# URBAN AGING IN ROMANIA – DYNAMICS, TRENDS AND EXPLANATIONS. A GEOGRAPHICAL PERSPECTIVE

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*Key-words*: urban ageing, multiple transition, regional patterns, typology, Weighted Ageing Index, Romanian cities.

**Abstract**. Urban aging is a generalized phenomenon in developed countries and Romania is no exception. Romanian cities, marked by alert urbanization during the communist period, against the background of forced industrialization policies, have rapidly joined the path of inevitable ageing in the post-1990. The territorial or hierarchical disparities that have emerged are based on connections with the specific evolution of demographic transition trends or with how society has adapted to the post-communist context (the transition to a market economy, integration into the European Union). This demographic process was favoured by the coincidence of three essential phenomena specific to this context: fertility decline, massive emigration and increased life expectancy. By using official data, processed from the perspective of both descriptive and multivariate statistics, this exploratory study points out the existence of distinct patterns of evolution, explainable by variables such as demographic size, geographical position, the existence of regional or local specificities, etc. The explanatory value of the variables tested to capture the context in which this process evolves in Romanian cities was validated, both from a general and from a regional or hierarchical perspective. The obtained results create a solid basis for deepening the studied process at the local level through case studies that can more accurately reveal how Romanian cities have adapted to the new social-economic context.

## 1. INTRODUCTION

Urban ageing is a global issue (Sciubba, 2020) and refers to the phenomenon which affects those urban areas that experience a significant increase in the number and share of older adults. Developed in the 1980s, ageing studies have established an essential research topic for economic and social public policies (Martin & Preston, 1994). Attempts to issue a theory of ageing have been based on the specific situation of developed countries, where improved health care has led to an increase in life expectancy, depending on geographic, cultural, and socioeconomic contexts (Preston *et al.*, 1989; Michel & Robine, 2004; Murphy, 2017). Thus, many researchers bring forward a contradiction between the theory of the demographic transition and the specific evolution of the aging process, which seems rather dependent on the geographical, political, institutional, and social-economic local characteristics, according to the so-called theory of multiple modernities (Dobrokhleb & Barsukov, 2017). Ageing, in the sense of an increase in the proportion of the elderly, is part of an overall demographic dynamic that "does not coincide chronologically with the transition, starts later and continues for longer" (Laslett & Paillat, 1999, p. 258). Explaining urban aging involves examining various social, economic and demographic factors that contribute to the phenomenon. Some of the key points that could be considered are: *demographic trends*; *migration patterns*; *health and social services*; *economic factors*; *cultural attitudes*; *urban planning*; *community engagement,* and *policy response* (Hoff, 2011). A study by Phillips & Feng (2017) highlights that global urban aging is a major concern, particularly in developing

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countries, where cities are not prepared for the burgeoning elderly population. This trend is normally mitigated in urban areas where young people from rural areas migrate for better opportunities, leaving behind an older population (Stockdale, 2004). But, in the former communist countries, the restructuring of economic activities (in particular the industrial kind) limited such an evolution. The increase in unemployment and cost of living, on the contrary, forced a significant part of the young urban population to migrate abroad (Nemenyi, 2014). The decrease in birth rate and the increase in life expectancy are thus added to the permanent migration of a significant part of the young adult population. This phenomenon is even more obvious in countries such as Romania, with a hesitant, incomplete economic transition that generated very large income disparities compared to Western countries, including after the integration into the European Union in 2007 (Weber, 2020). Economic stability is essential for supporting an ageing population. Urban ageing raises challenges related to healthcare, social services, and infrastructure. Older persons in urban settings often require specialized services for health care, mobility, and social engagement, which can strain existing systems (Rosso *et al.*, 2013). Urban areas may face budgetary constraints that limit the availability of services specifically designed for the elderly, affecting their quality of life. The attitude towards ageing and the elderly can influence how urban ageing is addressed. In some cases, there may be a lack of awareness or stigma associated with ageing, impacting the development of policies and community programs aimed at supporting older citizens. Cities must adapt to the needs of an ageing population by integrating age-friendly initiatives into urban planning. This includes accessible public transportation, recreational spaces, and housing options that accommodate older adults (Buffel & Phillipson, 2017). Urban environments that prioritize walkability and accessible public transport contribute positively to the quality of life of older residents (Clarke, Gallagher, 2013). Research by Rowles (2018) examines the roles of housing availability, emphasizing that affordable housing is crucial for supporting older adults who wish to age in place. Encouraging community engagement and social participation among the elderly can enhance their quality of life in urban areas. Caro and Fitzgerald (2017) found that community engagement initiatives can reduce loneliness and promote active aging, creating social networks that enhance the well-being of elderly residents in urban settings. Programs that foster intergenerational interaction and support networks are vital. The government and local authorities can play a critical role by implementing policies that address the challenges of urban aging, ensuring that the needs of older adults are recognized and met. By understanding these factors, stakeholders can better address the complexities of urban ageing and work towards creating more inclusive and supportive environments in urban settings for older adults. The literature emphasizes the need for age-friendly policies in urban planning, underlining the fact that the integration of adults' needs into urban development plans is essential for creating inclusive cities (Buffel *et al.*, 2020). Urban ageing is a global issue indeed, yet its implications vary by region (de Oliveira *et al.*, 2019). Sokolovski (2020) provide insight into how different countries are addressing urban ageing challenges, emphasizing the need for localized solutions that consider cultural, economic and political contexts. Future research is needed to explore the interdisciplinarity of urban ageing, including factors such as ethnicity, income, and gender.

The geographic view of urban ageing involves analysing how the spatial distribution of population age groups varies within urban areas, and understanding the implications of this distribution for urban planning, services, and infrastructure. The physical-social environment plays a crucial role in determining the quality of life for seniors with implications for residential, social, economic and health dimensions in both urban and rural contexts (Sanchez-González, 2015). Here are some key aspects to consider: *spatial distribution; urban* and *suburban dynamics; accessibility* and *mobility*; *built environment*; *socio-economic disparities*; *cultural* and *community factors*; *policy* and *planning*; *demographic projections*; *environment* and *quality of life*. Urban ageing does not uniformly affect the cities. However, at the intra-urban level, certain neighborhoods may have higher concentrations of elderly residents due to factors such as historical settlement patterns, availability of affordable housing, or proximity to healthcare services and amenities. In many situations, older adults are increasingly moving to suburban areas,

seeking quieter environments, lower living costs, and access to green spaces. This shift impacts the demographics composition of both urban centres and their surrounding suburbs. Geographic considerations are critical when assessing the accessibility of services for older adults. Urban areas with well-developed public transportation systems and pedestrian-friendly infrastructure can better support the mobility of aging populations, enabling them to access healthcare, social-activities and essential services. The physical design of urban spaces influences the quality of life, including for ageing populations. Cities that have an age-friendly design – such as parks, walkable streets, and accessible buildings – can enhance older adults' well-being, while poorly designed spaces may isolate or limit their options. Geographic analysis can reveal inequities in how ageing affects different communities within a city. Areas with higher poverty rates may experience greater challenges related to ageing, such as a limited access to healthcare, social services, and recreational opportunities. The geographic context can shape cultural attitudes toward ageing and community engagement. Neighborhoods with strong social networks and community centres may foster better support systems for elderly residents. Geographic information systems (GIS) and spatial analysis can help policymakers identify areas with significant ageing populations and assess the need for targeted interventions, such as healthcare services, transportation, and housing options that cater to the elderly. Urban planners can utilize demographic projections to anticipate changes in the ageing population over time. Understanding these trends can help with long-term planning and the allocation of resources. The geographic perspective also includes environmental factors, such as air quality, noise, and access to nature, which can significantly affect the health and well-being of older adults living in urban areas. Such a view was synthesized as early as 1986 by Rowles and continued by others thereafter (Warnes, 1990). The evidence of the manifestation of some spatial differentiations underlines the importance of some local and regional factors in explaining the evolution patterns of the structure by age groups (Kashnitsky *et al.*, 2021). Gerontological geography has evolved, with a shift towards a more humanistic approach that focuses on the relationship between the elderly and their environments (Tahara *et al.*, 2003). However, many papers recognize that ageing is highly dependent on the specific times, spaces, and places in which it occurs and that the geographical perspective on ageing raises important questions that have implications for policies and institutions dealing with ageing issues (Lulle, 2019).

Demographic ageing from a geographic perspective encompasses several key concepts. It involves theoretical aspects linked to the demographic transition theory, cognitive aspects focusing on the territorial distribution of ageing levels and dynamics, and application aspects related to socio-economic consequences and projections (Kurek, 2007). The spatial distribution of ageing populations and their migration patterns are crucial aspects, with studies examining rural-urban migration, counterurbanization, and international migration (Nash, 1994). The presentations of results in the urban ageing analysis from a geographical perspective includes theoretical frameworks, spatial distribution patterns, and socio-economic consequences. In the case of intra-urban studies, it's crucial to use both the ageing population ratio and density measures simultaneously to accurately detect diverse ageing communities (Shiode *et al.* 2014).

Thus, Romania, like other Eastern European countries, is experiencing an ageing population due to low birth rates and increasing life expectancy (Gabor *et al.*, 2022; Muntele & Horea-Șerban, 2024). Romania is experiencing alert population ageing, but research and public policy addressing the needs of the elderly are lacking (Bodogai & Cutler, 2014). Urban ageing in Romania has become a significant demographic challenge. The phenomenon is characterized by an increasing elderly dependency rate and a declining population (Țăruș & Dezsi, 2021). The process began in rural areas, with factors such as demographic change and rural exodus contributing to the ageing population since the 1930s (Muntele, 1994; Muntele, 2024). Recent studies forecast a continuation of this trend, projecting further population decline and increase in the ageing index for urban areas in Transylvania from 2020 to 2050 (Țăruș *et al.*, 2021). The implications of urban ageing extend beyond demographics, potentially affecting the social, cultural, and territorial aspects of Romanian society, requiring further research to fully understand

its impacts and develop appropriate responses (Asandului, 2012) or propose an analysis from the perspective of the concept of resilience (Istrate *et al.*, 2015). Certain studies show a discrepancy between the distribution of the elderly population and that of residential care centres for the elderly, prevailing in large cities and revealing the necessity for optimizing health policies (Matei *et al.*, 2018). Public policies in the field are also discussed from the perspective of smart and age friendly cities (Ivan *et al.*, 2020).

