FS	Ratio between population and number of localities	Romania's population censuses of 1992, 2002, 2011 and 2022	
Position in relation to main cities	LMC	Distance in km on the shortest route to cities with more than 50,000 inhabitants	"România. Mare atlas rutier" (Romania. Great Road Atlas) 1:200,000, AGC Busman SRL, 2011	
Access to major transportation network	AMT	Factor scores by importance of transport means. Maximum value (1) granted for railways and European roads; minimum value granted for local roads.	"România. Mare atlas rutier" (Romania. Great Road Atlas) 1:200,000, AGC Busman SRL, 2011	Factor score
Shared of population employed in agriculture	PEA	Share of the employed active population	Romania's population censuses of 1992, 2002, 2011 and 2022. Tempo Online database of the INS (2021)	Z scores, outliers removed
Newly completed dwellings	NHB	Ratio between the number of newly completed dwellings and the total population in each intercensal period	Tempo Online database of the INS (1966–2021), www.insse.ro	
Urbanistic index	BI	Average share of households with access to water supply, sewerage and central heating out of the total number	Romania's population censuses of 1992, 2002, 2011 and 2022	
Educational index	EI	Share of people with secondary and higher education	Romania's population censuses of 1992, 2002, 2011 and 2022	
Income	INC	Average income from wages and social benefits (RON/person) extrapolated based on the socio-professional structure of the population	Tempo Online database of the INS (1966-2021), www.insse.ro	
Roma share	RR	Share of the Roma population (% of the total)	Romania's population censuses of 1992, 2002, 2011 and 2022	

In the end, four standardized data series resulted for each census (1992, 2002, 2011 and 2021). They were subjected to a multivariate analysis using the functions of the XLSTAT software. Considering the large number of explanatory variables and the high probability of multicollinearity, we opted for the PLS (partial least square regression) model, recommended in such cases. Based on the covariance analysis, the outcomes provided by this model are the correlation matrix, regression quality coefficients, factorial axis distribution plots, information on regression residuals, predictions, etc. The main results pursued were the correlation matrices, the distribution of the factorial axes and the *R2* coefficient, which were illustrated either in tables or graphs.

3. RESULTS AND DISCUSSIONS

3.1. Descriptive analysis

According to the above-mentioned methodology, the AHC (agglomerative hierarchical clustering) typological classification aimed at tracking the changes produced in the specific weight of each age group, without gender differentiation. In order to limit the excessive dispersion of the values within classes, raw data were standardized with Z-scores, removing outliers. The eight resulting classes are grouped into two unequal clusters (1-3 and 4-8, respectively), divergent enough to express time gaps in terms of the influence of some age-structure drivers, such as fertility decline, increased life expectancy, economic, social and cultural indicators (Fig. 1).

The profile of the classes overlapped, on the same graph, for each of them, the lines representing the specific weight of each age group, thus enabling us to track the changes that occurred over time due to the use of a unitary scale (Fig. 2). The eight classes are well highlighted, both from the perspective of their geographical distribution, significantly regionalized, and as regards their evolution profile.

The first cluster, which includes classes 1-3, mainly groups localities situated in the north-east, centre and south-east of the country. Characterized by a share higher than the national average of young people (aged 0−14) and a lower share of the elderly, the three classes differ in their spatial distribution and rate of change. Class 1, which includes 120 localities scattered mainly in the north-eastern and central part of the country, stands out through its resilience to the ageing process, preserving a very high share of the young population and a low, stable percentage of the elderly. The only notable change is the tendency of the population to increase in the 30−50-year-old range which, in the medium term, may point to the beginning of the ageing process. The areas are relatively coherent, closely linked to the preservation of a high female fertility rate, which is due to certain ethnic specificities (the presence of the Roma community) or confessional features (neo-Protestants), with a more conservative demographic behaviour (Muntele, 2023).

