Using Ageing Index and 3AI for Highlighting Particular Forms of Demographic Ageing, A Case Study on Romania

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***Abstract*—The demographic ageing phenomenon has multiple forms. Among them, the most researched form is ageing at the bottom and at the top. However, it is well known that, in specific situations, secondary forms of demographic ageing may have a similar importance as primary forms. Among them, we mention the share of elderly, especially due to conditions such as migration or through a demographic heritage, which creates gaps between different areas.**

Therefore, the purpose of the present study is to identify these particular forms of demographic ageing. For highlighting the main objective of the present research, two established indicators (Ageing Index and 3AI) have been used and analyzed together. The chosen methodology – linear regression between these variables – proved to be useful and it distinguishes four demographic behaviors, depending on position and spacing of residuals in relation to regression axis. These behaviors are overlapping the territorial-administrative units with a demographic ageing index characterized by (1) extreme overrepresentation, (2) moderate over-representation, (3) moderate sub-representation or (4) extreme sub-representation.

***Index Terms*—Demographic ageing, ageing index, 3AI, linear regression, selective migration.**

I. Introduction

Theories concerning the emergence of the third age, researched since the 80s, have identified the presence of a new structural mechanism for the countries that have completed the phases of demographic transition and they are due to the increasing retired population [1].

From this point of view, the newly demographic structures claim the presence of a structural balance between the generations of 70 and 25 years old. By dividing survivors at 70 by those at 25, we get the so-called Third Age Indicator – 3AI. The indicator assumes that a population does not growing old if this rate exceeds 0.5. The indicator is frequently used in demographic research papers and it is appreciated for its ability to analyze from a comparative point of view the differences of current life between different cultures. Furthermore, it has the advantage of including longitudinal and transversal qualities of most of former demographic indicators [2].

Elderly-related indicators (used before this theory) are uppermost analytic and they point out structural modifications which derive from the effects of reproductive revolution. They plead for demographic ageing pattern and they are seen as a demographic transition effect. Some of these indicators are as follows: demographic ageing indicator, Pearl vitality index, Fritz index, etc.

Many of these indicators seek to determine the balance/unbalance between elderly and teen population. From this point of view, we point out several inconveniences:

- They are dependent on threefold classification according to major age groups of population and defective because they establish a limit highlighting the dichotomy provided by the ageing process, observed from both the bottom and the top of the pyramid.
- They are constrained to use fixed limits between adult and aged/young population, ignoring the trans-generational modifications imposed by the advance of longevity. A series of studies propose different methods for delineating different ageing indexes [3]-[5], considering that there is a sensitive border between adult and old cohort population;
- Another difficulty in characterizing the size of older population from an analytic perspective lies in determining at what age an individual is included in the elderly category [6].
- They cannot intercept the particular characteristics of ageing induced by demographic events that occur within adult population (migrations, breakdowns in demographic profile related to the presence of cohort symmetries, etc.).

The study of demographic ageing through synthetic indicators adds up to the inconveniences presented above. It implies the use of average, median age or methods based on regression functions proposed starting with 60s [7]-[9]. The results obtained from these indicators suggest that using Coulson's methodology is better for demographic masses with low population values. On the other hand, using synthetic indicators involve some of the inconveniences brought along by analytical indicators. They do not point out mechanical or structural causes of demographic ageing (migration, differentiated ageing on ethnic of confessional cohorts, etc.).

Romania as an example in this sense is not stochastic, as this country has experienced – after the communist fall – one of the most accelerated demographic ageing rhythms in the entire world. Furthermore, Romania has faced particular forms of evolution for the profile of age and sex groups. These reasons convert the Romanian experience into an ideal demographic reservoir for the main goal of the paper: extracting particular forms of demographic ageing.

From this point of view, it is well known that Romania is not a unique case for demographic ageing. Life expectancy has remained stable after the fall of the communism (1990), with values around 70 years old. Hence, the Romanian example is similar to the demographic movement for the majority of Eastern European countries, which have faced the

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communist regime.