Starting from these theoretical considerations, our study aims to analyse *the dynamics of the ageing process of the urban population* in Romania between 1992–2021, a period during which four population censuses were conducted. The geographical perspective is ensured by *the investigation of regional patterns, territorial differentiations and disparities*, as well as by the analysis of the demographic, economic or spatial characteristics of Romania's 319 centres with urban status. Both a descriptive and a multivariate analysis are envisaged, taking into account a number of relevant factors, within the limits of access to information. Several research questions are considered:

- How has the demographic transition and the transition to the market economy influenced the evolution of ageing in Romanian cities?
- What role did the process of deindustrialization and the integration into the European Union play?
- What is the relevance of the urban hierarchy in the evolution of this process?
- Is the resilience of the population structure in relation to the social-economic profile something to be discussed?
- What triggers the stabilization or even rejuvenation of the demographic structure in certain cases?

All these questions lead to the hypothesis *that*, in line with many of the opinions cited above, *the evolution of the ageing process is strongly dependent on the local context.* The presence of regional patterns is more related to the evolution of the urbanization process, social-economic profile and geographical location. All the more so in the case of societies that have experienced the shock of the fall of the communist regime and the transition from central planning to a free economy.

## 2. MATERIALS AND METHODS

To address the research question, the authors used both information provided by official statistics (censuses and multi-year databases) and observations extracted from cartographic documents. These resources were organized in two separate databases. From a spatial perspective, geographically weighted regression and spatial data analysis are appropriate statistical methods for analysing urban ageing (Lewandowska-Guarda & Antczak, 2020).

One database included the distribution of the population by 5-year age groups in each of the 4 censuses taken into consideration (1992, 2002, 2011 and 2021) for all 319 urban centres in Romania. Additionally, information on the active population (aged 16–64) was also included. This database was used for a descriptive analysis which comprises:

a) A typology of the evolution of the age structure of the population in the chronological perspective of the four censuses. AHC (*agglomerative hierarchical clustering*), provided by XLSTAT, version 2015 (developed by Addinsoft, https://www.xlstat.com/en/), was used to identify the classes. 6 distinct classes were separated, broadly following the trends expressed by the average profile but distinguished by particularities related to the speed of change of some structures, especially as regards the increase in the elderly population. The results were represented graphically and cartographically in order to trace the manifestation of regional patterns of evolution or the influence of the urban hierarchy.
b) An analysis of the dynamics of the active population between 1992 and 2021, which can point out the extent of the ageing process but at the same time the resilience of urban centres to the rigours imposed by the long transition to a market economy, which has entailed major changes in the economic profile (deindustrialization, development of basic or specialized services, etc.).

c) An analysis of the evolution of the ageing index and average age between 1992 and 2021. The ageing index was calculated by dividing the elderly population (aged 65 abd over) by the young population (under 15). The average age was calculated as follows: $X = \frac{\sum(x+0,5)Px}{\sum Px}$, where $X$ is 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 spatial distribution of the values of the two indicators at the beginning and at the end of the study period, as well as their percentage dynamics, were represented, considering the 1992 value as equivalent to 100%.

d) A comparative analysis of the evolution of the population structure by major age groups (0–14, 15–64, over 65) classifiying cities into several categories according to the following criteria: demographic size (based on the initial situation 1992), administrative status, position within the network of urban settlements, dominant economic profile. This analysis deepens the results of the previous analyses and provides additional explanations. The information is summarized in tabular format.

A second database was created for the multivariate analysis using as dependent variable the ageing index, calculated for each of the 4 censuses. For this purpose, 21 indicators and indices with explanatory potential were identified, as displayed in the table below (Table 1).

*Table 1*

Indicators and indices used for the multivariate analysis

| Acronym | Explanation | Data source |
|---|---|---|
| AI | Ageing index: ratio of population aged 65 and over to the population aged 0–14 at each census | Censuses of 1992, 2002, 2011 and 2022 |
| AA | Average age: as set out in the text above | Censuses of 1992, 2002, 2011 and 2022 |
| BA | Bottom ageing: the difference between the average birth rate of the last intercensal period weighted by the national average, and the decline in the average birth rate of the last intercensal period compared to the penultimate period (1977–1992, respectively 1966–1977 for 1992; 1992–2002, respectively 1977–1992, etc.) | Tempo-Online Database, INS |
| GF | General Fertilty of female population (15–49 years): pre-census values (1977–1991, for 1992, 1992–2001 for 2002, etc.). | Tempo-Online Database, INS |
| MA | Median ageing: average net migration over the last two intercensal periods in promiles (1966–1992 for 1992; 1977–2001 for 2002; 1992–2011 for 2011 and 2002–2021 for 2021), low value equals 1, high value equals 0. | Tempo-Online Database, INS |
| TA | Top Ageing: ratio of 50–64 to 65+-year-olds at each census | Censuses of 1992, 2002, 2011 and 2022 |
| OO | Oldest old: share of the over 80-year-old population in the total of over 65–year-olds | Censuses of 1992, 2002, 2011 and 2022 |
| LEG | Life Expectancy Growth: increase from one census to another (%, 1992 compared to 1977, 2002 compared to 1992, etc.) | Tempo-Online Database, INS |
| NP | Network position: distance to cities of min. 50,000 inhabitants ever reached in this interval (including Miercurea Ciuc, seat of Harghita county). 0=city over 50 thousand inhabitants; 1 = 0–15 km; 2 = 15–30 km; 3 = 30–45 km; 4 =45–60 km; 5 = over 60 km; 0 is given 0.1, 1 – 0.3, 2 – 0.5, 3 – 0.7, 4 – 0.9, 5 – 1) | Road Atlas of Romania (2011) |
| ATN | Access to the transport network: Access to Rail and European road = 1, European Road = 0.75; Rail and National road = 0.6; National road = 0.45; Rail and County road = 0.3; County road = 0.15; Local road =0 | Road Atlas of Romania (2011) |
| AGR | Share of the population employed in agriculture at each census | Censuses of 1992, 2002, 2011 and 2022 |
| ED | Educational index: share of secondary and tertiary education in the population aged 19 and over | Censuses of 1992, 2002, 2011 and 2022; Tempo-Online Database, INS |

*Table 1* (continued)

| | | |
|---|---|---|
| HF | Habitat fragmentation: Population of 1992, 2002, 2011, 2021 divided by the number of localities | |
| MAC | Medical Accessibility: the weighted average of the ratio of the population to the average number of medical staff, i.e. physicians, in 1992, 2002, 2011, 2021 | Tempo-Online Database, INS |
| DNS | Population Density in relation to urban area (inhabitants/100 ha) | Tempo-Online Database, INS |
| DEP | Dynamics of the employed population in each previous intercensal period (1977–1991 for 1992, 1992–2001 for 2002, etc.) | Tempo-Online Database, INS |
| HBD | House building dynamics: Number of dwellings completed in the previous intercensal period relative to the population | Tempo-Online Database, INS |
| FOR | Area covered by forests in 1992, 2002, 2011, 2021 | EVC (2019–2023) |
| ALT | Average altitude: less than 100 m = 1;100–200 m =0.84; 200–400 m = 0.67; 400–600 m =0.5; 600–800 m =0.33; 800–1,000 m =0.17; over 1,000 m =0.01 | DTM |
| GDP | Gross domestic product, estimated for 2021 using socio-professional structure, average wage and other sources of income. | Tempo-Online Database, INS |
| RB | Revenue budget of the administrative unit, in RON/inhabitant (average of 2019–2023) | Tempo-Online Database, INS |
| ART | Accessibility to Retirement Homes: number of institutions per 1000 elderly persons | CPV |

These indicators were first used in a preliminary analysis to test their collinearity and bring down redundancy. Following this analysis, some of the indicators were merged into more complex indices, setting aside for the final analysis a total of 10 variables, the last two for 2020 alone, the reasoning behind it being the lack of information for the previous period (Table 2).

*Table 2*

Variables used in the final multivariate analysis

| *Index* | *Acronym* | *Equivalence* |
|---|---|---|
| Weighted Ageing Index | WAI | 0.666*AI + 0.334*AA |
| Bottom Ageing Index | BAI | 0.666*BA + 0.334*GF |
| Median Ageing Index | MAI | MA |
| Top Ageing Index | TAI | 0.5*TA + 0,25*OO + 0,25*LEG |
| Positional Index | PI | 0,666*NP + 0,334*ATN |
| Urbanity Index | UI | 0,325*AGR + 0,25*EDU+0,125*HF+0,15*MAC + 0,15*DNS |
| Deindustrialization Index | DI | DEP |
| Housing Index | HI | HBD |
| Environmental Index | EI | 0,666*FOR + 0,334*ALT |
| Wealth Index | WI | 0,666*GDP + 0,334*RB |
| Institutional Access Index | IAI | ART |

The choice of a PLS (*partial least squares*) multiple regression was also justified by the fact that it is well suited to multivariate analyses. In the present case, the dependent variable (the Ageing Index as estimated in the previous table) was followed in two distinct sets of analyses: one in which cities were separated into three distinct categories according to size criteria (cities with more than 50 000 inhabitants, cities with 20 000 – 50 000 inhabitants and cities with less than 20 000 inhabitants), and another aimed at identifying the regional specificities at the level of three territorial ensembles that overlap the major historical divisions – north-eastern (Moldavia), southern (Wallachia and Dobruja) and intra-Carpathian (Banat, Crișana-Maramureș and Transylvania) The multivariate analysis thus deepens the observations resulting from the descriptive analysis, providing a more complex picture of the differences recorded in the hierarchical or regional profile.