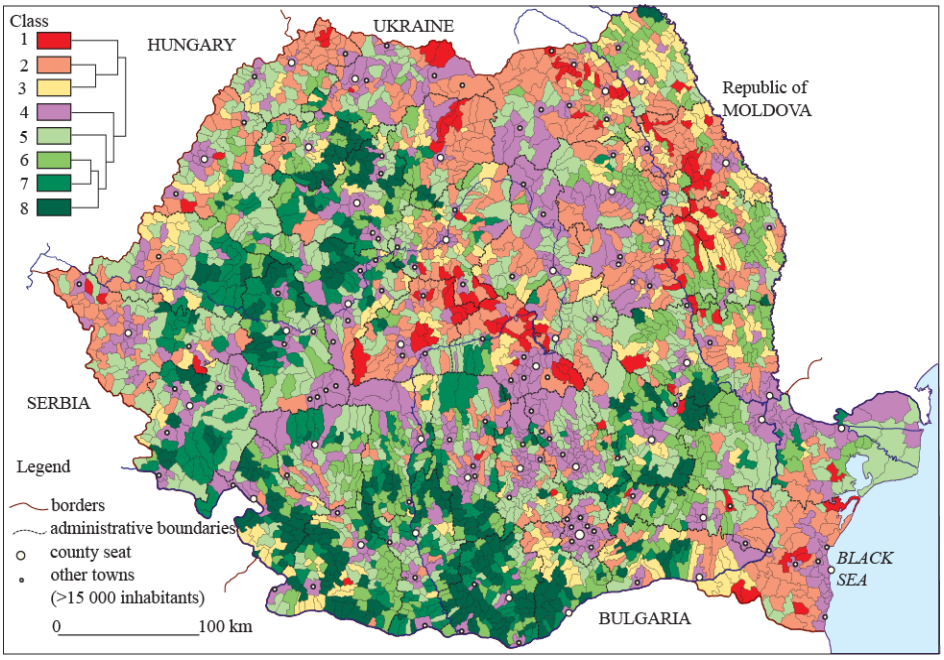

Fig. 1 – Typology of population structure by age groups.
(*Data source*: RPL 1992, 2002, 2011, 2021, INS).

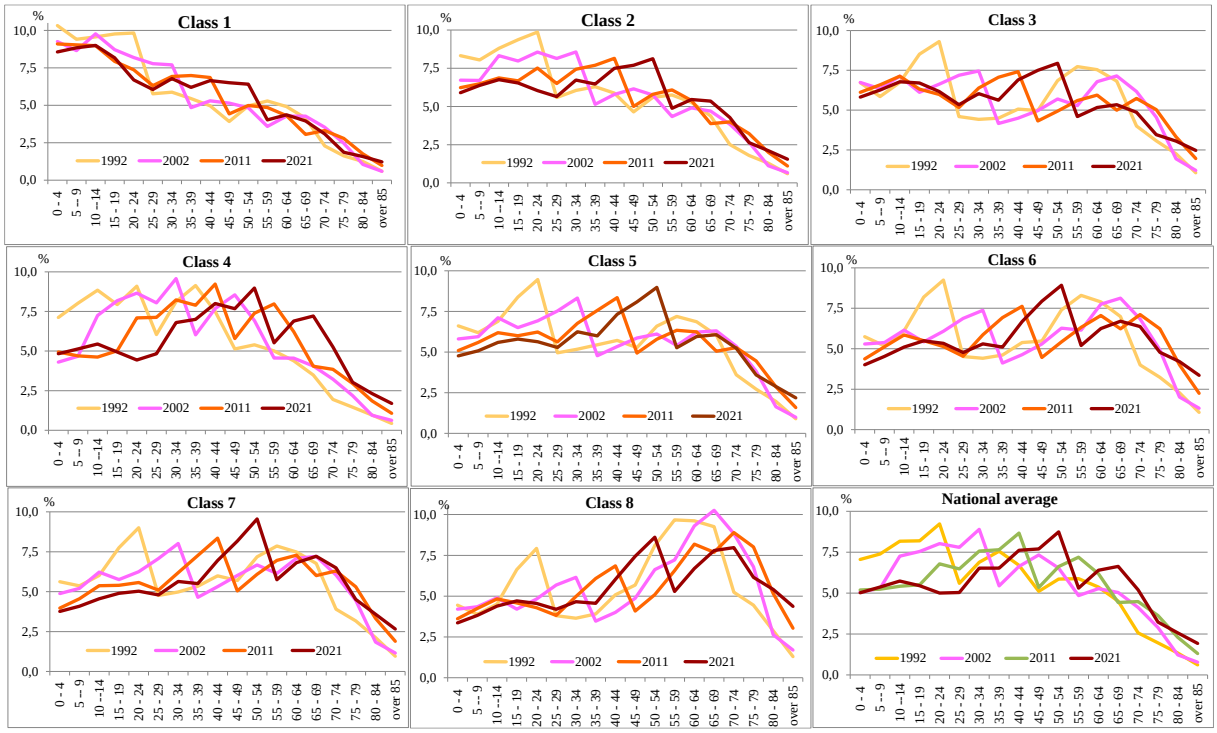

Fig. 2 – Classes profile. *Source:* own elaboration.

