ANALYSIS AND FORECAST OF ROMANIA'S POPULATION AGEING BY NON-LINEAR METHODS[1]

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Abstract

Demographic ageing of population turned lately into an extremely sensible issue, even thorny at times, and with deep impact on all generations and on most fields of economic activity.

Romania, like all other European countries, is faced currently with demographic decrease. Demographic changes in the next decades are susceptible of having significant impact on the development of the Romanian economy. Population ageing, as a whole, affects negatively the GDP increase, by diminishing factor entries. At the same time, this phenomenon has negative impact also on GDP per capita, in particular for the future, mainly because of the decline in the employed population segment. In this context, knowing about the future evolution of the population plays a determinant role in adopting the measures and policies of economic growth.

The paper intends in this stage of research to analyse and forecast Romania's population ageing by using non-linear models.

Key-words: population ageing; indicators of natural population movement; non-linear models; forecasts

JEL Classification: C53, E20, E27, J10, J11

Introduction

In the 20th century, one of the most acute issues of mankind will be the demographic ageing of the population, with important implications on the socio-economic development of the various regions of the Earth. Both in economically developed

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countries, but also in the majority of developing countries, the weight of elderly in the population structure increases at swift rates, imposing the necessity of developing some specific policies in the field.

Population ageing is an important outcome of the social progress obtained in various areas: medicine, quality of life, social protection and is owed mainly to decreases of the mortality rate for elderly and increases in the life expectancy average. At the same time, the changes of the population structure are triggered by the significant decreases of the birth-rate.

The increase in the weight of elderly in the population structure, the change, maintenance and valorising of their functional capacities open new ways for this population group in aspects regarding the economic, social, cultural and spiritual activity.

Nevertheless, population ageing implies also a series of difficulties related firstly to ensuring financial stability of the pension insurance systems, to increasing expenditures for medical care, as well as for providing the conditions leading to valorising the potential of elderly. In this context, the phenomenon of population ageing has drawn increasingly more the attention of societies and of governments.

The last 25 years were characterised by the continuous decrease of the Romanian population. The swift and significant decrease of the birth-rate, the recrudescence of mortality, and a negative external migration have changed dramatically the demographic Romanian landscape. The year 2014 was the 25th year of demographic decline, a period in which Romania lost 1.95 million inhabitants, which means 8.4% of the population registered at the beginning of the nineties.

Romania is among the top 5 member-states of the EU-28 (next to Slovakia, Poland, Latvia and Slovenia) that will have the most rapid population ageing rate in the next decades. The total population age median will be of 46 years in the year 2030 and of 52 years in the year 2060 (according to the information provided by the National Institute of Statistics).

The evolution of the demographic variables in Romania is not an exception from the general trend of the European populations. Here, on one hand, birth-rates, mortality and marriage-rates have increasingly more lower values, and on the other hand the average age at first marriage, the birth of the first child, the frequency of family dissolution, and of consensual unions are all on the increase.

In Romania, the structure on ages of the population bears the characteristic fingerprint of a demographic ageing process, mainly because of the decrease in the birth-rate (9.3‰ in 2013), which triggered the absolute and relative diminishment of the young population (0-14 years of age). In parallel, the increase in life expectancy (71.24 years of age men and 78.28 years of age women) meant an increase in the numbers and weight of the elderly population (65 years of age and over).

At the same time, we witness a decrease in the weight of the young population aged between 0 and 14 years of age from 23.6% (in 1990) to 14.86% (in 2013) and an increase in the weight of the elderly aged 65 years and over, from 10.4% (in 1990) to 15.2% (in 2013). The adult population, aged 15 to 64 years of age increased constantly from 66.03% (in 1990) to 69.97% (in 2013).

For the first time in the last four decades, on 1 January 2012 the weight of young population was equal to the weight of elderly population (15.0%). The elderly population is a heterogeneous entity as it includes the sub-group of “younger elderly”

(65 to 74 years of age), the sub-group of "older elderly" (75-84 years of age) and the very old (85 years of age and over).

If, nowadays, from the 21.26 million inhabitants, 9.3 millions are adults, 5.7 millions are young and children, and over 6 millions are elderly, over 50 years the demographic landscape shall look completely different: pensioners will be more than half of the country's population, the number of adults and children will decrease, and the ages' pyramid will narrow significantly at the basis.