Even though the patterns of transition towards market economy had different paths, N. Botev concludes that, in these countries, aged population was "the loser of transition" and that Eastern Europe has an atypical demographic background, where population systems observed the phrase "aging without living longer" [10].

These types of behavior are biased by an unexpected growth of mortality, and especially of morbidity indexes, both dependent on the overall demographic pattern specific to each eastern European country. They comprise visible gaps between the age groups of males and females, as well as abnormal values for morbidity, which could only be ascribed to some exceptional conditions, like those generated by wars or pandemics [11].

From this perspective, in Romania, as well as in other countries in Eastern Europe, ageing at the top of the pyramid does not apply. The reason can be found in its position, involving a rapid advance to the category of demographically aged countries as a result of both mechanical and reproductive factors (Fig. 1).

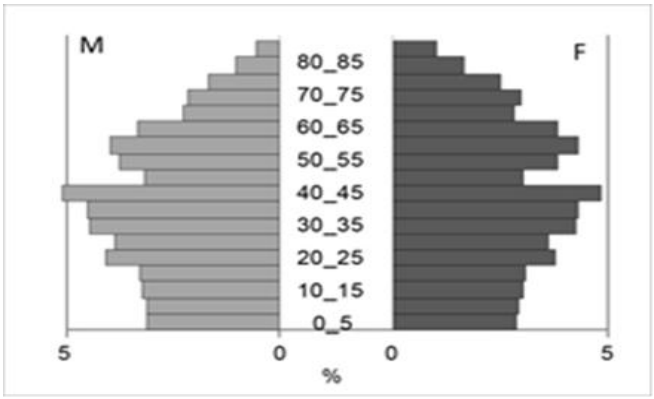

Fig. 1. Age pyramid for Romania (2011)(source: authors).

II. Data and Methods

The main goal of the present research is to identify the particular cases of ageing that cannot be found in the established forms for population ageing (ageing due to reproductive modernization and ageing increasing life expectancy). For attaining our goals, a simple linear regression will be used; the explicative variable is Laslett index and the dependent variable is demographic ageing index.

Considering these statistical operations, the study will take into account the residual results. The residual will confirm the existence of supra-representations or sub-representations forms for demographic ageing. Statistical operations do not have the ability of separating the particular factors, but they have the advantage of pinpointing the synergy between them. Validation of the model will use the graphic solution within the age pyramid, built on each residual situation (both positive and negative). Because each residual type obtained will have two different situations (the moderate and the extreme case), we will have four group pyramids to compare with the general age pyramid (Fig. 1), consequently for the entire population from which the subtypes values have been extracted.

The model will be tested using the data provided by Population and Dwelling Census (2011) (12), and the scale of the territorial units will be the basic administrative units for the country (communes/cities/municipality – LAU2 according to the terminology used by European Commission).

The linear regression model proposed was statistically validated; findings highlight that a large share of demographic ageing (which is separated by the old/young rate) is also explained by the rate from 70 and 25 years old cohorts (Fig. 2).

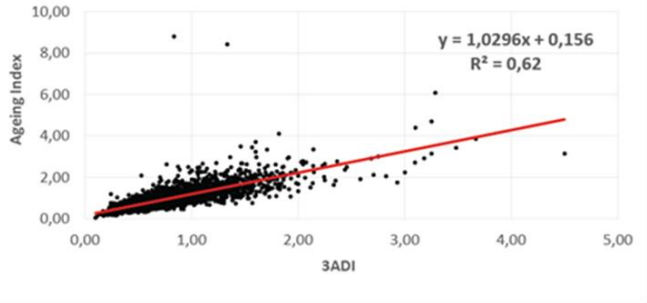

Fig. 2. Linear regression between 3AI and demographic ageing index (source authors).

Notwithstanding, the high value for the r2 (which indicates that 62% of the statistical variation of the ageing index is due to the variation of 3AI) is not the interesting one, but the demographic profile of the communes/cities/municipalities comprising a major deviation from the regression axis. Do these territorial units have a profile and a distinct demographic behavior, which is related to distance and position in regard to regression axis?