Class 2 is much better represented, grouping almost a fifth of the total number of localities (577 out of 3,181). It covers large areas which stretch over a significant part of some north-eastern (Iași, Suceava, Bistrița-Năsăud) or south-eastern counties (Constanța). Unlike the previous class, the tendency of the bottom to get narrower is more clearly expressed, and the augmentation of population at advanced ages (over 50) is much more obvious. It reveals a mature, relatively balanced structure, with a significant risk of ageing in the medium term. Class 3 comprises a smaller number of localities (233), forming larger areas, especially in the north-east of the country, in continuity with the previous classes, without being absent in the rest. It may be considered the more advanced version of classes 1 and 2, with an earlier decrease in the number of people in the younger age groups and a more significant increase in the number of the elderly; it is often located in rural areas remote from cities. The risk of short-term ageing is low, the 50-70-year-old generations, intensely represented in the years 1992 and 2002, recording a shrinking tendency. In the medium term, the evolution is similar to that of Class 2.

The first class in the second group (4) is well represented (592 localities) and forms very spatially coherent areas in the Carpathian Mountains and around important cities (Bucharest, Cluj-Napoca, Constanța, Timișoara). It is also typical of most urban centres, standing out through the swiftness of the transformations, both at the bottom, where the decrease in the share of the 0−30-year-old groups was very strong, and at the top, where the ageing process experienced a spectacular upsurge, fuelled by the massive augmentation of the adult population. This evolution pattern expresses the deep demographic changes felt after the fall of communism, stronger in these areas which had previously attracted large masses of young population, following the industrialization policy of the communist regime (Ianoș, 2001). The behavioural mutations, favoured by the larger share of the active population or by the higher level of education, brought about the profound drop in the fertility rate. Having become attractive again in the past decade, these areas can no longer secure their own workforce resources, having to call on regions that still have reserves, or even on international migration. Class 5, the most representative (615 cases), expanded all over the country, most often associated with class 4 in areas with relatively easy access to

urban centres, and represents its more advanced version, with an earlier and massive but stabilized ageing process during the past two decades. It covers compact areas, most frequently in the intra-Carpathian regions and in the central-northern part of Muntenia, the most developed regions of the country. In the medium term, the risk of preserving the ageing level is relatively high because of the significant share of the 40-60-year-old age group, the circumscribed areas being less affected in the past both by the communist rural exodus and by international labour migration. Classes 6 and 7 have a similar profile and are spatially associated in rural areas located at an average distance from important urban centres. The highest frequency is found in the sub-Carpathian areas of Moldavia and Oltenia, or in the southern plain regions. The first of them (Class 6) is much better represented (526 cases), displaying a degraded structure, with low shares of the young population, an advanced ageing process and prospects of preserving this trend in the medium term. The other (Class 7, with 238 cases) is the even more serious version, mainly located in isolated mountain areas. The degradation of the bottom of the demographic structure (the young population) is severe, extending to the 40-year age group, with a massive augmentation at the level of the 50-64-year-old-groups. The relative stagnation of the ageing process during the past 20 years will, thus, be followed by a strong comeback. The last class (Class 8: 280 cases) reveals the most disharmonious structure, degraded even before the beginning of the study period, with a progressive and massive shrinking of the 0-39-year-old group and an excessive concentration for older-age groups. The significant increase in the oldest-age group (80+ years) is remarkable, at a level well above the national average. The ageing potential exceeded the maximum level, so that we may expect the relative shrinking or stagnation of the elderly population.

The spatial distribution of the changes in age structure overlaps the one derived from the analysis of the average age, used as a dependent variable in the factorial analysis. It is simpler and with a stronger homogeneity within the 6 selected classes (average intra-class dispersion is below 20%). The observed territorial differences can be explained through the evolution of fertility and life expectancy, with sufficiently clearly marked urban-rural disparities and well-defined regional distributions. The 6 classes are grouped in pairs, the first one having a slower evolution and the second one a faster one.

Class 1 coincides with the areas in the north-east and centre of the country, which preserve a still favourable age structure, with a share of adults above the national average. Consequently, the average age is much lower than in the rest of the country (Fig. 3, Table 2).

Class 2 is mainly typical of urban centres, but also covers extensive mountain areas (in the Eastern and Southern Carpathians), certain mining basins located in hilly areas (such as Motru) and agricultural regions with frequent state-owned agricultural enterprises during the communist period (particularly in Dobruja). The appeal they exerted prior to 1989 increased the number of the working-age population but, during the transition, it also fuelled a rapid transformation of the age structure. The significant rise in the average age of the population in these localities also reflects the more efficient access to medical services, with positive effects on life expectancy. However, immediately after 1990, the main impetus for changes was provided by the decline in fertility, more strongly felt in towns and localities with a population massively employed in non-agricultural activities. Labour migration (in particular of the younger population) gradually increased the average age. It is, perhaps, the most vividly felt effect of the transition, as the average age rose by about 10 years over the course of three decades.