## 3. RESULTS AND DISCUSSIONS

### 3.1. The evolutional typology of the age structure of the urban population in Romania

The typological analysis separated 6 distinct, unequal classes with a spatial distribution that appears to be rather dependent on the urban hierarchy, although some clusters expressing regional patterns can also be noticed (Fig. 1).

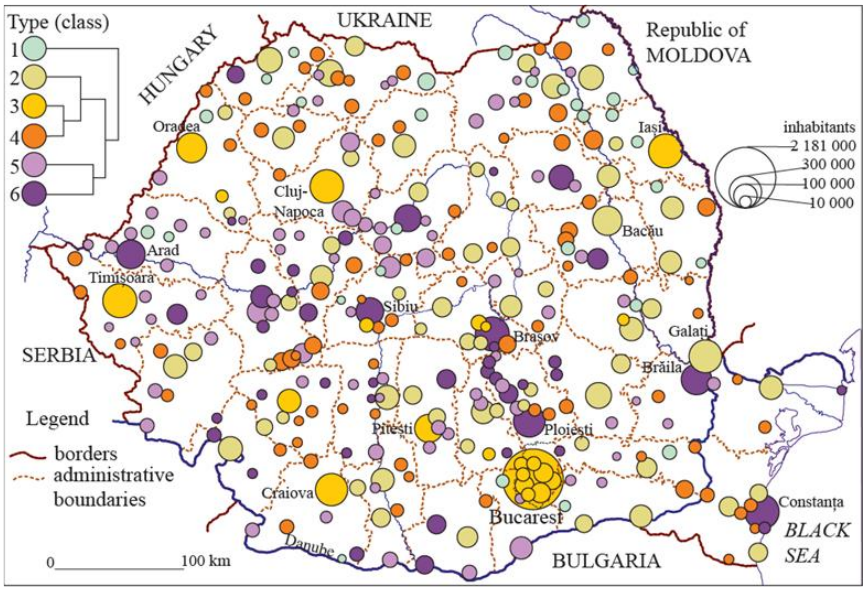


Fig. 1 – Typology of the population age structure (1992–2021).
*Data source*: Censuses of 1992, 2002, 2011, 2021, INS, Bucharest (www.insse.ro).

The class profile shows a strong specificity against the background of the general decrease in the share of young population groups (aged 0–14) and a sometimes rapidly increasing share of the elderly population (over 65 years), as shown in Figure 2.

The first class is less well represented (29 cases out of 319) but interesting because it is characteristic exclusively of small towns, which rarely exceed 10 000 inhabitants. Many of them have recently acquired town status (in 2003–2005) and still show rural features, visible in the evolution profile, marked by the maintenance of a relatively high proportion of young population and a less visible ageing process, plus a lower share of middle-aged groups (25–50 years), due to the preservation of a negative net migration, which affects this category in particular.

Class 2 is much better represented (63 cases), comprising cities located on all hierarchical levels, from large and medium-sized (Galați, Bacău, many county seats) to small ones. Predominantly distributed in the north-east and south of the country, it groups together cities that experienced strong population growth during the communist period, which resulted in a relatively high proportion of young people at the beginning of the analysed period. However, this favorable age structure changed very rapidly, so that by the end of the study period, the elderly population had reached a significant share, while the active population had massively shrunk. This evolution can be regarded as an effect of de-industrialization, which reduced the supply of jobs, leading to a massive migration to rural places of origin (in the 1990s) and, later, to foreign countries. Generally late to the industrialized trend and dominated by heavy or polluting industries, these urban centres can be considered the main victims of transition.

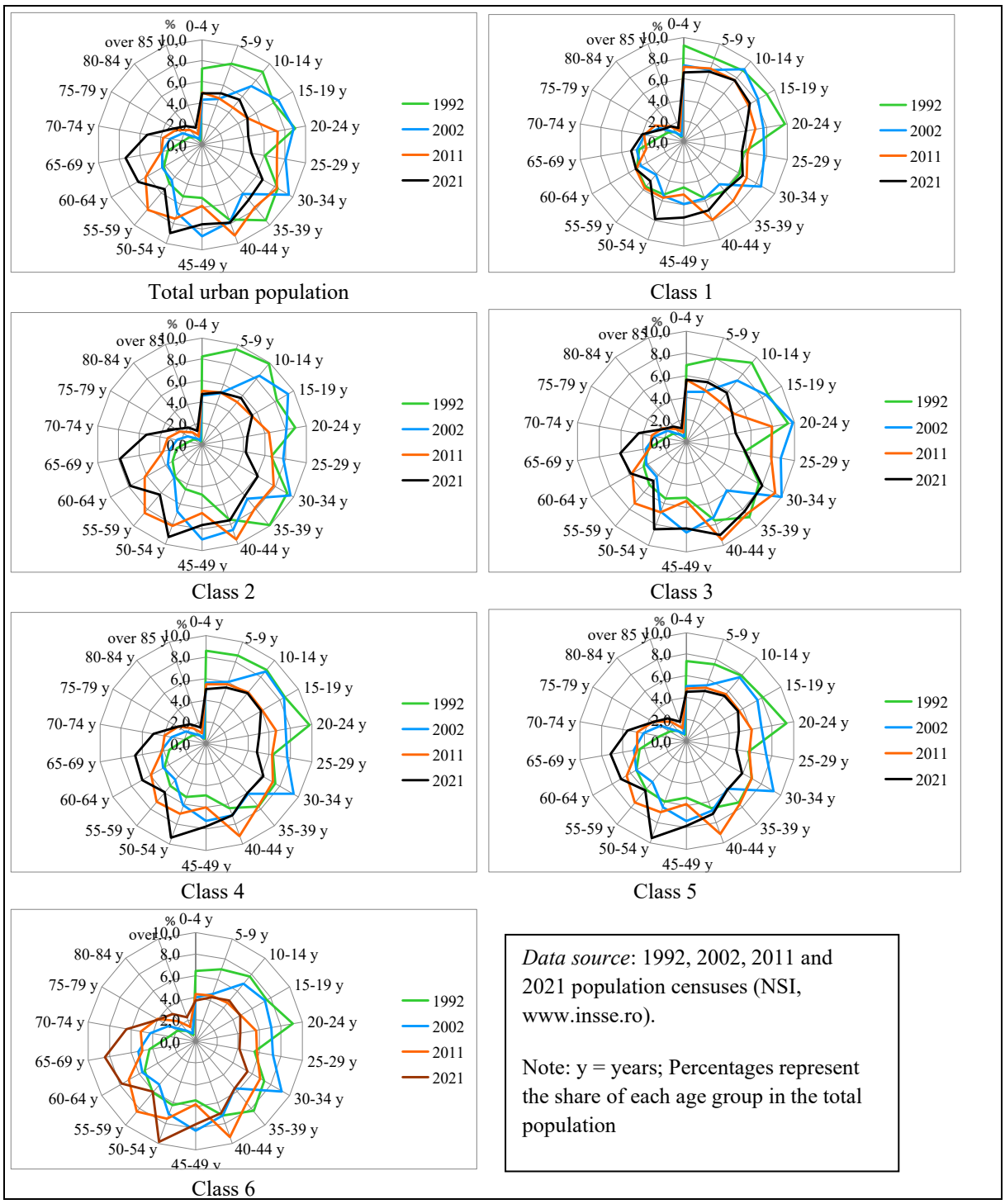


Fig. 2 – Profile of classes (types of evolution).

Class 3 is the least represented, comprising most of the large, dynamic cities (Bucharest, Cluj, Timișoara, Iași, Oradea, Craiova) and a number of towns located mainly in the agglomeration of Bucharest. What sets this class apart is the massive increase in the adult population, especially in the

30–50-year age groups, revealing an increased attractiveness for the population with higher education, the above-mentioned cities being also the main university centres. These cities can be considered the main winners of the transition, despite the reduction in the share of young population. On the other hand, the ageing process appears more mitigated.

Class 4 is much more common (79 cases), grouping together medium-sized or small towns which, like those in Class 2, underwent massive industrialization during the last decades of communism (1970–1989), managing to preserve, through sheer inertia, a lower proportion of elderly people. The transition hit these urban centres, often mono-industrial (as in the Jiu Valley, for example), just as hard, massively reducing the share of the working-age population.

Class 5 is the most well represented (82 cases) and characterizes many small and medium-sized towns where the process of accumulation of the elderly population is a consequence of the early onset of ageing. Whether they are industrial centres developed earlier (in the inter-war period or immediately after the establishment of the communist regime, such as Hunedoara, Mediaș, Turda, etc.), these urban centres are particularly vulnerable in terms of ageing.

Class 6 is relatively well represented (44 cases), grouping very diverse cities, from large (Constanța, Brașov, Ploiești, Arad, Brăila, etc.) to small ones, often clustered in highly industrialized regions (southern Transylvania, Prahova Valley). This class stands out through the sharp fall in the share of young people and the earlier onset of the ageing process which, coupled with the decline in fertility, is facing an accelerated evolution. From this point of view, it is the most vulnerable class.

As this brief analysis shows, the changes in the age structure of the population in Romanian cities depended on the extent and length of the industrialization phenomenon during the communist period. Thus, deindustrialization, with its harmful social and economic effects (unemployment, emigration of young labour force), differently affected urban centres, the most vulnerable being those that faced an early augmentation of the elderly population (even before 1989). The spatial distribution of labor force dynamics in Romanian cities in 2021, compared to 1992, shows a significant correlation with the typology presented (Fig. 3).