III. Results and Discussions

The extraction of the residual space from the regression implies the existence of two extreme situations. On one hand, it highlights the sub-representation demographic ageing model which is separated from the demographic ageing index, an aspect confirmed by the presence of predicted values (low) for the Laslett index (Standard deviation <-1). On the other hand, it can be easily observed the supra-representation of the demographic ageing process, where predicted values of the Laslett index are higher than the statistical model (Standard deviation >1).

Both situations are separated by two distinct situations, according to the explained variable, on demographic ageing case and the ones situated below the limit of demographic ageing (established for the 0.75 from the ageing index values). The main objective of this approach is, therefore, to highlight the presence of the particular behavior process of demographic ageing; it is hard to identify it by using separate analyses for each indicator taken into consideration.

Drawing the structural profile for age group per subtype, through the age pyramid, represents the easiest way of validating the presence of deviations from the structural model taken as baseline (Romanian population in this case).

A. Extreme Underestimation

This type of structural profile (Fig. 3) is generated by the difference between the low values of ageing index and the very high values of Laslett Index. The discrepancy is explained by the presence of some population structures with distinct demographic behavior: ethnic and / or religious structures that were initially a minority in demographic expansion compared to the majority already reproductively modernized, or socioeconomic structures with differentiated appetite for migration. The latter include sequential migration of certain demographic masses having a contraction effect only on certain cohorts, which creates inflections on the age-sex pyramid.

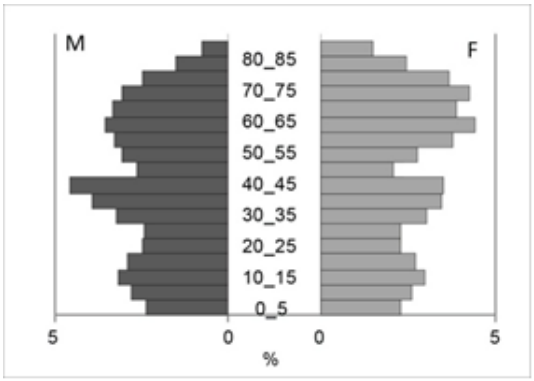

Fig. 3. Population pyramid for localities facing extreme underestimation (source: authors).

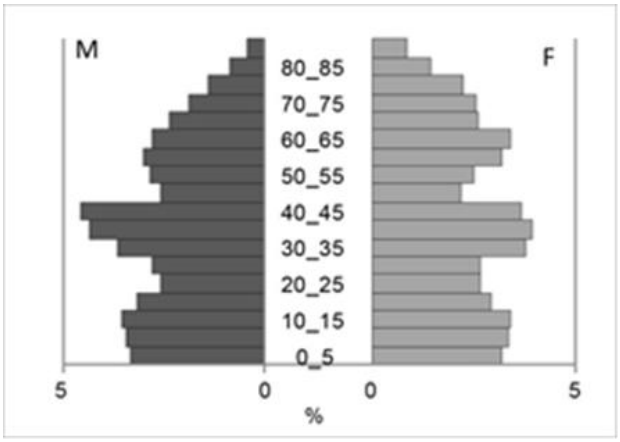

Fig. 4. Population pyramid for localities facing moderate underestimation (source: authors).

The appearance of a rejuvenation at the bottom of the pyramid is inconclusive, being dependent both on the differentiated behaviour of substructures composing the demographic body and on the migration rhythms. Under these circumstances, the translations of demographic masses from the adult to the elderly area corroborated by the generalisation of reproductive modernisation for the future adult cohorts will set up an accelerated regime of demographical ageing during the next 20 years.

B. Moderate Underestimation

Unlike the first subtype of underestimation, in this case, demographic structures are evaluated as being "aged" by both indicators used in the regression, although an underestimation on Laslett Index is identified. The demographic picture of the municipalities included in this subtype is explained by the presence of old forms of migration triggered simultaneously with the reproductive modernisation, but weakened in the recent past (Fig. 4). Under these circumstances, the translation of the current elderly cohorts to the top of the pyramid will coincide with a stabilization of aging process. The underestimation is thus dependent on the dynamic of elderly flows.