Class 3 stands out through a slow growth, from relatively high values falling below the national average towards the end of the period. It is mainly specific to economically attractive and dynamic areas (the west of the country, the capital region), less affected by international labour migration. In 1992, class 4 recorded values well above the average, preserving a relatively strong increase, which reflects a more advanced ageing process. It is typical of more isolated mountainous and sub-mountainous areas or of the plain regions in the south-east of the country, and reflects the difficulties in adapting to the new conditions imposed by transition, against the background of a relative demographic stability during the communist period.

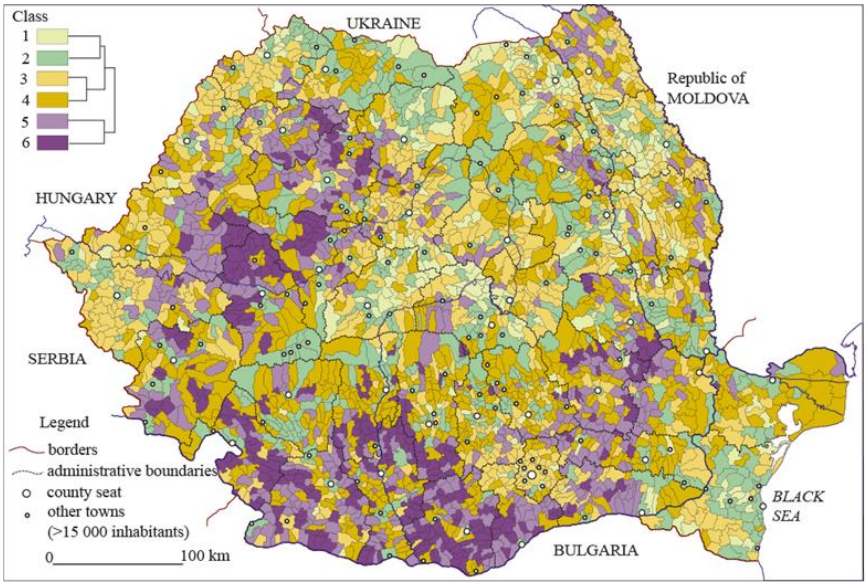

Fig. 3 – Typology of average age.
(Data source: RPL 1992, 2002, 2011, 2021, INS).

Table 2

Class profile

Class	Year			
	1992	2002	2011	2021
1	32.7	33.9	35.2	35.9
2	32.7	35.8	39.4	42.0
3	36.8	37.8	39.2	40.1
4	38.1	40.0	42.5	44.2
5	42.1	43.3	44.6	44.9
6	44.3	46.8	48.9	49.9
National average	**34.9**	**37.8**	**40.6**	**42.4**

Source: Own elaboration.

The last two classes have always ranked above the national average. They correspond to the vast demographically aged areas in the south of the country and in the Western Carpathians, and are positioned in territorial continuity, clearly differing from each other in terms of the speed of the evolution of this process. Class 5 stands out through its relatively stable values, which are much higher than the national average, and Class 6 with the preservation of an active dynamics, until around the 50-year-old limit towards the end of the study period. In both cases, the elevated average age emphasizes a drastic shrinking of the labour force potential and imminent depopulation trends, with irreversible effects in the most isolated localities.

The descriptive analysis thus highlighted the manifestation of some profound regional gaps in the evolution of the population structure by age. The patterns of evolution are well outlined spatially, closely related to the differential diffusion of the socio-economic modernization process. The present contrasts only certify the failure of the communist policies meant to homogenize the level of development. The transition which followed the fall of the communist regime disrupted the previous trends in evolution, already strongly marked by the gap between the urban and rural environments. New disparities have thus appeared, corresponding to the faster integration into the market economy circuit of various regions favoured by their geographical position (the west of the country, the metropolitan areas), or to the decline

of certain activities that once provided stability, especially in mountain areas (mining, logging) or plain regions (marked by agro-industrialization). In terms of the average age, a major cleavage can be perceived between intra-Carpathian and extra-Carpathian areas. The first category, with the exception of the Western Carpathians, affected by depopulation, seem rather to correspond to some relatively stable evolution patterns. The others, except for the metropolitan areas (especially those that belong to the capital city), are more strongly marked by the aggressiveness of the ageing process. From this perspective, it may be stated that Romania holds an intermediate position between Hungary and Bulgaria. Thus, the average age in Romania increased by 21.3% between 1992 and 2021, from 34.9 to 42.4 years old, lower than in Bulgaria (23.3%, from 36.1 to 44.5 years old) but higher than in Hungary (19.3%, from 35.8 to 42.7). The western regions of the country have more so followed a central-European pattern, since in Banat the increase was of 20%, and in Crișana of just 15.2%. Dobruja has experienced a faster rise in the average age (by 25.3%), even higher than in Bulgaria. The contrast between western and southern areas is illustrated by the evolution of the average age in Crișana, a region on the border with Hungary, and Oltenia, which neighbours Bulgaria. Thus, from 36.5 and 36 years old respectively in 1992, it reached 42 and 43.6 years old, respectively, in the year 2021, a similar evolution to that of neighbouring states. In the rest of the country, the growth was closer to the average except for the capital and its metropolitan area (București-Ilfov), which recorded lower values.