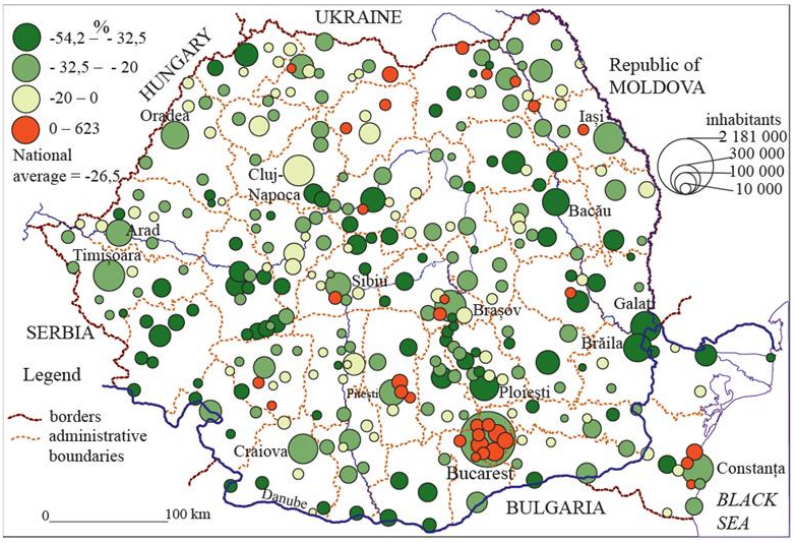


Fig. 3 – Active population dynamics in Romanian cities (1992–2021).
*Data source*: Censuses of 1992, 2002, 2011, 2021, INS, Bucharest (www.insse.ro).

The most drastic reduction characterized classes 2, 4 and 5, mentioned as being strongly marked by communist industrialization. At the opposite pole, the urban centres located in metropolitan

agglomerations (especially visible around the capital but also in Constanța or Brașov) experienced an expansion of the active population, while many small urban centres with a deeply rural character were stable. The same relative stability is also specific for a number of urban centres that seem to have adapted better to the transition, converting from a predominantly industrial profile to one dominated by services (Cluj-Napoca is the most representative, but also medium-sized cities such as Bistrița, Alba-Iulia, Zalău, etc.).

The importance of the demographic criterion, administrative status or economic profile is unquestionable, as revealed by the comparative analysis in Table 3). There is thus a gradual change in the distribution of the population structure by major age groups among the analysed categories.

*Table 3*

Evolution of the urban population structure by major age groups according to demographic size, administrative status, position in the urban network and economic profile

*Data source*: Censuses of 1992, 2002, 2011, 2021, INS, Bucharest (www.insse.ro).

| Year | 1992 | | | 2002 | | | 2011 | | | 2021 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age group | 0–14 | 15–64 | 65 + | 0–14 | 15–64 | 65 + | 0–14 | 15–64 | 65 + | 0–14 | 15–64 | 65 + |
| Demographic size categories (thousand inhabitants in 1992) | | | | | | | | | | | | |
| 2–5 | 23.7 | 66.0 | 10.3 | 19.3 | 67.1 | 13.6 | 16.2 | 69.0 | 14.8 | 14.7 | 64.6 | 20.7 |
| 5–10 | 24.4 | 66.2 | 9.4 | 19,4 | 68.6 | 12.1 | 16.9 | 68.7 | 14.4 | 16.3 | 64.7 | 19.0 |
| 10–20 | 25.3 | 66.5 | 8.2 | 19.1 | 69.8 | 11.2 | 16.5 | 69.3 | 14.2 | 16.3 | 64.7 | 19.0 |
| 20–35 | 26.4 | 66.9 | 6.7 | 18.1 | 72.5 | 9.3 | 15.9 | 71.1 | 13.0 | 16.2 | 64.2 | 19.6 |
| 35–50 | 25.2 | 68.1 | 6.7 | 16.9 | 73.2 | 9.9 | 15.0 | 71.9 | 13.1 | 15.9 | 64.9 | 19.2 |
| 50–75 | 26.6 | 68.0 | 5.4 | 17.1 | 75.1 | 7.7 | 14.9 | 73.8 | 11.3 | 16.1 | 65.3 | 18.6 |
| 75–100 | 27.4 | 67.5 | 5.1 | 17.6 | 74.9 | 7.5 | 14.0 | 74.2 | 10.9 | 15.7 | 65.1 | 19.2 |
| 100–150 | 24.1 | 69.4 | 6.6 | 15.5 | 74.9 | 9.6 | 13.9 | 72.9 | 13.1 | 15.3 | 63.9 | 20.8 |
| 150–200 | 23.0 | 68.7 | 8.4 | 14.9 | 73.6 | 11.5 | 13.2 | 72.1 | 14.7 | 13.9 | 64.4 | 21.7 |
| 200–250 | 24.2 | 69.1 | 6.7 | 14.6 | 75.9 | 9.5 | 12.6 | 74.2 | 13.2 | 14.6 | 64.2 | 21.2 |
| 250–350 | 23.3 | 68.9 | 7.8 | 13.6 | 76.1 | 10.3 | 11.7 | 75.2 | 12.8 | 15.9 | 63.9 | 20.2 |
| Over 2 000 | 21.9 | 67 | 11.1 | 12.6 | 73.7 | 13.8 | 12.4 | 73.1 | 14.4 | 15.4 | 65.2 | 19.4 |
| Administrative status | | | | | | | | | | | | |
| County seats | 24.0 | 68.2 | 7.8 | 14.7 | 74.9 | 10.4 | 13.2 | 73.8 | 13.0 | 15.4 | 64.6 | 20.0 |
| Municipalities | 25.5 | 67.4 | 7.0 | 17.8 | 72.0 | 10.2 | 15.4 | 70.6 | 14.0 | 15.3 | 63.4 | 21.3 |
| Towns in metropolitan areas | 25.0 | 66.4 | 8.6 | 18.6 | 70.9 | 10.5 | 16.6 | 71.2 | 12.2 | 17.7 | 67.5 | 14.8 |
| Towns | 24.9 | 65.9 | 9.2 | 19.7 | 68.2 | 12.1 | 17.2 | 68.3 | 14.6 | 16.5 | 64.8 | 18.7 |
| Economic profile | | | | | | | | | | | | |
| Agro-industry | 24.5 | 64.6 | 10.9 | 20.3 | 66.2 | 13.5 | 18.0 | 67.0 | 15.0 | 17.6 | 64.2 | 18.1 |
| Tourism | 22.1 | 67.7 | 10.2 | 16.7 | 69.7 | 13.6 | 15.1 | 68.6 | 16.3 | 13.9 | 63.6 | 22.5 |
| Mining | 25.6 | 67.3 | 7.1 | 20.2 | 69.8 | 10.0 | 16.2 | 70.3 | 13.4 | 14.6 | 66.7 | 18.7 |
| Transportation | 25.7 | 66.1 | 8.2 | 18.4 | 70.7 | 10.9 | 15.9 | 69.9 | 14.2 | 15.8 | 63.6 | 20.6 |

In terms of demographic size, in 1992, the most favorable structure characterized the medium-sized cities (20–100 thousand inhabitants), favoured by the massive investments of the last decades of the communist period (25–27.4% young population and only 5.1–6.7% elderly population). The capital, which at the time had more than 2 million inhabitants, had the most ageing structure, just like the smallest towns, many of them with a rural economic profile. In 2002, the medium-sized cities preserve their advantage, smaller towns show some resistance while larger cities (over 100 000 inhabitants) experienced a considerable fall in the share of young people, due to the completion of the demographic transition, which was earlier in this category. In 2011, the share of the young population decreases proportionally with the number of inhabitants, while the share of the elderly population is levelling off. At the end of the study period, in 2021, there is a significant increase in the share of the young population in large cities, while the advanced ageing process becomes more and more widespread, affecting mainly some of the large cities (between 100 and 250 thousand inhabitants), many of them subject to the process

of peri-urbanization, which attracts part of the young population to the sprawling suburbs. Also worth noting is the decrease in the potential of the active population, which, after peaking in 2000, has steadily declined, reaching a remarkable uniformity, regardless of demographic size.

The administrative status did not initially appear to be a criterion capable of introducing significant differences between the four categories of cities identified. It was only a relative advance of the elderly population in cities without a major administrative role that could be noticed. However, since 2002, there has been a gradual differentiation between the county seats. They are accumulating more adult population, while also experiencing a stronger decrease in young people. The context in 2011 still seemed to favour the county seats and municipalities but, in the end, the situation turned out to be completely reversed to the initial one, where they had the highest share of older people. The rapid advance of the ageing process in major cities between 2011–2021 shows, on the one hand, a significant increase in life expectancy (the access to medical infrastructure being higher), and on the other hand, the massive loss of young population through emigration or movement to peri-urban areas. This idea is supported by the evolution of those towns which are located in metropolitan areas (less than 15 km away), which are experiencing a relative rejuvenation of their structure and a certain stabilization in the share of the elderly.

In terms of economic profile, the authors took into consideration only the cases where agro-industrial, tourism, mining and transportation activities are predominant. It can thus be seen that towns with an agro-industrial profile have had a higher survival rate, even though they initially had the highest share of elderly population. Towns with a tourist profile stand out through a faster ageing process, although at the beginning they did not differ from the agro-industrial towns. In this case, the influx of pensioners, retired in tourist areas, can be taken into account, especially from the capital towards the Prahova Valley. The mining towns, initially with an extremely favorable age structure, have experienced a sharp decline in the share of the young population and a significant increase in the share of the elderly. At first, the cities specialized in transport activities (ports, railway hubs, etc.) initially had a similar structure to the mining ones, but towards the end, their structure got closer to that of tourist towns, due to the massive shrinking of specific activities (decline of river transport, reduction of rail transport in favour of road transport, etc.).