During the last years, is noticed a trend of higher increase in the numbers of "older elderly" (from 816.7 thousands in 1990 to 1.206 millions in 2013), against the sub-group of "younger-elderly" (from 1.47 million in 1990, la 1.74 million in 2013).

The demographic ageing phenomenon is more marked in the rural area than in the urban one. Thus, at the beginning of 1990, the weight of the population aged 65 years of age and over in the rural was of 13.5% from total population and this increased to 18.4% in the year 2013.

A characteristic of the ageing process is the increase in the numbers of women in the elderly population, respectively a process of *"old-age feminisation".* Women are living longer than men, and their numbers are almost twice as high as the number of men.

The present paper presents a brief analysis of the population ageing phenomenon in Romania, and of its determinant factors. The forecast regarding some characteristic indicators of this phenomenon is realised by Markovian methods.

1. Determinant factors of the demographic ageing process for Romania's population

Romania has recorded in the last decades significant changes in the population structure, partly because of undergoing a period of demographic transition, but also because of the political transformations that had a strong influence on the evolution of the demographic phenomena. The demographic transition turned into an increasingly more complex process, being an integral part of the social-economic process of modernising the society as the interdependency between demographic variables and socio-economic variables became more and more marked.

The changes occurred after 1989 within the political system, in the economy, in the social life and in the mentality of the population have influenced the demographic behaviour of the latter. In the first stages of the current process of demographic transition, the decrease in the birth rate was the most significant while, as the process reaches last stages, the diminishment of the mortality rate, especially for old ages, will contribute to increasing numbers of elderly and, implicitly, to an accelerated process of ageing. The effects of the ageing process are already felt in Romania, as of 1 January 2000, when the elderly exceeded in numbers and as percentage the young population.

1.1 Characteristics of population ageing in Romania

The demographic situation in Romania is not an isolated case in the European context. All countries in economic and social transition have crossed and still undergo a demographic crisis. The deterioration degree of the demographic component is more important than in Romania in several European countries. Moreover, worrying and concern-raising developments are encountered also in the developed European countries, and the most recent forecasts of the UN Population Division outline a sombre demographic landscape for all European populations in the first half of this century. There are, certainly, triggering factors and common mechanisms for the deterioration of

the demographic situation in the European countries, and this reality cannot be neglected when analysing the demographic situation of Romania.

The population ageing process began in Romania 4 to 5 decades later than in the other western European countries.

Romania underwent during the last decades significant changes in the population structure, partly as outcome of the demographic transition period, and because of the political changes which had a strong influence on the evolution of the demographic phenomena. The demographic transition became an increasingly more complex process, as integral part of the social-economic development process, and of modernising the society because the interdependency between the demographic and the socio-economic variable becomes increasingly more marked. The projection of Romania's population, based on the hypothesis of maintaining the current conjectural birth-rate index (1.3), outlines an inevitable demographic downtrend which will be complete after the years 2025-2030 as the generations which are numerically smaller turn 20 to 40 years of age, respectively all generations born after 1989. The forecasts realised by Eurostat indicate also that Romania's population will be of 19.6 million in the year 2035 (a decrease by 8.4%) and of under 17 million people in the year 2060 (a decrease by 21.0%).

During the last 6 decades, Romania's population ageing became more marked, the number of elderly being almost doubled (15.4% in 1989 against 7.4% in 1930), and the most pregnant ageing phenomena being observed for women.

The decrease of mortality and the increase in life expectancy have led initially to a growth of the natural birth-rate and to a break in the traditional balance over-mortality and over-birth-rate. A population which increased numerically had to face the lack of subsistence means, which led to rationalisations, individual mobility and new attitudes towards life, birth control and reduction in the number of births.

Low mortality and fertility have changed the dependency relationship and led to the population ageing phenomena. Thus, in Romania, the population aged 0 to 14 years of age decreased from 33.4% in 1930 to 26.7% in 1980 and 18.3% in 2000 while the population over 60 years of age increased from 7.4% in 1930 to 13.3% in 1980, and 19.1% in the year 2000.