3.2. Factorial analysis

The descriptive analysis of the typology of the evolution of the structure by age groups and of the dynamics of the average age pointed out the existence of some local and regional features, general trends and structural changes induced by the economic transition. All these cannot be correspondingly interpreted without the contribution of a multivariate analysis, integrating a series of relevant variables, within the limit imposed by the availability of information on this scale of detail.

The PLS-type multiple regression, performed on the 14 variables selected for analysis, corresponding to each of the 4 censuses taken into consideration (1992, 2002, 2011 and 2021) used the average age as a dependent variable. This choice was also stimulated by the homogenous distribution of the evolution trends identified at the spatial level; consequently, it is easy to interpret within a correlative analysis. The R2 coefficient of determination validates the factorial model through its high values, ranging from 0.555 to 0.603 (Table 3). The slightly decreasing trend of this coefficient between 1992 and 2002 may correspond to the disruption caused by the fall of the communist regime, while its subsequent recovery may be the expression of the manifestation of various forms of adaptation. Its satisfactory level is also given by the significant correlation of most of the explanatory variables.

At the beginning of the study period a strong correlation dispersion is revealed: 10 of the 14 factors recorded a value higher than a level indicating a significant influence (0.2). The AP, BI, HF, PEA and AB variables primarily stand out, illustrating the differences between the urban and rural environments, the latter being characterized by a more fragmented habitat, a lower urban comfort and massive agriculture employment rate of the active population. The augmentation of the elderly population, against the background of the birth rate decline, which began as early as the 1980s, already involves a strong influence of the ageing process at the top of the pyramid. But the other two forms of ageing (AB and MA) also have an important impact, as a consequence of the massive rural exodus specific to the communist period. The weak influence of certain factors can be explained by the context of the communist regime. For example, OO describes the stagnation of life expectancy during the last two communist decades, which limited the increase in the population aged 80 and over. The low level of the correlation with ALT points to the generalization of the ageing process, regardless of the geographical context. The lower value of the PMC emphasizes the limited polarization capacity of the main urban centres as a consequence of the strict planning policy of the party, which, from the urbanistic point of

view, caused rural localities (even those situated in the proximity of towns) to lag behind. The gaps in the demographic behaviour that could be expressed by the cultural factor (as illustrated by the RR variable) are not so obvious, demographic transition being just in the process of completion.

Table 3

Correlation matrix of average age and explanatory factors

Variables	Average age				
	1992	2002	2011	2021	Trend
BA	**0.337**	0.070	**0.252**	0.168	decreasing
MA	**0,307**	**0,420**	**0.557**	**0.611**	growing
TA	**0.606**	**0.593**	**0.661**	**0.651**	high stable
OO	0.091	0.156	**0.251**	**0.338**	growing
ALT	0.114	0.071	**0.251**	-0.011	low stable
FS	**0.413**	**0.383**	**0.328**	**0.275**	decreasing
LMC	0.192	**0.214**	**0.212**	0.195	middle stable
AMT	**0.284**	**0.309**	**0.273**	**0.247**	middle stable
PEA	**0.343**	**0.349**	**0.285**	0.195	decreasing
NHB	**0.218**	**0.201**	0.19-5	**0.209**	middle stable
BI	**0.431**	**0.413**	**0.350**	**0.246**	decreasing
EI	**0.276**	**0.244**	0.158	0.040	decreasing
INC	**0.274**	**0.238**	0.171	0.058	decreasing
RR	0.102	0.168	**0.268**	**0.330**	growing
Coefficient R2	0.556	0.520	0.603	0.573	

Source: Own elaboration.

Based on these premises, the explanatory framework changes spectacularly a decade later, even though the augmentation of the elderly population (AP) is still the fundamental vector for the evolution of the ageing process. However, the role of median ageing also becomes more important. The significant increase in the PMC factor reflects the beginning of the suburbanization process, forced by the shrinking industrial activities and the rise in unemployment, following privatization measures. The distance from the city thus becomes an important vector for changes in the structure by age groups. The inertia induced by the massive accumulation of young population in cities, during the last two communist decades, preserves the explanatory value of the AMT, PEA and BI factors.