### 3.2. Ageing index and average age dynamics

The two synthetic ways of expressing the degree of population ageing, used for the standardization required by the multivariate analysis, although apparently redundant, can have a significantly different evolution. In the case of Romanian cities, both indices increased rapidly after 1990 (Fig. 4).

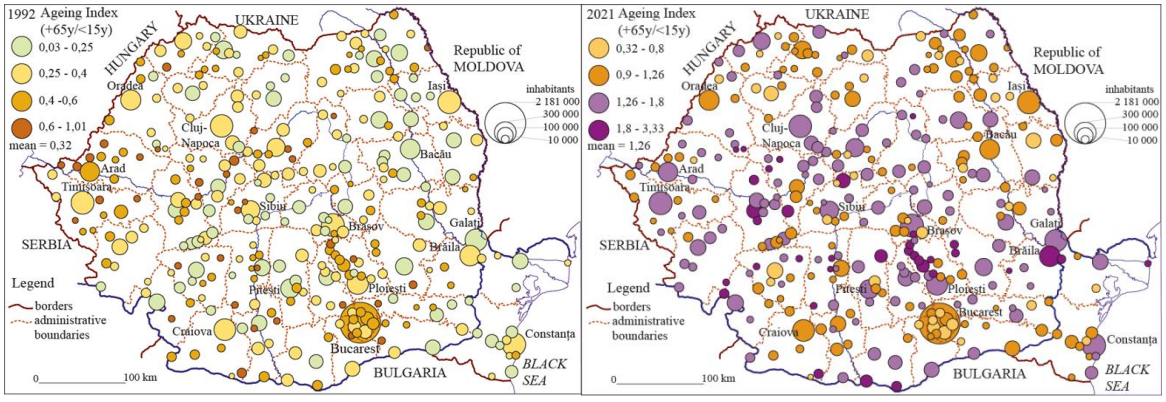


Fig. 4 – Spatial distribution of the ageing index in Romanian cities (1992 and 2021).
*Data source*: Censuses of 1992 and 2021, INS, Bucharest, www.insse.ro

If in 1992 only one town exceeded the threshold of 1 (Bălcești, Vâlcea county, a rural commune at that time), in 2021, only a few urban centres (73) still had values below it. In 2021, quite a few cities had values higher than 2, an indication of a very strong ageing process. In terms of geographical distribution, at the beginning of the study period higher values were concentrated in the western and central-southern part of the country (around the Capital and Prahova Valley), characterizing small towns. Among major cities, Bucharest and Arad recorded the highest values. In 2021, the highest rates were registered either in cities located in strongly industrialized areas (Prahova Valley, southern Transylvania), cities with an agro-industrial profile, or port cities (along the Danube). The lowest values were mainly typical of towns located in the metropolitan area of the Capital.

The dynamics of the ageing index, using 1992 as a benchmark, show a very rapid evolution. A relative stability was specific for small towns with an agro-industrial profile, less affected by the economic reforms of the transition, or for towns located in peri-urban areas (especially around the Capital), which have become very attractive with the motorization of the population (Fig. 5). The strongest dynamics of the ageing process has characterized the cities located mainly in the south and east of the country, which used to be heavily industrialized during the communist period (Galați, Pitești, Bacău are some of the most important cities in this group). A special category is presented by the large cities located far from the capital city (Iași, Cluj, Timișoara) which experienced a moderate growth, as a consequence both of the attractiveness generated by the expansion of IT and services and of their status of nationally reputed university centres.

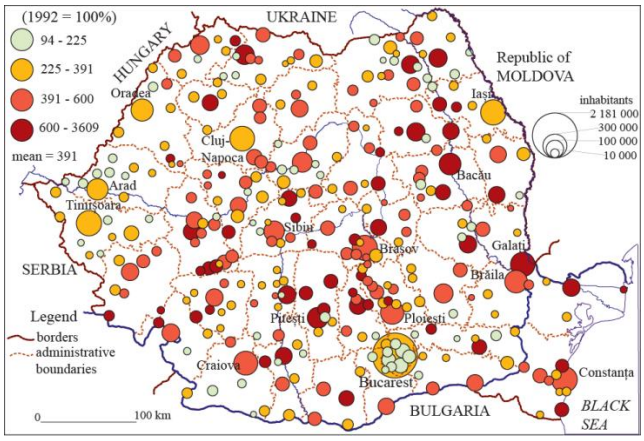


Fig. 5 – Ageing index dynamics (1992–2021, 1992 =100%).
*Data source*: Censuses of 1992 and 2021, INS, Bucharest, www.insse.ro.

A similar picture is provided by the dynamics of the average age. In 1992, there was a significant difference between the north-east and the south-west of the country, with a larger presence of low values in the former (Fig. 6). This disparity can be interpreted as a direct effect of the spread of the demographic transition, which was earlier in the south-west of the country (Trebici, 1986). Small towns in the south-west of the country generally recorded a higher average age than those in the north-east. In the case of large and medium-sized cities there was a certain uniformity, with the exception of the capital and Arad. The spatial distribution of values changed significantly in 2021, similar to the aging index. Thus, the old industrial areas in Central Muntenia and Southern Transylvania stood out though particularly high values, even exceeding 50 years, while urban centres in metropolitan areas or with a predominantly agro-industrial profile preserved their low values. A special case among large cities is that of Iași, which still maintained a favorable level, possibly due to its status as a university centre.

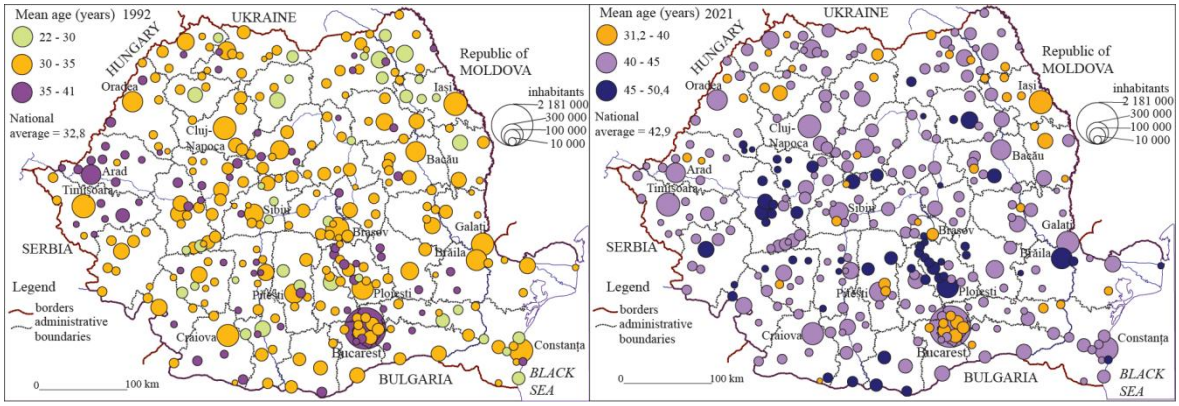


Fig. 6 – Spatial distribution of average age in Romanian cities (1992 and 2021).
*Data source*: Censuses of 1992 and 2021, INS, Bucharest, www.insse.ro

The dynamics of the average age, taking 1992 as a benchmark, provides a picture that is comparable to that of the ageing index, attesting to their redundant character (Fig. 7). The most profound change was experienced by the cities that had undergone a massive industrialization process during the communist period, being either county seats or small towns with a mono-industrial profile (particularly mining). The western part of the country generally stands out through a more obvious degree of stability, just like the area around the capital. Many small urban centres also experienced insignificant changes, against the background of a predominantly agro-industrial profile or of their integration into metropolitan areas. This validates the importance of the deindustrialization that accompanied the transition to the market economy in the acceleration of the ageing process. This phenomenon, characteristic of post-socialist towns and cities on the whole, marked by what some authors call „urban shrinking" (Turok & Mikhnenko, 2007; Steinführer & Haase, 2007), unevenly affected the Romanian urban centres, the most favoured being those that developed the ability to adapt more quickly to the requirements of the market economy. In this context, the large cities, with a more diversified profile of their economic activities, receptive to contemporary technological and cultural changes, appear to have best adapted.

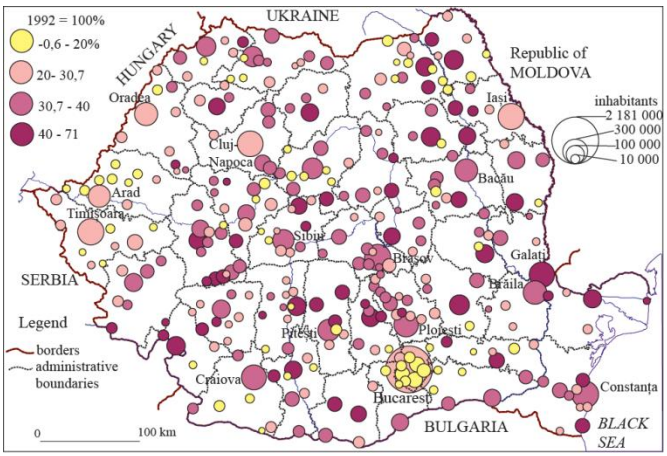


Fig. 7 – Average age dynamics (1992–2021, 1992 =100%).
*Data source*: Censuses of 1992 and 2021, INS, Bucharest, www.insse.ro.

