NATALITY IMPACT ON RECENT DEMOGRAPHIC AGEING DYNAMICS IN ROMANIA

Constanta MIHAESCU
PhD, University Professor, Statistics and Econometrics Department
University of Economics, Bucharest, Romania

E-mail: cmihaesc@yahoo.com

Ileana Gabriela NICULESCU-ARON
PhD, University, Senior Lecturer, Statistics and Econometrics Department
University of Economics, Bucharest, Romania

E-mail: gabriela_aron@yahoo.com

Dana PETRE (COLIBABA)[1]
PhD, University Professor, Statistics and Econometrics Department
University of Economics, Bucharest, Romania

E-mail: dana@ase.ro

Abstract: *The decrease of Romanian natality after the abrogation of the pronatalist-coercive legislation at the end of 1989 was a natural and expected reaction. The surprise was generated by the speed and the magnitude of the fertility decrease and, thus, of the natality, which not even the specialists managed to predict. In this paper we elaborate a statistical model, which evaluates the impact of this evolution on the acceleration of the demographic ageing process.*

Key words: *Demographic ageing; fertility decline; statistical model; age distribution; population decrease; young population; elderly people; population dynamics*

Introduction

The decrease of Romanian natality after the abrogation of the pronatalist-coercive legislation at the end of 1989 was a natural and expected reaction. The surprise was generated by the speed and the magnitude of the fertility decrease and, thus, of the natality, which not even the specialists managed to predict. If in the ninth decade the generations were frequently above 350 thousand live births, with natality rates of over 16‰, after 1990 the statistics accustomed us with highly diminished effectives and rates that gravitate around 10 live births for 1000 inhabitants (see Figure 1). Only six years after the liberalization of abortion, the natality fell to 237 thousand live births, only to decrease even further, after another six years, in 2002, to reach the smallest generation in the modern demographic history of Romania (210,520 live births and a rate of 9.7 live births for 1000 inhabitants). The most recent data show a slight vivification of the phenomenon, with a stabilization tendency. During each of the last five years came into the world larger contingents that varied between 214 thousand and almost 222 thousand live births and the rates exceeded the threshold of 10‰.

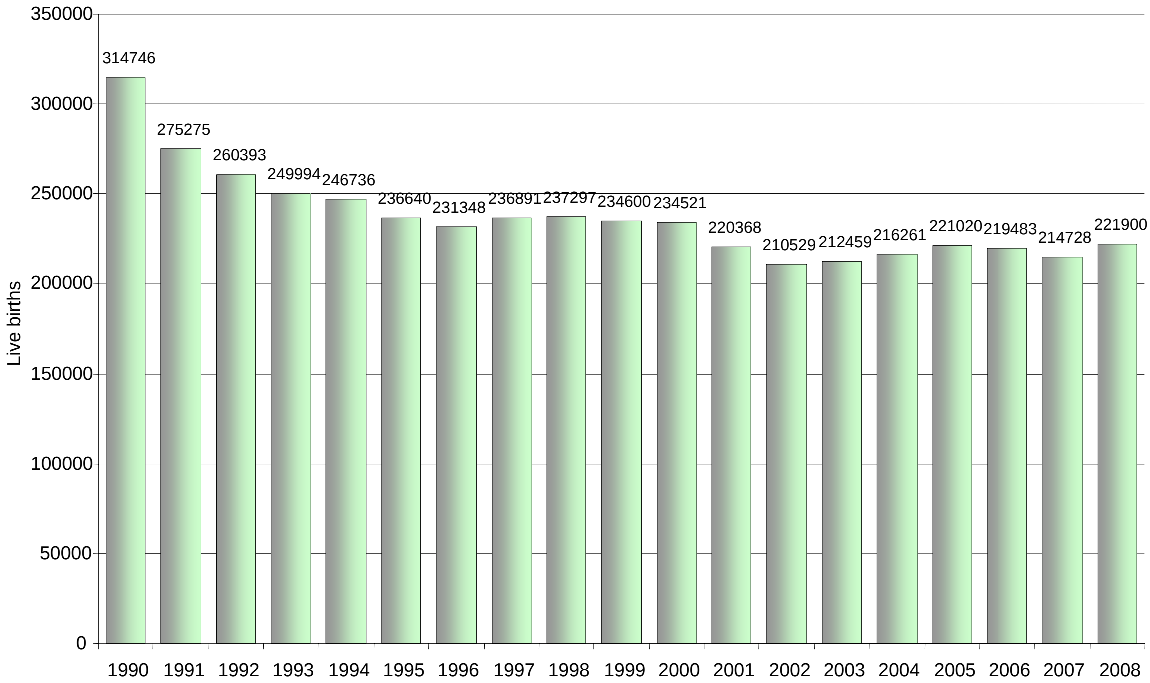

Figure 1. Evolution of natality in Romania during 1990-2008
Source: Compiled by the authors, based on the data available in the on-line Tempo database of the National Statistics Institute regarding live births during 1990 and 2008

Through this evolution natality adjudged for itself the role of decisive (but not exclusive) factor in triggering and accelerating two of the demographic processes that have been affecting the country's population for almost two decades: **demographic decline** and **demographic ageing**.