The main change introduced by the period before and after the accession to the European Union was the strong increase in the significance of the MA factor. This underlines the increasing (often permanent) international labour migration, against the background of easier access to the Schengen space. This context also brought about a slight drop in the birth rate, after having become stable at the end of the 1990s, hence relaunching the bottom ageing process. To all these we can add the sharp increase in life expectancy (from 70.8 to 74.2 years old between 2002 and 2011), which also strengthened top ageing. Their cumulative effect led to the fastest ageing speed during the analysed period, also visible in the significant correlation with the Oldest Old variable. Consequently, although between 1990 and 2002 the contingent of this category dropped from 280,000 to 258,000, in 2011 it rose to a spectacular 726,000, which is 3.6% of the total population. Among the variables that express urban-rural disparities, the ones related to education, income and dynamics of new housing constructions lose their importance. The others preserve a certain influence, but on a downward trend compared to the previous timeframe. This period also displays the stronger part played by cultural factors: the percentage of the Roma communities has now become an explanatory factor, dependent on demographic conservatism, which makes them resistant to the ageing process, but also prone to a lower standard of living, which is likely to limit the increase in life expectancy.

The last timeframe (2011−2021) captures new changes that certify the significance of the socio-economic changes that followed the accession to the European Union. The economic crisis of

2008−2011 and the pandemic crisis certainly played a role in these transformations. The importance of population mobility becomes more obvious than ever, the correlation expressed by the MA variable being very strong, similar to AP. The median ageing brought about by the continuous emigration of the young generations after the year 2001, along with the constant augmentation of the elderly population (derived from the numerous generations born after World War II) have also caused the *oldest old* category to increase (4.5% of the total in 2021). The steady increase in life expectancy (temporarily halted by the negative effects of the pandemic) also contributed to this. The variables that express urban-rural differences decrease in importance, but the explanatory value of the RR cultural variable increases.

The evolution of the explanatory capacity of the 14 variables can also be followed in a cross-sectional profile. Some of them experience a constant growth (MA, OO and RR), a perfect example of the role played by median ageing in the evolution of the transition of the age structure of the Romanian population, of the importance of the increasing life expectancy in the augmentation of the elderly population or of the preservation of a relatively high fertility rate in keeping a favourable structure. The stability of AP throughout the entire analysed period is remarkable, as well as that of the PMC, AMT and NHB variables, even though they have a smaller explanatory role. However, the other variables have experienced a downward trend. A stabilization of the fertility level during the last decades is thus validated, the specific fertility index ranging between 1.25 and 1.8, with its lowest values recorded at the beginning of the 2000-2010 period. Thus, the variation in the birth rate, which used to fuel bottom ageing in the past, has lost some of its importance. Variables such as habitat fragmentation, access to modern means of transport and a share of the agricultural population still play an explanatory role, but following a downward trend. This evolution may be related to the constant augmentation of peri-urbanization and metropolization. The massively decreasing explanatory role of income and educational variables may also be a consequence of the interference of some cultural factors, as proved by the rise of the RR variable. As a result, the high level of income and education seems to rather be correlated with an increased degree of ageing, reflecting the massive emigration of (especially well-qualified) young people. In this context, we can talk about a genuine explosion of urban ageing, even in the most attractive cities.

The analysis of the contribution of the variables with a strong explanatory value (BA, MA, TA and OO) has revealed four types of ageing within the Romanian space: early or uncertain; predominantly bottom ageing; combined ageing; predominantly top ageing (Fig. 4, Table 4).

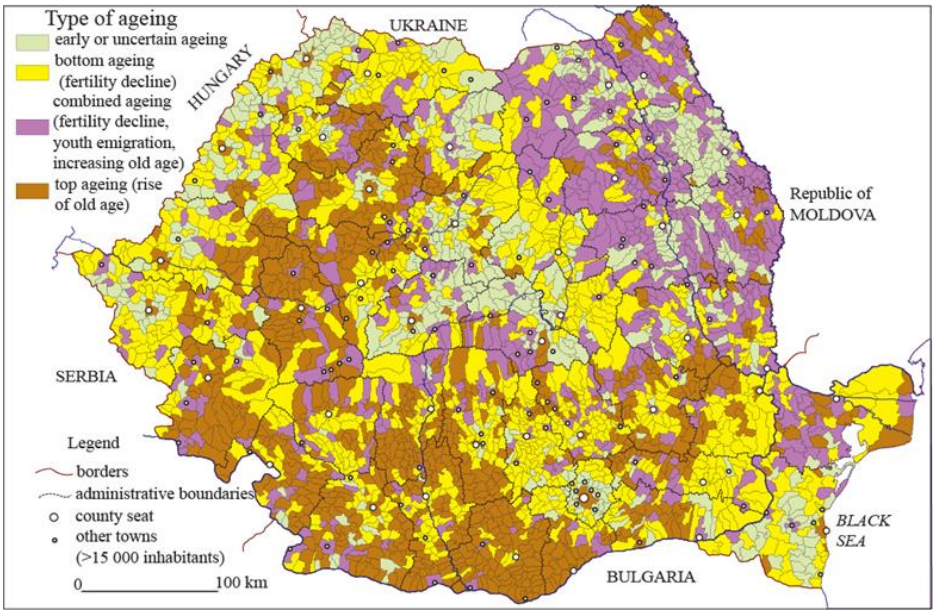

Fig. 4 – The typology of ageing in Romania according of the contribution of demographic variables.