The beginning of Romania's depopulation was in 1990, when 23 million inhabitants were recorded, while in 2013 there were only 20 million inhabitants registered. Intensive emigration, the decrease in the birth-rate, and the increase of mortality had as outcome a natural population deficit which is even older than fifteen years ago. The population aged 65 years of age and over increased from 1990 up to 2004 by 4.2% in parallel with the decrease in the share of population represented by children and youths.

The demographic downslide of Romania in the nineties and in the first years of the 21st century has extremely complex causalities, being the direct or indirect outcome of the entire political, economic and social context of the transition. The economic factor has its incontestable role, but the contribution of other factors of non-economical nature and with independent, objective action or modelled by the new economic and social realities of the Romanian society cannot be underestimated.

Even if the demographic ageing degree is still somewhat smaller in Romania than in other western European countries, if we take into account the rate of the process and its mechanisms, it can be stated beyond any mistake that in but few years Romania's population will be more aged demographically than the one of developed countries. Romania is part of an ageing, demographically affected Europe, and with a population that no longer ensures its own replacement rate by voluntary under-fertility and which

is not far from an installed general demographic decline. What particularises the country is only a certain advance in this general negative context.

In the period 1990 – 1997 was recorded the highest decrease of Romania's population, respectively by over 650 thousand persons. At the same time, in Romania, the process of demographic ageing became more marked in the last decade. If in 1998 the total population was diminished by about 1.5% against the year 1990, the population aged 60 years and over registered an absolute increase by 500 thousand persons. At the same time, the weight of the population aged 0 – 15 years decreased from la 25.3% to 20.9%. The decrease in the numbers and weight of the young population and the increase of the elderly population is the most striking shift of Romania's population structure in the last decade. Demographic ageing corroborated with the low birth rate shall generate most toughest effects on the labour force cohorts and structure of the future, on the economic dependency index and on schooling, as well as on the budget and on the social insurance system.

The deterioration of the demographic phenomena in Romania is characterised by the decrease in the number of live-births, the increase in mortality, and the existence of a natural negative birth increase. The diminishments of the birth-rates have an important role to play regarding Romania's decreasing population. The effects of this negative trend, registered in the years 1992-1997 became even more marked after the year 2010, when the generations born in this period reached ages when the fertility is at its highest.

The average life-expectancy of the population diminished from 69.8 years in 1991 to 69 years in 1997. The dynamics of Romania's demographic indicators for the last decade is the effect of two processes of different nature. On one hand, it is the sudden reaction of the population to a series of previous constraints, which was reflected directly in: i) severe decrease of the birth-rate after 25 years of imposed increases based on the enforcement of legal provisions to this end; ii) the explosion of the external migration in the years 1990-1991. On the other hand, it is an effect of the economic-social changes from this period.

Another factor that contributed to the decrease of Romania's population is also the external migration which constituted and still constitutes (even if to lesser extent) another reason, of particular importance with respect to population decline. After the migratory explosion of the years 1990 and 1991, external migration tends to stabilise around the figure of 19 to 20 thousand migrants annually. If we consider return (repatriations) migration as well, of about a few thousand individuals yearly, the balance of external migration is lower. On this background, the most striking phenomenon is the increase in the weight of emigrants aged 26 to 40 years of age as these represent, by and large, a better trained population, with significant working capacity and creative potential.

2. Non-linear models for the forecast of population's evolution

One of the most important issues of mankind in the 21st century is the one of population's demographic ageing. This will trigger significant changes in the socio-economic development in various regions of the Earth. Both in economically developed countries, but also in developing ones, the weight of elderly in the population structure increases rapidly.

The demographic trends at world and, implicitly, at European level indicate longer and healthier life-spans and bring into discussion topics such as the new costs for an ageing society, the equity between generations, the higher importance granted to child

nurturing and to the work/life balance in fostering family life, the relationships between generations and the new poverty threat (Giesecke J., Meagher G.A., (2009).

Romania is faced already with the complex economic and social consequences of a population in a slow, but continuing process of demographic ageing (Trian, R., 2009). As result of population ageing, the contribution of the workforce to GDP increase diminished and, as result, next to other factors, the potential GDP of Romania decreased to 1.3% in the year 2013 against 5% in the year 2004. Also, the increase in the expenditures for social assistance and health led to growing pressure on the state budget, while the population ageing increases the weight of households with a low rate of savings.