The analysis of the evolution of the ageing index and the average age by demographic size, administrative status and economic profile validates the above remarks. As in the case of the structure

by major age groups, in 1992, the most favoured seemed to be the medium-sized cities (20–100 thousand inhabitants), with a low value of the ageing index and average age (Table 4). The concentration of higher values for both indicators at the top and bottom of the hierarchy was the natural result of the investment in medium-sized and large cities during the communist period, as well as of the policies meant to limit population overcrowding in Bucharest. From one census to the next, however, the distribution of values changes, even reaching a relative standardization in 2021.The fastest evolution was characteristic of large cities with a predominantly industrial profile, in contrast with the capital, which initially recorded the highest values (an ageing index of 0.51 and an average age of 39 years) but which experienced a slower evolution, its attraction potential enabling it to favourably restructure the distribution by age groups. However, the evolution of medium-sized cities was equally alert, especially for those with 75–100 thousand inhabitants, mostly county seats that had experienced a strong population growth in the last decades of the communist period. The evolution of the total and active population is strongly correlated with these structural changes. Very small towns appear to be strongly affected because they often had a mono-industrial profile. However, the strongest decrease in the active population was specific for cities with a population of 100–250 thousand inhabitants, expressing the forced character of communist industrialization, of which they were the main beneficiaries.

*Table 4*

Evolution of the ageing index and average age by demographic size, administrative status, position in the urban network and economic profile
*Data source*: Censuses of 1992, 2002, 2011, 2021, INS, Bucharest (www.insse.ro).

| Categories | Ageing Index | | | | Median Age | | | | 2021 compared to 1992 (%) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1992 | 2002 | 2011 | 2021 | 1992 | 2002 | 2011 | 2021 | Total population | Active population |
| Demographic size categories (thousand inhabitants in 1992) | | | | | | | | | | |
| 2–5 | 0.43 | 0.70 | 0.92 | 1.41 | 34.3 | 37.1 | 40.8 | 43.6 | – 38.6 | – 29.4 |
| 5–10 | 0.39 | 0.62 | 0.85 | 1.17 | 33.6 | 36.3 | 40.4 | 42.2 | – 23.7 | – 21.0 |
| 10–20 | 0.32 | 0.59 | 0.86 | 1.17 | 32.6 | 36.1 | 40.7 | 42.5 | – 29.8 | – 25.0 |
| 20–35 | 0.25 | 0.52 | 0.82 | 1.21 | 31.3 | 35.6 | 40.7 | 42.8 | – 29.4 | – 25.9 |
| 35–50 | 0.27 | 0.59 | 0.87 | 1.20 | 32.0 | 36.4 | 41.3 | 42.8 | – 21.1 | – 21.2 |
| 50–75 | 0.20 | 0.45 | 0.75 | 1.16 | 30.7 | 35.0 | 40.5 | 42.6 | – 34.3 | – 28.5 |
| 75–100 | 0.19 | 0.43 | 0.73 | 1.22 | 30.2 | 35.0 | 40.4 | 43.1 | – 34.7 | –28.2 |
| 100–150 | 0.27 | 0.62 | 0.94 | 1.36 | 32.4 | 36.6 | 41.4 | 43.5 | – 35.3 | – 31.9 |
| 150–200 | 0.36 | 0.77 | 1.12 | 1.56 | 33.8 | 37.6 | 42.2 | 44.6 | – 37.7 | – 31.9 |
| 200–250 | 0.28 | 0.65 | 1.05 | 1.45 | 32.5 | 36.5 | 41.7 | 44.1 | – 35.4 | – 31.4 |
| 250–350 | 0.33 | 0.76 | 1.09 | 1.27 | 33.4 | 36.7 | 40.3 | 42.4 | – 21.6 | – 23.7 |
| Over 2 000 | 0.51 | 1.09 | 1.16 | 1.26 | 35.4 | 39.0 | 41.3 | 42.6 | – 27.0 | – 23.4 |
| Administrative status | | | | | | | | | | |
| County seats | 0.32 | 0.70 | 0.99 | 1.30 | 32.9 | 36.9 | 41.0 | 43.1 | – 23.8 | – 27.8 |
| Municipalities | 0.28 | 0.57 | 0.91 | 1.40 | 32.0 | 36.2 | 41.6 | 44.0 | – 31.5 | – 35.6 |
| Towns in metropolitan areas | 0.34 | 0.57 | 0.73 | 0.83 | 32.9 | 35.6 | 39.2 | 39.9 | 30.7 | 32.8 |
| Towns | 0.37 | 0.62 | 0.86 | 1.13 | 33.2 | 36.2 | 40.4 | 42.0 | – 20.7 | – 21.9 |
| Economic profile | | | | | | | | | | |
| Agro-industry | 0.45 | 0.67 | 0.83 | 1.03 | 34.2 | 36.6 | 40.0 | 41.2 | – 18.8 | – 19.4 |
| Tourism | 0.46 | 0.81 | 1.08 | 1.62 | 34.9 | 38.2 | 42.2 | 44.8 | – 21.1 | – 25.9 |
| Mining | 0.28 | 0.50 | 0.83 | 1.28 | 31.9 | 35.1 | 40.3 | 43.1 | – 28.8 | – 29.5 |
| Transportation | 0.32 | 0.59 | 0.89 | 1.30 | 32.4 | 36.3 | 41.4 | 43.5 | – 29.3 | – 32.0 |

### 3.3. Multivariate analysis

The choice for partial least squares (PLS) multiple regression was guided by the large number of selected variables. As specified in the methodology, in order to avoid redundancy, the preliminary analysis set up 10 synthetic indices, which were analysed as explanatory variables for the Weighted Ageing Index, estimated by calibrating the ageing index with the average age in a 2-to-1 ratio. Three sets of multiple regressions were run, the first one analysed all 319 cities, while the other two were meant to separate size categories and regional urban subsystems, respectively. Thus, the aim was both to validate the proposed model by capturing correlations specific to the Romanian urban system as a whole and to highlight the differences induced by demographic size as well as the regional disparities able to point out the importance of the local context.

The multivariate analysis reveals an interesting dynamic of the correlations between the explanatory variables and the dependent variable (Weighted Ageing Index). The quality of the model is illustrated by the relatively high correlation coefficient ($R_2$), which ranged from 0.351 in 2002 to 0.406 in 2021 (Table 5).

*Table 5*

Matrix of correlations between the Weighted Ageing Index and the explanatory variables

| Variables | BAI | MAI | TAI | PI | UI | DI | EI | HI | WI | IAI | WAI |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1992 ($R_2$ = 0.389) | | | | | | | | | | | |
| BAI | 1 | **–0.513** | 0.023 | **–0.208** | **–0.250** | –0.155 | –0.093 | **–0.275** | | | **–0.255** |
| MAI | | 1 | –0.163 | **0.472** | **0.699** | **0.205** | **0.389** | **0.339** | | | **0.527** |
| TAI | | | 1 | –0.161 | **–0.217** | –0.011 | –0.030 | –0.039 | | | –0.037 |
| PI | | | | 1 | **0.397** | 0.163 | **0.324** | 0.104 | | | 0.191 |
| UI | | | | | 1 | 0.105 | **0.292** | 0.193 | | | **0.539** |
| DI | | | | | | 1 | 0.024 | 0.170 | | | 0.031 |
| EI | | | | | | | 1 | 0.153 | | | **0.274** |
| HI | | | | | | | | 1 | | | **0.332** |
| WI | | | | | | | | | 1 | | |
| IAI | | | | | | | | | | 1 | |
| WAI | | | | | | | | | | | 1 |
| 2002 ($R_2$ = 0.351) | | | | | | | | | | | |
| BAI | 1 | **0.223** | 0.131 | –0.023 | 0.008 | 0.061 | 0.072 | 0.030 | | | **0.527** |
| MAI | | 1 | –0.149 | **0.404** | **0.480** | 0.054 | **0.325** | –0.061 | | | **0.233** |
| TAI | | | 1 | –0.119 | **–0.286** | –0.023 | –0.037 | 0.089 | | | –0.001 |
| PI | | | | 1 | **0.422** | 0.044 | **0.326** | –0.104 | | | 0.134 |
| UI | | | | | 1 | –0.049 | **0.316** | **–0.336** | | | **0.279** |
| DI | | | | | | 1 | 0.025 | 0.114 | | | –0.018 |
| EI | | | | | | | 1 | –0.071 | | | **0.204** |
| HI | | | | | | | | 1 | | | –0.067 |
| WI | | | | | | | | | 1 | | |
| IAI | | | | | | | | | | 1 | |
| WAI | | | | | | | | | | | 1 |
| 2011 ($R_2$ = 0.357) | | | | | | | | | | | |
| BAI | 1 | 0.094 | **–0.365** | 0.142 | **–0.235** | **0.295** | 0.087 | **0.246** | | | **0.515** |
| MAI | | 1 | –0.132 | –0.101 | **–0.406** | –0.039 | –0.073 | 0.024 | | | –0.054 |
| TAI | | | 1 | –0.025 | **0.399** | **–0.224** | –0.007 | **–0.287** | | | **–0.363** |
| PI | | | | 1 | **0.425** | **0.257** | **0.326** | 0.077 | | | 0.135 |
| UI | | | | | 1 | –0.017 | **0.324** | –0.156 | | | 0.013 |
| DI | | | | | | 1 | 0.034 | **0.346** | | | 0.129 |
| EI | | | | | | | 1 | –0.014 | | | 0.197 |
| HI | | | | | | | | 1 | | | 0.092 |
| WI | | | | | | | | | 1 | | |
| IAI | | | | | | | | | | 1 | |
| WAI | | | | | | | | | | | 1 |