Table 4

Ageing types profile (Data source: RPL 1992, 2002, 2011, 2021, INS)

Type	*Year*	*0−14 years*	*15−29 years*	*30−49 years*	*50−64 years*	*Over 65 years*	*Number of administrative units*
Early or Uncertain Ageing	1992	25.0	24.3	21.1	17.5	12.2	559
	2002	23.4	23.5	24.1	14.9	14.1	
	2011	22.2	20.3	27.4	16.0	14.1	
	2021	21.3	19.1	28.5	16.9	14.2	
Bottom Ageing (Fertility Decline)	1992	20.7	23.0	22.3	19.8	14.2	1056
	2002	18.9	21.6	25.0	17.5	16.9	
	2011	16.8	18.2	28.2	18.6	18.2	
	2021	15.4	16.6	28.3	20.3	19.4	
Combined Ageing (Fertility Decline, Youth Emigration, Increasing Old Age)	1992	21.5	23.8	21.5	19.5	13.6	702
	2002	19.8	21.0	24.2	17.3	17.8	
	2011	17.8	17.1	26.6	18.4	20.0	
	2021	16.1	16.8	25.6	20.3	21.2	
Top Ageing (Rise in Old Age)	1992	15.9	20.4	20.6	24.1	19.0	864
	2002	15.2	17.4	21.8	21.2	24.5	
	2011	13.6	14.6	24.6	20.2	27.1	
	2021	12.2	14.1	24.3	21.4	28.0	

Source: Own elaboration.

The first category groups those administrative units where the ageing process is either in an early phase, or uncertain in the short term. It circumscribes sufficiently vast areas in the north, east and centre of the country, but it also appears, sporadically, in the metropolitan areas of the main cities (Bucharest, Cluj-Napoca, Timișoara, etc.). The slower decline in fertility explains the preservation of a high share of the 0-14 and 15-29-year-old age groups. The middle part of the age pyramid is widening (especially in suburban areas), while the progress at the top is insignificant, resulting in a more balanced structure. These areas have become the main source of young labour force.

The second type is marked by bottom ageing, induced by the massive decline in fertility after 1990. It is the most characteristic, typical of the southern and central-western part of the country. Extending to intermediary rural spaces, located at a relatively short distance from the main urban centres, often advancing in suburban areas, it stands out through the constant and rapid decrease in the share of young age groups (0-14 and 15-29), the permanent augmentation of the young adult population (aged 30-49, which indicates a lower impact of emigration) and especially the strong rise in the share of the elderly population. Ageing will inevitably continue in these areas, being fuelled by the numerous middle age generations.

The third type is marked by combined ageing: at the bottom, median and at the top. It is particularly specific to north-eastern regions, dominated by intermediary or isolated rural areas. Compared to the previous type, it experiences a lower growth of the young adult population and a stability in the 50−64-year-old age group, massively involved in international labour migration. On the other hand, the share of the elderly population has rapidly progressed, generating a more advanced ageing process than in the previous case. This context suggests a slowdown of this process in the medium term, although it is possible that it will be fuelled by the return to the country of many who have emigrated in recent decades.

The last type stands out through the prevalence of top ageing, as an effect of the constant augmentation of the elderly population. Mainly specific to the south-west and west of the country (while also still to be found in the other sectors), it covers vast areas, sometimes overlapping entire counties (i.e., Teleorman, Hunedoara). The massive shrinking of the young population will maintain the spectrum of ageing in these regions, which, from the demographic point of view, are the most gravely affected. This group also comprises most urban centres, including the most important ones, urban ageing being,

for the moment, a certainty in Romania. To a certain extent, this phenomenon is related to the tendency of young people to move to suburban areas which, as previously presented, are much less affected, sometimes even experiencing a revival of their age structure. The strongly regionalized territorial distribution of the four types of ageing proves the existence of specific patterns, generated by the interference of various factors, partially analysed using a multivariate analysis. This confirms the suggested hypothesis. We believe that a more profound investigation of the relationships between age structure and relevant demographic, socio-economic and cultural factors, at other scales of analysis, may provide additional explanations. It is the case of some previously mentioned phenomena, such as the revival of the population structure in metropolitan areas or urban ageing.