From the record population of 23,211 thousand persons on January 1st 1990, Romania's population fell to only 21,489 thousand persons on January 1st 2009. However, what raises most concerns is not this decrease in the population number, but the deformation of the population's age structure. Thus, if in 1990 the elder population (65 year old and over) represented 10.4% of the total population, twenty years later it grew to 14.9%, while the weight of the young population plunged from 23.7% in 1990 to 15.2% in 2009. Therefore, the most recent demographic data indicate almost equal weights for elder and young people. Under such circumstances, the demographic "pressure" supported by the adults (20-64 year old) is almost equally distributed on the two population segments.

The implications of this structural deterioration are numerous, complex, sometimes hard to identify and to predict, but most importantly very difficult to "repair", due to the considerable inertial load that demographic phenomena accumulate in time. The demographic ageing process has many economic, financial, demographic and, not least, social consequences. The first challenge is associated with the dramatic increase of the population that reached the retirement age compared to the population in labour force, which will create social and political pressures on the social protection system. Also, demographic ageing leads to the change of the social structure: more and more generations will live together; the solidarity between the generations will be of a different nature; shortly said, the entire social and organisational structure will change or will have to be changed in order to keep pace with the demographic reality.

The advance of demographic ageing is suggestively given by the age pyramids for one period compared to another. The natality shapes, through its specific evolutions, the base of the pyramid while mortality influences its top. In this context, the dissociated influences of the two demographic phenomena may be quantified, relatively to ageing through the base of the pyramid, respectively through its top.

Since the decrease of natality was unexpectedly severe during the last 20 years, we intend to determine the impact of this evolution on the accentuation of the demographic ageing process; to be more precise, through the decrease of the young segment in the total population. Quantification of this impact constitutes a part of the generous study area of the project entitled **"Modeling the financial behaviour of the population under the impact of demographic ageing. System of specific indicators and measures for controlling the financial disequilibria"**, financed by the state budget through the contract number 91-016/2007 CNMP (National Centre for Program Management), in the competition Partnerships PNDII2007[2] Romania.

Method, model and data

Taking into consideration the situation of the Romanian population dynamics in the past two decades, we may frame, even only intuitively, the idea of a consistent influence of natality for structural changes in the young population segment, of the migration for the adult population and of mortality for the elder population.

Data regarding the natural and migratory movement confirm the significant contribution of the migratory movement to structural changes within the adult population (20-64 year old) and of natality within the young population[3] (0-19 year old), with direct implications on the demographic ageing process. For the elder population (65 year old and over) the change of the population is the almost exclusive result of the mortality specific to this segment.

Determining the external migratory movement influence on the demographic ageing process during 1989 and 2009 roughly overlaps a projection of the evolution of the categories involved and the subsequent later amendment of the population effectives in different moments of time (preferably the 1st of January) with the effectives of the survivors that who build up the migratory variation.[4]

In the same context, the evolution of the demographic ageing in Romania during 1990-2009 is tightly tied to the tendency of natality decrease, manifested through the important diminish of the young population weight in total population (ageing through the base of the pyramid).

The population group aged between 0 and 19 year old is characterized by a relatively low external migratory movement. This is why it is the most appropriate for the presentation and probation of the model we propose with the view to quantify the influence of natality and mortality on structural mutations by age, registered within a population. Obviously, the change in natality during 1989-2009 will be considered factor of influence for ageing exclusively within this age group.

Broadly, the quantification method we propose derives from the general theory of statistical indexes – the most useful method of factorial analysis in dynamic processes.

We assume that we want to identify the influence of natality variation on the demographic ageing process during 1989-2009. The total number of live births in the interval between 1989 and 2008 must be opposed to, for comparison, the natality of the decade 1969-1988, because from among them become the survivors of the 0-19 year old age group, in the two observation moments (R_0 and R_1), represented Figures 2a and 2b.