C. Moderate Overestimation

The values of ageing index can appear as exaggerated due to variables they takes into consideration, which ignore the importance of positive selective migration. Although relatively similar to the national structural profile, the population pyramid for this group of localities highlights many specific features (Fig. 5):

- The presence of negative irregularities in the age-sex structure, especially for the 45-55 cohorts, which correspond to live births registered between 1957 and 1960 (period of maximum incidence of abortions in Romania);
- The expansion of adult-young cohorts, corresponding to the part of pyramid mostly affected by population inflows generated by migration;
- The oversizing of feminine cohorts older than 75, beyond the average life expectancy of female population in Romania.

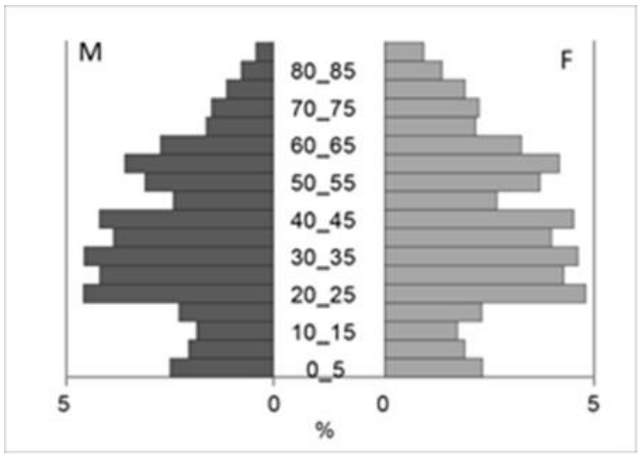

Fig. 5. Population pyramid for localities facing moderate overestimation (source: authors).

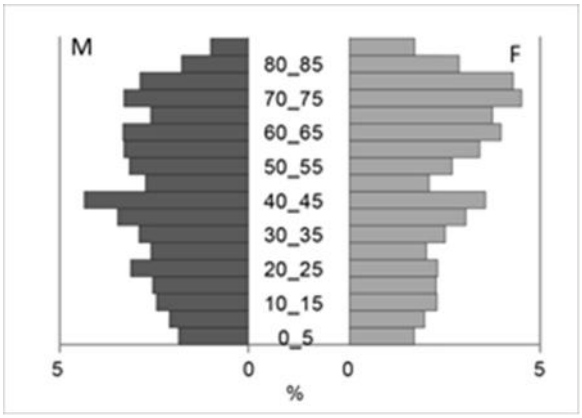

Fig. 6. Population pyramid for localities facing extreme overestimation (source: authors).

These characteristics invoke the presence of demographic properties that were more recently modernized compared to

the stereotype of the Romanian demographic behaviour. These proprieties correspond to positive migration rates and to the central position that such localities assume at national/local level in radiating the demographic modernity. Thus, this class has an urban profile, encompassing Bucharest and some of the regional capitals (Iasi, Cluj-Napoca, Timișoara, and Brasov).

D. Extreme Overestimation

It represents the particular situation of rural localities early affected by ageing due to migration phenomena but experiencing a belated demographic modernisation compared to the national trend.

Although reproductive modernisation is obvious, it was redefined by old forms of migrations (rural exodus) reflected in the structure of the pyramid through cohort effects (Fig. 6). The exit of elder population from the pyramid during the next 20 years will reduce ageing index, but without profound effects on the Laslett Index.

IV. Conclusions

This paper presented a method for identifying particular forms of demographic ageing using linear regression between Ageing Index and Laslett Index. Testing the method in the Romanian case revealed the existence of some specific forms of demographic ageing, extracted by analysing the residuals of the regression:

- Extreme cases of overestimation or underestimation are strongly influenced by the lack of symmetry between adult parts of the pyramid on one hand and the young and old parts of the pyramid on the other;
- Extreme overestimation is specific to predominantly attractive spaces, their demographic route throughout the ageing process being mitigated by positive migration;
- Cases of underestimation require detailed analysis, many of these situations confirming the endurance of some traditional demographic behaviors compared to the national trend. The presence of some subpopulations differentiated by ethnic or confession criteria could be one of the explanations for such deviations.

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