4. CONCLUSIONS

As a process that goes hand in hand with socio-economic modernization, demographic ageing recorded a relatively rapid development in Romania, in close connection with the shock felt after the collapse of the communist regime, which sped it up through its effects. We can state that the generalization of this process on the national scale is a certainty, proved by the almost threefold increase in the ageing index during the study period (from 0.48 to 1.21). Basically, over the course of a single generation, Romania has passed from a relatively young population structure, to one marked by intense ageing. Within the European context, the age structure of the Romanian population may seem more favourable, but this is primarily due to a lower life expectancy. Romania is far from the ageing level of Italy or Germany (1.65 and 1.76 respectively in 2021, according to Eurostat), but close to that of France (1.25 in the same year), countries with a constant intake of young adult population through migration. Comparatively, neighbouring states, such as Hungary or Bulgaria, with similar demographic characteristics, appear to be significantly older (1.39 in 2021). However, the speed of the ageing process was equally fast in Bulgaria or Hungary (the ageing index was of 0.54 and 0.65, respectively, in the early 1990s). Germany's value has been in excess of 1 even since 1990 (1.07), Italy was close to it (0.86) and France held an intermediary position (0.7). If ageing is indisputable at the national level, typological analyses highlighted the presence of several conservative areas where this process is in its early stages, or which faced a revival as a result of the influx of young population (the metropolitan areas) and where ageing is uncertain. In the case of the conservative areas, their isolation and predominantly rural character (often marked by certain ethnic or confessional specificities) can be treated as explanatory factors, as partially proved by the factorial analysis. The long differential evolution of the demographic transition, first in the south-west of the country and later in the north-east, is still valid, conservatory areas being concentrated mainly in the north-east of the country.

Significant gaps in the chronology of the manifestation and speed of the ageing process were emphasized. The main cleavage opposes the urban environment to the rural one. In just three decades, Romanian cities passed from an ageing index of 0.31 to one of 1.26. In contrast, in rural areas its evolution was slow, from 0.72 in 1992 to 1.16 in 2021. The main explanations that can be brought forth are: the increase in life expectancy (more consistent in the urban environment due to a better accessibility to medical services), the relative rural conservatism (fertility decline being much steeper in the countryside) and the increasing mobility, in various forms, which drains the young urban population in particular, either to neighbouring rural localities or to other countries. The fast urban ageing process that has manifested itself in post-communist Romania is in sharp contrast with the alert urbanization specific to the decades of forced industrialization. This reason is enough for a more thorough analysis of the causes, forms and effects generated by this insufficiently studied phenomenon. Significant gaps also appear according to other criteria, both in urban and rural regions. Hierarchy and administrative status produce distortions when it comes to cities, as does the position regarding urban centres with an

important polarizing role in rural localities. In the case of cities, differences are not so significant but, in a seemingly paradoxical way, the evolution of the ageing index was much more accelerated in urban centres with over 50,000 inhabitants (generally county capitals), compared to medium or small cities (Table 5).

At the same time, large communes, with over 10,000 inhabitants, almost exclusively located in the proximity of the main cities, have faced a slower evolution, with rejuvenation trends even in the last timeframe. The transfer of the young urban population to suburban areas is thus certified, enabling connections between the decline of the urban population and the advancement of the ageing process correlated with the formation of metropolitan agglomerations. The compensation of this decline is often complete in the case of the large poles of development (especially the Capital).

Table 5

Evolution of Ageing Index by urban and rural hierarchy

Type of localities, by hierarchy	*Ageing Index*			
	1992	*2002*	*2011*	*2021*
Urban localities over 50 000 inhabitants	0.32	0.71	0.99	1.30
Urban localities with 10 000 - 50 000 inhabitants	0.28	0.55	0.83	1.19
Urban localities under 10 000 inhabitants	0.41	0.66	0.91	1.22
Rural localities over 10 000 inhabitants	0.40	0.60	0.67	0.64
Rural localities with 1 000 - 10 000 inhabitants	0.73	0.94	1.10	1.20
Rural localities under 1 000 inhabitants	1.23	1.72	2.06	2.39

Data source: INS, RPL of 1992, 2002, 2011, 2021.

Contrasts between rural localities are strong, the communes with a smaller number of inhabitants (prone to imminent depopulation) being heavily aged. Low accessibility, the predominantly rural character, and the more dispersed habitat partially explain this contrast, as validated by the factorial analysis.

The study certified the existence of certain regional evolution patterns of the ageing process, the role of the demographic decline having manifested after 1990 as a combination between fertility decline and the increasing international migration, as well as the local manifestation of a resistance, explainable by cultural factors. The factorial analysis proved the prevalence of the demographic factors, the ageing process being part of the perpetual restructuring of the population which is currently disturbed by the completion of the demographic transition. In Romania, this transition overlapped both the economic transition and the European integration which, in all probability, hastened the ageing process. At the same time, in the long term, the massive loss of young generations caused by international migration in recent decades will diminish the impact of ageing, provided that the status of the country changes from emigration to immigration (if possible).

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