The severe demographic imbalance of the country triggers severe economic and social imbalances: on the labour force market, within the pensions' system, in the one of the healthcare services, in education, in the general social protection system, and in the system of budgetary incomes and expenditures, etc. to name but few. The determinant factor for defining and structuring a viable strategy for the sustainable development of the country, the country's population, must remain the core element on which the entire attention of the decision factors should be focused, and the one of the entire Romanian society, as well.

The demographic projections have been always a fundamental instrument in elaborating economic and social development programmes and strategies

The use of some non-linear models allows for estimating the consequences of demographic ageing on some macroeconomic indicators. Knowledge about the evolution of labour resources and the active population is necessary for substantiating the economic and social development programmes.

2.1 Analysis and forecast of demographic evolution based on Markovian techniques

The specialised literature comprises an impressive number of various types of models by which is attempted, among others, to evaluate the stage at which is the population from a certain area, to determine the impact of various factors on some characteristic indicators of the demographic phenomenon, and to population forecast on short-, medium-, and even long-term (Ratitch B. and Precup, D., 2001; Klock, F. and Nimmer J., 2010; Krolzing, H.M., 2000).

❖ Brief theoretic formulation of the Markovian-type model for studying, analysing and forecasting demographic phenomena

Probabilistic models are elaborated, in general, under two forms: a first category using the variable discreet "time" and a discreet age scale, and another category where time is a continuous variable, as is the age scale.

In the stochastic model, with discreet time, used for analysing and forecasting the demographic phenomenon, a series of assumptions are made, respectively:

- Female population census (called population *F*) is realised at discreet time intervals, $n = 1, 2, 3...$;

- This population is divided into *k* age groups, $k \in Z^*$;

- The number of women in the age groups at the time *n* is given by the random variable $\eta_n(j)$. As result, the moment and dispersion of the random variable becomes: $\mathbf{E}\eta_n(j) = M_{j,n}$ and $\mathbf{D}\eta_n(j) = D_{j,n}$

- If a member of the age group j at the time *n-1* gives birth to a girl at the time

n, then the number of women in the age group 0 at the time *n* whose mothers were included in the age group *j*, is a random variable $\eta_n^{(j)}(0)$, cu $\eta_n(0)=\sum_{j=0}^{k}\eta_n^{(j)}(0)$;

- The probability p_j that a person from the age group j at the time *n* will be in the age group $j+1$ after one unit of the time interval is fixed and for which $j<k$ is positive, and $p_k=0$. These probabilities are assumed as independent, thus $q_j=1-p_j$;

- The probability b_j that a person in the age group j at the time *n* to give birth to a single girl in the time interval (*n, n+1*) and for this girl to be active in the group 0 at the time *n+1*, is fixed and these are assumed as independent. Hence: $d_j=1-b_j$;

- The birth and death processes are assumed as being independent;

- The changes in the structure of the masculine population are assumed as consistent with the assumptions of the constant measurement of fertility $\{b_j\}$;

- Multiple births are ignored.

In the case of a Markov chain with the states 0, 1, 2,...,n, the transition probabilities are given by the relation:

$$p(i,j)=C_n^j\left(\frac{i}{n}\right)^j\left(1-\frac{i}{n}\right)^{n-j},\ 0\le i,j\le n \qquad (2.1)$$

The state *0* and *n* of the Markov chain are both absorbing.

The form of the transition probabilities given by the relationship (2.1) does not allow for direct calculation of the fundamental matrix of the chain, but provides for the possibility of identifying the general expressions of the transition probabilities in *n* steps, n>1.

If *i* is regarded as a non-absorbing state then, by virtue of the relationship Chapman-Kolmogorov is obtained:

$$p(n,i,j)=\sum_{k=0}^{n}p(n-1,i,k)p(k,j)=\sum_{l=0}^{n-j}(-1)^l C_n^j C_{n-j}^l n^{-j-i}\sum_{k=o}^{n}p(n-1,i,k)k^{j+i} \qquad (2.2)$$

where:

$$p(n,i,j)=\sum_{l=0}^{n-j}(-1)^l C_n^j C_{n-j}^l n^{-j-i}\mathbf{E}_i\left(X^{j+i}(n-1)\right) \qquad (2.3)$$

Which means that, in order to determine $p(n,i,j)$ is enough to know the first order moments *n* of the random variable *X(n-1).*

If it is considered, as well, for the proposed analysis that:

- λ and μ are discreet random variables with integrally positive values;

- $\lambda_1^{'}$ and $\lambda_2^{'}$ are random variables with binomial distribution $B(\lambda_1^{'},p_1)$, $B(\lambda_2^{'},p_1)$ and conditioned by λ.