*Table 5* (continued)

| 2021 ($R_2$ = 0.406) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| BAI | 1 | –0.057 | 0.033 | –0.062 | 0.061 | **–0.203** | –0.014 | 0.002 | 0.020 | –0.099 | –0.135 |
| MAI | | 1 | 0.018 | 0.129 | **–0.290** | **–0.207** | 0.058 | 0.547 | **0.240** | **–0.200** | **0.578** |
| TAI | | | 1 | 0.094 | 0.098 | 0.003 | 0.153 | 0.085 | 0.034 | 0.055 | **0.230** |
| PI | | | | 1 | **0.442** | 0.062 | **0.326** | **0.320** | **–0.399** | –0.090 | 0.112 |
| UI | | | | | 1 | 0.167 | **0.343** | 0.081 | **–0.617** | –0.172 | –0.177 |
| DI | | | | | | 1 | 0.084 | –0.071 | –0.121 | –0.064 | –0.166 |
| EI | | | | | | | 1 | 0.121 | –0.138 | –0.058 | 0.157 |
| HI | | | | | | | | 1 | –0.099 | **–0.213** | **0.302** |
| WI | | | | | | | | | 1 | 0.087 | **0.299** |
| IAI | | | | | | | | | | 1 | –0.019 |
| WAI | | | | | | | | | | | 1 |

Bottom ageing (BAI), triggered by declining fertility, had a significant negative correlation in 1992, when Romanian cities, although more advanced in the demographic transition, managed to maintain an extremely favorable structure due to the strong attractiveness during the communist period. Earlier studies showed that until 1975, the ageing index of the urban population in Romania was higher than that of the rural population (Measnicov *et al.*, 1977, p. 160). The demographic shock brought about by the transition period, expressed by the sudden drop in fertility (Muntele, 2022), generated a tipping of the BAI correlation to a level indicating a strong correlation in 2002, maintained in 2011 but limited in 2021. It is thus certified that the massive decline in the birth rate, especially between 1990 and 2010, has been the main driver of the acceleration of the ageing process, through the massive decrease in the share of the young population.

Median ageing (MAI) had a different evolution, with significant positive values at the beginning and at the end of the study period, respectively, and a limitation of the impact in beetween. For 1992, the strongly positive correlation expresses the impact of the attractiveness of cities during the communist period, the ones recording negative net migration being, consequently, more exposed to the ageing process. Subsequently, although the 1990s saw a massive rural return migration of the people who had been left jobless by company closures and, after 2000, by the added massive inflow of emigration, through structural inertia, the effect was not immediate, becoming visible in 2021. It can be assumed that the effects of the strong wave of emigration during the past two decades will be felt in the medium-term, despite the return movement that has been noticed recently. Hence, it can be stated that, at present, ageing due to population loss in the middle part of the age pyramid represents, alongside fertility decline, the main cause of the ageing process.

Top Ageing (TAI), generated by the augmentation of the elderly population, had an insignificant correlation, in the context of the slow increasing life expectancy during the communist period. This form of ageing, which is the most important from a statistical point of view, became visible only in 2021, along with the post-2000 strong increase in life expectancy, but also along with the massive accumulation of elderly population deriving from the generations that had settled down in towns during the communist period. It can be assumed that this form will become dominant in the coming decades, as the large number of generations born after 1966 will be over 65. It is worth noting that, over time, this form of ageing has become positively correlated with the degree of urbanization that favors large cities, as defined in Table 2.

The position of cities within the urban and communicational network, as expressed by the PI index, did not exert a decisive influence, being distorted, as previously demonstrated, by the existing territorial gaps in terms of the evolution of the demographic transition, the share of rural-urban migration, etc. The constantly positive value, albeit at the limit of its significance, may indicate an important influence at other scales of analysis, regional or by size categories. This is indirectly proven by the strongly positive correlation between the PI and UI indices.

The urbanity index (UI), which mixed the share of the population employed in agriculture, educational attainment, habitat fragmentation, access to health services, and population density in relation to built space, experienced a downward trend, from a highly positive correlation in 1992 to slightly negative values at the end of the period. Closely correlated with median ageing in 1992 and 2002, towards the end it appears better connected with top ageing and, a fact which seems conclusive, strongly negatively correlated with the level of well-being, expressed by a combination between gross domestic product and per capita budget expenditure.

Deindustrialization (DI) is often blamed for accelerating the ageing process. As a result of the declining attractiveness and shrinking labor market, it seems to have been relatively indifferent. This impression may also be the effect of the generalization of this process. Worth noting is the significantly positive correlation with median ageing in 1992, possibly the effect of reduced attractiveness for the active population with the implementation of the first reforms. Two decades later (in 2011), it is also reflected in the strong correlation with bottom ageing, generated by the massive decline of fertility. The fact that the values of the correlation with top ageing are insignificant or negative for 2011 may also reflect the departure of a significant number of the elderly population, especially to peri-urban areas, but also to their rural places of origin.

The environmental index (EI) expressed by the degree of afforestation and the altitude position (which generally refers to the mountain/plain opposition) also shows an interesting evolution, with positively correlated values which are sufficiently significant between 1992 and 2002. It is possible that this reflects the stronger urbanization of the highlands during the communist period, in order to exploit natural resources. However, for 2021 it shows a reorientation of attractiveness towards those urban centres which provide more favourable environmental conditions. It may also be interesting to discuss the fact that, in the first part (1992–2002), this index was well correlated with median ageing, the cities located in higher areas, especially mono-industrial ones, being more strongly hit by the reforms imposed by the transition to a market economy. It is also noteworthy to mention that, subsequently, environmental quality is more strongly correlated with the positional and urbanity index. A study addressing in detail the importance of environmental factors for structural changes in the urban population could deepen these issues.

HI, the index which express the importance of housing market dynamics (indirectly of land interests, too) is illustrative, although incompletely represented by the evolution of the housing construction sector. Positively correlated with the dependent variable at the beginning and at the end of the period, it explains quite effectively the ability to limit the aging process by permanently attracting the young population which requires new dwellings (a need felt as early as 1992) and the recent evolution which particularly favours large urban centres, with a diversified structure of the job supply. The middle part of the study period, marked by the massive effects of the restructuring of economic activities, including the sharp reduction in new housing construction, has limited the real estate market (even in the case of large cities) to transactions with the housing stock inherited from the communist period. This index may also be subject to distortions due to the fact that many urban centres, apparently in a process of rapid ageing, have experienced a rather strong dynamics of new housing constructions, reflecting the investments made by the people who emigrated to Western European countries, who escaped the records of the latest censuses.

The last two indices (WI and IAI) provide information only for 2021. The degree of well-being (expressed by the WI) appears to be well correlated with the level of population ageing. This may indicate the interaction of such effects as the stronger increase in life expectancy in urban centres with a high level of development and an easier access to health services, etc. The index which ilustrates the access to elderly-care institutions currently gives a contradictory picture, not having an explanatory capacity yet. However, what is interesting in its case is the negative correlation with the degree of well-being, which may induce the idea that such institutions are more likely to be concentrated in cities with a lower level of development but also the possibility that they prefer peri-urban areas, which evade this

analysis. At the same time. It also appears to be negatively correlated with median ageing, attesting to the preference of these institutions for urban centres that are more attractive for the young population, which provide a more active labor market, resilient to the social problems generated by the ageing process.

As shown by the multivariate analysis, some variables have a strong explanatory value, while others have only an episodic or borderline impact. In order to deepen the relationship between the aging process and the analysed set of variables, a smaller scale analysis was carried out, taking into consideration the dimensional categories of cities and the historical macro-regions. Hence, it is possible to highlight certain specificities related to these aggregation criteria (Table 6).

*Table 6*

Correlation of the synthetic ageing index (WAI) with the explanatory variables by hierarchical categories of urban centres and by historical macro-regions

| Categories of cities and towns by size | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Explanatory variable | Small towns (under 20 thousand inhabitants) | | | | Medium sized cities (20–50 thousand inhabitants) | | | | Main cities (over 50 thousand inhabitants) | | | |
| | 1992 | 2002 | 2011 | 2021 | 1992 | 2002 | 2011 | 2021 | 1992 | 2002 | 2011 | 2021 |
| BAI | –0.153 | **0.526** | **0.598** | –0.146 | **–0.351** | **0.688** | **0.353** | 0.030 | **–0.311** | **0.360** | 0.068 | **–0.277** |
| MAI | **0,386** | 0.088 | –0.079 | **0.621** | **0.404** | **0.209** | 0.030 | **0.456** | **0.455** | **0.550** | –0.011 | **–0.322** |
| TAI | 0.001 | 0.006 | **–0.381** | **0.200** | 0.126 | 0.089 | **–0.512** | **0.376** | –0.114 | 0.103 | –0.186 | **0.343** |
| PI | –0.022 | 0.043 | 0.196 | **0.291** | 0.162 | 0.190 | 0.185 | 0.199 | **–0.347** | **–0.369** | **–0.264** | –0.126 |
| UI | **0.440** | **0.249** | 0.025 | –0.137 | **0.207** | 0.155 | –0.044 | 0.058 | **–0.345** | **–0.367** | **–0.236** | 0.066 |
| DI | –0.102 | 0.003 | 0.158 | –0.159 | 0.168 | –0.119 | 0.027 | –0.063 | 0.011 | –0.097 | 0.073 | –0.123 |
| EI | 0.168 | 0.186 | **0.276** | **0.298** | 0.058 | 0.014 | –0.057 | –0.070 | 0.087 | 0.016 | –0.032 | 0.039 |
| HI | **0.272** | –0.032 | 0.083 | **0.297** | **0.329** | 0.093 | 0.172 | **0.472** | **0.435** | 0.142 | 0.108 | **0.279** |
| WI | | | | **0.305** | | | | **0.248** | | | | **0.202** |
| IAI | | | | –0.019 | | | | –0.136 | | | | 0.092 |
| $R_2$ | **0.258** | **0.326** | **0.429** | **0.435** | **0.226** | **0.434** | **0.384** | **0.364** | **0.430** | **0.524** | 0.172 | **0.364** |
| Historical macro-regions | | | | | | | | | | | | |
| | Transylvania (including Banat, Crișana and Maramureș) | | | | Wallachia (including Dobrogea) | | | | Western Moldavia | | | |
| | 1992 | 2002 | 2011 | 2021 | 1992 | 2002 | 2011 | 2021 | 1992 | 2002 | 2011 | 2021 |
| BAI | –0.189 | **0.382** | **0.520** | –0.170 | **–0.317** | **0.629** | **0.484** | –0.030 | **–0.325** | **0.406** | **0.631** | **–0.410** |
| MAI | **0.367** | –0.098 | –0.022 | **0.626** | **0.720** | **0.535** | **–0.206** | **0.567** | **0.631** | **0.395** | 0.196 | **0.696** |
| TAI | –0.068 | 0.083 | **–0.410** | **0.360** | 0.023 | –0.095 | **–0.342** | **0.205** | –0.139 | –0.039 | **–0.458** | 0.020 |
| PI | 0.108 | 0.016 | 0.047 | 0.103 | **0.263** | **0.238** | **0.275** | **0.221** | **0.288** | 0.123 | –0.025 | –0.164 |
| UI | **0,548** | **0.215** | –0.072 | **–0.265** | **0.584** | **0.390** | 0.194 | 0.028 | **0.629** | **0.233** | **–0.203** | **–0.399** |
| DI | –0.060 | **–0.248** | 0.041 | –0.157 | 0.170 | 0.019 | **0.240** | –0.184 | –0.012 | **0.358** | **0.249** | –0.004 |
| EI | **0.207** | 0.104 | 0.081 | 0.058 | **0.333** | **0.235** | **0.263** | 0.199 | **0.314** | **0.368** | **0.328** | **0.248** |
| HI | **0.206** | 0.077 | 0.190 | **0.281** | **0.432** | **–0.275** | –0.016 | **0.307** | **0.339** | 0.039 | 0.157 | **0.367** |
| WI | | | | **0.413** | | | | 0.053 | | | | **0.591** |
| IAI | | | | 0.106 | | | | **–0.236** | | | | **0.261** |
| $R_2$ | **0.248** | **0.282** | **0.312** | **0.512** | **0.572** | **0.527** | **0.436** | **0.293** | **0.428** | **0.404** | **0.355** | **0.558** |