By using the relationships:

$$\begin{cases}\mathbf{E}\lambda_1^{'}=p_1\mathbf{E}\lambda\\ \mathbf{D}\lambda_1^{'}=p_1^2\mathbf{D}\lambda+p_1q_1\mathbf{E}\lambda\end{cases} \qquad (2.4)$$

with $E\left(X^{l}(n)\right)=\mu_i^{l}(n)$

$$\begin{cases}\operatorname{cov}\left[\lambda_1^{'},\lambda_2^{'}\right]=p_1p_2\mathbf{D}\lambda\\ \operatorname{cov}\left[\lambda_1^{'},\mu^{'}\right]=p_1p_2\operatorname{cov}\left[\lambda,\mu\right]\end{cases} \tag{2.5}$$

where $q_1=1-p_1$, the Markovian demographic model becomes:

$$\begin{cases}\mathbf{E}\,\eta_{n+1}(0)=M_{0,n+1}=\sum_{j=0}^{k}b_jM_{j,n}\\ \mathbf{E}\,\eta_{n+1}(1)=M_{1,n+1}=p_0M_{0,n}\\ \mathbf{E}\,\eta_{n+1}(2)=M_{2,n+1}=p_1M_{1,n}\\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\\ \mathbf{E}\,\eta_{n+1}(k)=M_{k,n+1}=p_{k-1}M_{k-1,n}\end{cases} \tag{2.6}$$

By using the relationships (2.4) and (2.5) we obtain:

$$\mathbf{D}\eta_{n+1}(j+1)=D_{j+1,n+1}=p_j^2D_{j,n}+p_jq_jM_{j,n},\ j\geq 0 \tag{2.7}$$

$$\begin{cases}\operatorname{cov}\left[\eta_{n+1}(j+1),\eta_{n+1}(h+1)\right]=p_jp_h\operatorname{cov}\left[\eta_n(j),\eta_n(h)\right]\ ,\ j,h\geq 0,\ j\neq h\\ \operatorname{cov}\left[\eta_{n+1}^{(j)}(0),\eta_{n+1}(h+1)\right]=b_jp_h\operatorname{cov}\left[\eta_n(j),\eta_n(h)\right]\ ,\ j\neq h\\ \operatorname{cov}\left[\eta_{n+1}^{(j)}(0),\eta_{n+1}(0)\right]=b_jb_h\operatorname{cov}\left[\eta_n(j),\eta_n(h)\right]\ ,\ j\neq h\end{cases} \tag{2.8}$$

$$\mathbf{D}\eta_{n+1}^{(j)}(j+1)=b_j^2D_{j,n}^2+b_jd_jM_{j,n}\ ,\ j\geq 0$$

If by definition, $\eta_{n+1}(0)=\sum_{j=0}^{k}\eta_{n+1}^{(j)}(0)$, then,

$$\begin{aligned}\mathbf{D}\eta_{n+1}(0)=\sum_{j=0}^{k}\mathbf{D}\eta_{n+1}^{(j)}(0)+\sum_{j\neq h}\sum\operatorname{cov}\left[\eta_{n+1}^{(j)}(0),\eta_{n+1}^{(h)}(0)\right]=\sum_{j=0}^{k}\left(b_j^2D_{j,n}+b_jd_jM_{j,n}\right)+\\ +\sum_{j\neq h}\sum b_jb_h\operatorname{cov}\left[\eta_n(j),\eta_n(h)\right]\end{aligned} \tag{2.9}$$

and we obtain:

$$\begin{aligned}\operatorname{cov}\left[\sum_{j=0}^{k}\eta_{n+1}^{(j)}(01),\eta_{n+1}(k+1)\right]=\operatorname{cov}\left[\eta_{n+1}^{(j)}(0),\eta_{n+1}(h+1)\right]+\sum_{j=0}^{k}\operatorname{cov}\left[\eta_{n+1}^{(j)}(0),\eta_{n+1}(h+1)\right]=\\ =b_hp_hD_{h,n}+\sum_{j\neq h}^{k}b_jp_h\operatorname{cov}\left[\eta_n(j),\eta_n(h)\right]\end{aligned} \tag{2.10}$$

The equations (2.6)-(2.10) define completely the recurrence relationships for the average, variance and covariance of the sample which is the subject of the study. Under matrix form, these may be written:

$$\begin{pmatrix}\mathbf{M}_{n+1}\\ \mathbf{V}_{n+1}\end{pmatrix}=\begin{pmatrix}\mathbf{A} & \mathbf{O}\\ \mathbf{B} & \mathbf{AxA}\end{pmatrix}\begin{pmatrix}\mathbf{M}_n\\ \mathbf{V}_n\end{pmatrix} \tag{2.11}$$

where the vector V contains the variance and covariance elements $D_{ij,n}$, and A is a Leslie matrix defined by:

$$\mathbf{A}=\begin{pmatrix} b_1 & b_2 & ... & b_{k-1} & b_k \\ p_0 & 0 & ... & 0 & 0 \\ 0 & p_1 & ... & 0 & 0 \\ . & . & ... & . & . \\ . & . & ... & . & . \\ . & . & ... & . & . \\ 0 & 0 & ... & p_{k-1} & 0 \end{pmatrix}$$

Thus, we obtain the following relationship between variance and covariance:

$$\mathbf{V}_{[n]}=(\mathbf{A}x\mathbf{A})^n\mathbf{V}_{[0]}+\sum_{i=1}^{n}(\mathbf{A}x\mathbf{A})^{n-i}\mathbf{B}\mathbf{M}_{i-1}$$

By noting: $\boldsymbol{\mu}_i^{'}(n)=\left(\mu_i^1(n),...,\mu_i^p(n)\right)$, this relationship allows for matrix writing:

$$\boldsymbol{\mu}_i^{'}(n+1)=\mathbf{C}\boldsymbol{\mu}_i^{'}(n) \qquad (2.12)$$

with **C** as diagonal matrix. As result,

$$\mathbf{E}_i\left(X^{j+1}(n-1)\right)=\mu_i^{j+l}(n-1)=\begin{cases}\mathbf{1}, & daca \quad j=l=0\\ in^{j+l-1}+\sum_{r=2}^{n}\sum_{k=1}^{r}\lambda_r^{p-1}v_r(j+i)u_r(k)i^k & , j+l>0\end{cases} \qquad (2.13)$$

where $u_r^{'}=(u_r(1),...u_r(n))$ is the own vector to the left associated to the own value λ_r

$v_r^{'}=(v_r(1),...v_r(n))$ is the own vector to the right.

Thus, for *j>0* we obtain for the transition probabilities the expression:

$$p(n,i,j)=\begin{cases}C_n^j\sum_{l=0}^{n-j}(-1)^l C_{n-j}^l n^{-j-i}\sum_{r=2}^{n}\sum_{k=1}^{r}\lambda_r^{p-1}v_r(j+l)u_r(k)i^k & , daca\ j\neq n\\ \frac{i}{m}+n^{-n}\sum_{r=2}^{n}\sum_{k=1}^{r}\lambda_r^{p-1}v_r(n)u_r(k)i^k & , daca\ j=m\end{cases} \qquad (2.14)$$

- **Applying the Markovian model to the study of the evolution and the forecast of demographic phenomena**

For the proposed analysis were used the data provided by the National Institute of Statistics (TEMPO online) for the period 2007-2013 and by other publications of the NIS regarding the evolution of the main demographic phenomena.

The used databank contains the following indicators:

- Romania's population on 1st July (yearly);
- Population on large age groups;
- Live-births (in absolute data and as rates per 1000 inhabitants);
- Deaths (in absolute data and as rates per 1000 inhabitants);
- Still-born (in absolute data and as rates per 1000 inhabitants);
- Deaths at less than 1 year of age;

- General fertility rate (number of children born by a women during her fertile period);
- Population from the urban and rural area;
- Emigrants;
- Immigrants.