***The size criterion***, which separated three large categories (small towns, medium-sized cities and large cities), relevant also in terms of their polarization capacity, the last category comprising mostly county seats, shows a high level of relevance for the analysis model, with significant $R_2$ values. In the case of small towns and medium-sized cities, the strong relationship with the BAI stands out for 2002 and 2011. This strengthens the massive impact of the 1990 demographic shock, in contrast to larger cities which were better correlated with the MAI in the first part of the study period, expressing a higher sensitivity to the loss of attractiveness at the beginning of the economic transition. Top aging (TAI variables) shows a more important impact for large and medium-sized cities. The towns and medium-sized cities were the most sensitive to the PI (especially towards the end), in contrast to large cities,

which appear to be indifferent, most of them benefitting both from their administrative status, their position as regional and local growth poles. The level of urbanistic development (UI), which appeared to be strongly correlated in the overall analysis, mattered more in the first part, especially for small urban centres, while for the major ones the correlation was predominantly negative. This shows that the access to a higher level of life quality matters for cities which lack adequate infrastructure.

Deindustrialization (DI), as previously defined through the lens of labor market contraction, did not have a particular impact for any of the three categories. The environmental index (EI) has a high, increasing significance, especially for small towns. The new housing cosntruction (HI) index was relatively uniform, with a positive correlation at the beginning and at the end of the period, closely related to the decline in housing activity during the transition, especially before EU integration (2007). The two indices for which information was not available until 2021 showed different patterns. The level of well-being seems to matter significantly, especially for small towns, but there is no conclusive correlation with the access to elderly care institutions.

At the ***macro-regional level***, there are important differences, the model being even better validated than for the size criterion, especially in the south and east of Romania where the $R_2$ values were very high. However, even in the north-western regions there is a constant upward trend in the coefficient. All over the country bottom ageing shows a strong link in 2002 and 2011, when the effects of the post-1990 birth rate decline became obvious. The strongly negative value of the correlation between BAI and WAI in 2021 in the north-eastern part of Romania (Moldavia) underlines the persistence of a certain demographic conservatism in the region, despite the massive emigration. At the regional level, the correlation with MAI is very strong, especially in the south and east of the country, while top ageing (TAI) appears more conclusive in the case of the north-western regions (Transylvania), as an effect of the stronger increase in life expectancy in the last decades (Muntele *et al.*, 2020). The positional index (PI) has a higher explanatory value only in the case of the southern regions of the country (Wallachia), while the level of urban development (UI) has undergone a sharp shift from an initially intensely positive correlation to significantly negative values, especially in the north-west and north-east of the country. This shows that during the communist period, the ageing process was more advanced in the more developed cities than in the late industrialized ones, but after 1990 it lost its relevance. The fact that the most developed urban centres from this perspective appear to better cope with the ageing process can be regarded as evidence of their resilience. While in the other analyses the index used to express deindustrialization (DI) for 2002 and 2011 did not seem to have a high explanatory value, at the regional level it stands out through positive correlations in the south and east of the country. Not coincidentally, they were also more affected by this process after 1990. The fact that in 2021, the impact is low may demonstrate that the Romanian city on the whole entered another phase, practically ending the transition. In the same regions, the environmental index (EI) also has a higher explanatory capacity, expressing the contrast between the Carpathian/sub-Carpathian regions and the plain areas. The new housing construction index (HI) does not show major differences at this scale of analysis, recording a positive correlation at the beginning and at the end of the study period. The WI index exhibits a strong correlation in Moldavia and Transylvania, reflecting disparities between the more developed cities and those lagging behind. In the south of the country, the lack of an explanatory potential from this perspective may be related to the presence of Bucharest. In terms of access to elderly care institutions (old people's homes), Moldavia shows a significantly positive correlation, their distribution appearing to be in line with the degree of population ageing. In contrast, in the south of the country, the correlation is strongly negative, which attests to a mismatch between the supply and demand for these services, possibly distorted by the presence of the capital, which concentrates a large proportion of these services.

## 4. CONCLUSIONS

The results of the descriptive and multivariate analyses converge towards the validation of a positive answer to the research questions, the hypothesis of a significant link between the extent of communist industrialization and the evolution of the ageing process after 1990 being thus attested. The overlapping of the first post-communist decade over the final phase of the demographic transition, which can experience an accelerated growth of the elderly population, derived from numerous generations born in the expansion stage and created unfavorable premises for maintaining a balanced demographic structure (Rotariu, 2014). A fast bottom ageing thus emerged, along with a rapid decline in the birth rate, combined a decade later whith an erosion of the middle part of the age pyramid through massive emigration, which affected especially the cities that had experienced massive industrialization during the communist period.

The analyses revealed a number of nuances related to the capacity to adapt to the new conditions imposed by the transition to a market economy (restructuring of inefficient, energy-intensive industries; unemployment and impoverishment of large parts of the population, the return of many, especially the young, to rural areas, followed by emigration to western countries, etc.). This highlighted the greater resilience of large cities with a more diversified economy and a greater capacity to integrate into international markets, as well as the relative conservatism of many small urban centres, against the background of a ruralization of the population. The hardest hit by the negative post-communist evolution were the medium-sized cities, which had been designed to ensure hierarchical balance before 1989 and had benefited from massive investment in industries which were not always linked to their local resources. Medium-sized cities thus became most affected by ageing, becoming the losing parties of the transition period. Small urban centres integrated into major metropolitan areas, especially around the capital, and they fared best, being favoured by the attractiveness generated by urban sprawl, peri-urbanization and exurbanization processes. There is also a significant difference between specialized, mono-industrial urban centres, agro-industrial towns being less affected by the ageing process, as opposed to those which have a mining, transport or, especially, tourist profile. In the latter case, we can also discuss the migration of the retired, as tourist towns are especially appealing to the elderly.

The multivariate analysis revealed strong correlations between population ageing and the explanatory variables. Median ageing thus seems to have been caused by the process of deindustrialization that generated waves of massive emigration in the second part of the study period. The decline in fertility is strongly correlated with bottom ageing immediately after the fall of the communist regime, while the degree of urbanistic development expresses an increasingly evident correlation with ageing at the top towards the end, demonstrating the importance of life quality. Significant gaps were pointed out in terms of urban hierarchies and regional differentiations, certifying previous research on the drivers of ageing (Jemna & David, 2021).

Large cities have undergone the most complex transformations, having the best prospects for reducing the phenomena that have led to generalized bottom and median ageing, through a slight improvement in fertility indicators and an increase in the share of young adults drawn to job opportunities. In contrast, small towns and medium-sized cities will generally follow the same harmful trends of multiple ageing. At the territorial level, there is an essential gap between the extra-Carpathian (Moldavia, Wallachia) and intra-Carpathian regions (Transylvania, Banat). The cities in the south and east appear to be more vulnerable to the ageing process (which seems to be more aggresive on all levels), while those in the centre and west show a greater capacity to adapt, being less affected by declining fertility or massive emigration. In all cases, however, the overall level of development, as expressed by several variables, is strongly correlated with population ageing. The investigation of a possible link between the ageing level and the presence of elderly care institutions reveals strong regional disparities, with a strong correlation in Moldavian cities, as opposed to the South.

This exploratory study has broadly highlighted, at a detailed level, the manifestation of a phenomenon that will mark Romanian cities in the medium term: population ageing. A structural effect of the accelerated urbanization during communist period, this phenomenon must be known and taken into account by all those involved in local governance. The elderly population should not be treated as a problem which burdens local budgets, but as an economic opportunity. The orientation towards a silver economy thus becomes imperative, as Romanian cities need to adapt to the specific needs of this growing part of the population. The continuation of this general study with case studies, corresponding to the observed evolution patterns, could emphasize much more clearly the extent to which Romanian society on the whole is or is not resilient from this perspective.

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Received January 2, 2025