The study of the evolution and the forecast of the demographic phenomena by the Markov chains methods imply several stages, respectively:

- Calculating the structures for the considered indicators;
- Calculating the transition matrices (transition from one state to another). Each of the computed transition matrices highlights the changes in the structure of each indicator for a certain year against the previous year;
- Calculating the total transition matrix;
- Calculating the transition probabilities matrix (transition);
- Determining the provisioned structure.

The analysis of the demographic phenomena was realised for the historical period 2007-2014, and their forecast was realised for the period 2015-2017.

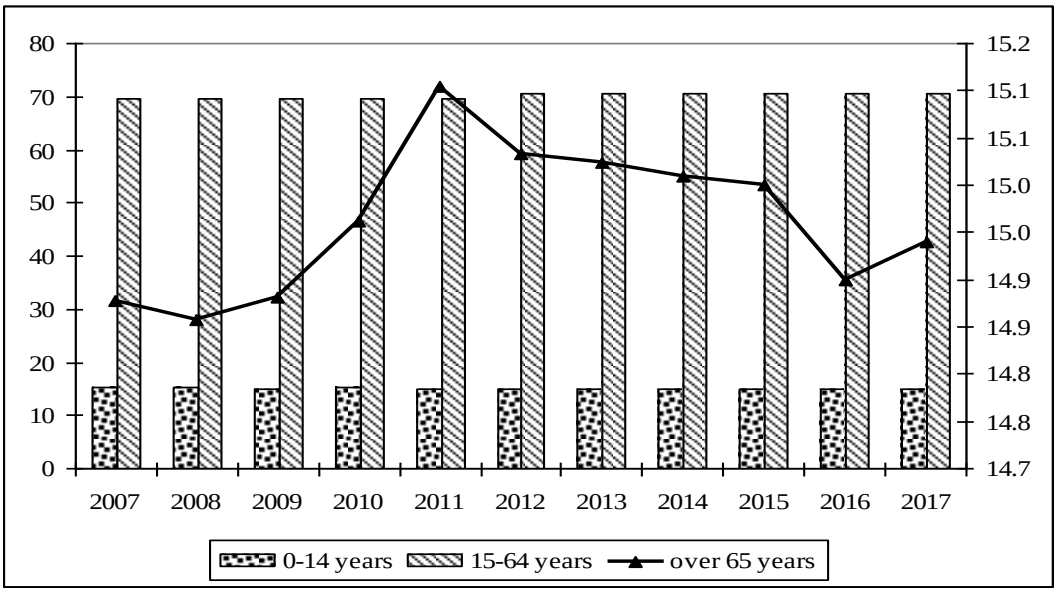
The analysis of the projection by Markovian techniques highlights that after an increase in the birth-rate to 10.4‰ in the year 2009, a decrease takes place to 9.1‰ for 2015 and to about 8.9 ‰ in 2017.

The analysis of the projection by Markovian techniques of the indicator "general mortality rate" highlights that after a slight decrease by 0.3 pp against the year 2012, this will vary for the forecasted period around the value of 11.0‰.

Regarding the stillborn rate, a decreasing trend is highlighted both for the historical period, and for the one of forecasting. If in 2007 were registered 1009 stillborn, their number decreases in 2014 to 771, and for 2017 to about 683. Also, in the case of the indicator "deaths at less than 1 year of age" the scenario realised according to the Markovian modelling highlights a decreasing trend, its weight in total population decreasing from 12.0‰ in 2007, to 8.8‰ in 2014 and to 7.4‰ in 2017.

Regarding the evolution of the population on large age groups, during the historical period 2007-2014, a decrease of about 127 thousand persons takes place for the age group 0-14 years, of 24 thousand persons for the age group 15-65 years, and for the age group 65 years of age an increase of about 9.3 thousand persons takes place in the year 2011, and thereafter the number of the individuals included in this age segment decreases. For the forecast period, diminishments are registered for all population segments (Figure 1).

Figure 1 Population on large age groups in the period 2007-2014 and forecasted values for the period 2015-2017, (%)



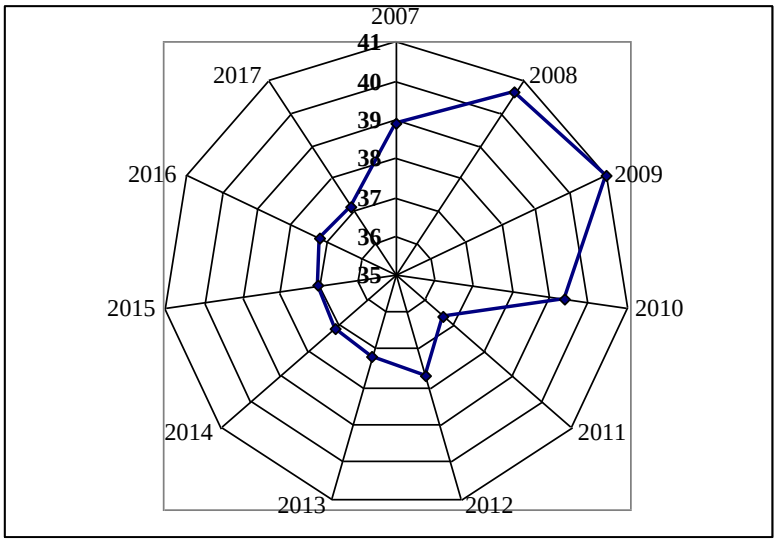
Data source: NIS Statistics, Tempo online database, www.insse.ro, own calculations of the author

This indicates that on short term the ageing process of the Romanian population will continue. To it will contribute also the structure of the migratory flows from the forecasted period.

As exogenous variables in the model were included information related to the number of emigrants and immigrants, as well, but because the historical data regarding their evolution have as source only official bulletins, the forecasted outcomes about the future evolution of these indicators of population movement should be regarded only from the qualitative and not quantitative viewpoint.

Regarding the general fertility rate (the number of children born by a woman during her fertile life) for the period 2007-2014, it has an oscillating evolution with a maximum of 41% in 2009 (Figure 2), followed by decrease up to the year 2011 and, thereafter, a slightly increasing trend is registered. The variation of this indicator for the forecasted period is oscillating.

Figure 2 Evolution of the general fertility rate in the period 2007-2014 and forecasted values for the period 2015-2017



Data source: NIS Statistics, Tempo online database, www.insse.ro, own calculations of the author

In brief, it might be stated that nowadays our concern about the demographic evolution re-emerges because of the risks born by the occurrence of some crises at local, regional, continental or even world level.

Non-linear models allow for a more accurate description of the impact of some factors such as the fertility rate, the birth-rate, the mortality rate or the migration rate on the demographic evolution and, implicitly, on the demographic ageing phenomenon of the population of Romania.

Conclusions

Demographic ageing is firstly the outcome of progresses registered in several fields: economic, social and healthcare sectors which provided Europeans the chance of living longer. The effects of the ageing process on the development of the economic and social life and on future demographic evolutions will emerge in time, triggering disturbances at the level of the school population, of the fertile population and of the working age population.

Romania has known, in the last decades, significant changes in the population structure partly because of undergoing the demographic transition period, and also because of the political changes which had strong influence on the evolution of demographic phenomena.

The speed up of the ageing process, as of 2010, has major relevance for social policies having as objective to guarantee a decent standard of living, in a society with ageing population.

At Romania's level, the phenomenon of demographic ageing displays increased intensity with visible differences at territorial level. The main trends of this process are:

- The decrease in the population numbers by about 14% in the period 1990-2014;
- The increase in the share of elderly (65 years of age and over);
- The diminishment of the population with ages between 0 and 14 years of age;

- A more marked dependency rate and ageing index;
- Significant disparities in the population structure and in the demographic ageing process on genders and environments;
- Visible gaps between Romania and the other member-states regarding social protection expenditures;
- An alarming increase in the number of pensioners, on the background of the reduction in the numbers of employees on the economy; this diminishment determined a continuous deterioration of the ratio pensioners/employees.

The demographic analyses and forecasts on short-, medium- and long-term with the help of stochastic models might be useful in accurately substantiating the development plans and strategies. The demographic changes of the last decades represent an increasing concern at European and national level, as the decision factors at highest levels become aware regarding the amplitude of these phenomena and about the importance of knowing them in order to foresee the future evolutions of the societies.

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