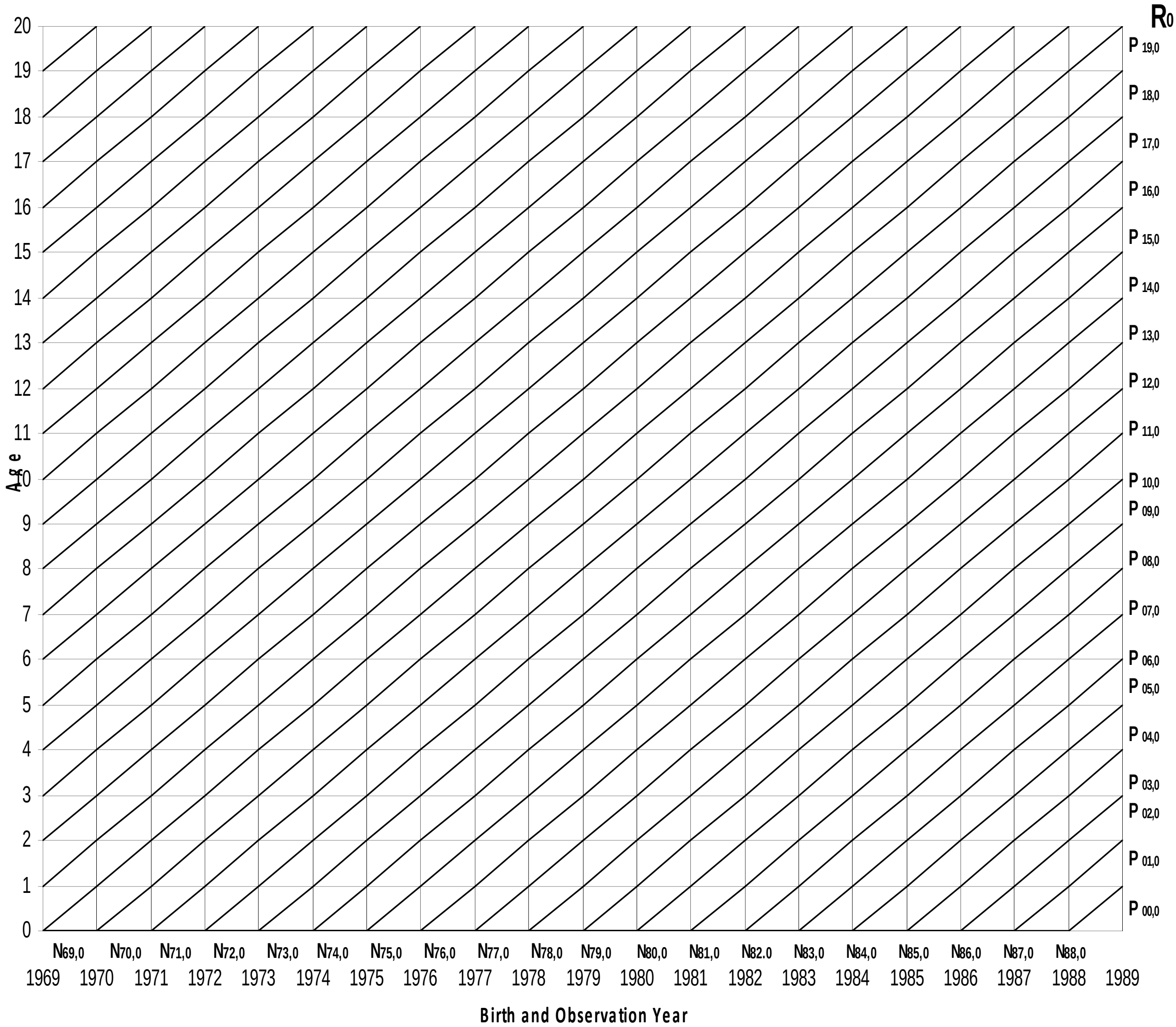

Figure 2a. Lexis Diagram for the population aged 0-19 years on 1st January 1989

The population size of the 0-19 year old age group on the 1st of January 2009 (R_1) was formed under the influence of the following factors:

- number of live births from the previous 20 years (1989-2008) (N_k^1) (see fig. 2b)
- the impact of the mortality intensity on these generations until the moment R_1, quantified through the surviving indexes (s_i^1)
- the migratory gain allotted to (the 20) generations prior to the R_1 moment (1989-2008) in the time frame between the two observation moments. (Δ_m^1)

For the population from the 0-19 year old group alive at R_0 (computation base), one must – symmetrically – identify the same factors acting in the previous period, 1969-1988, respectively N_k^0, s_i^0, Δ_m^0 (see fig. 2a).

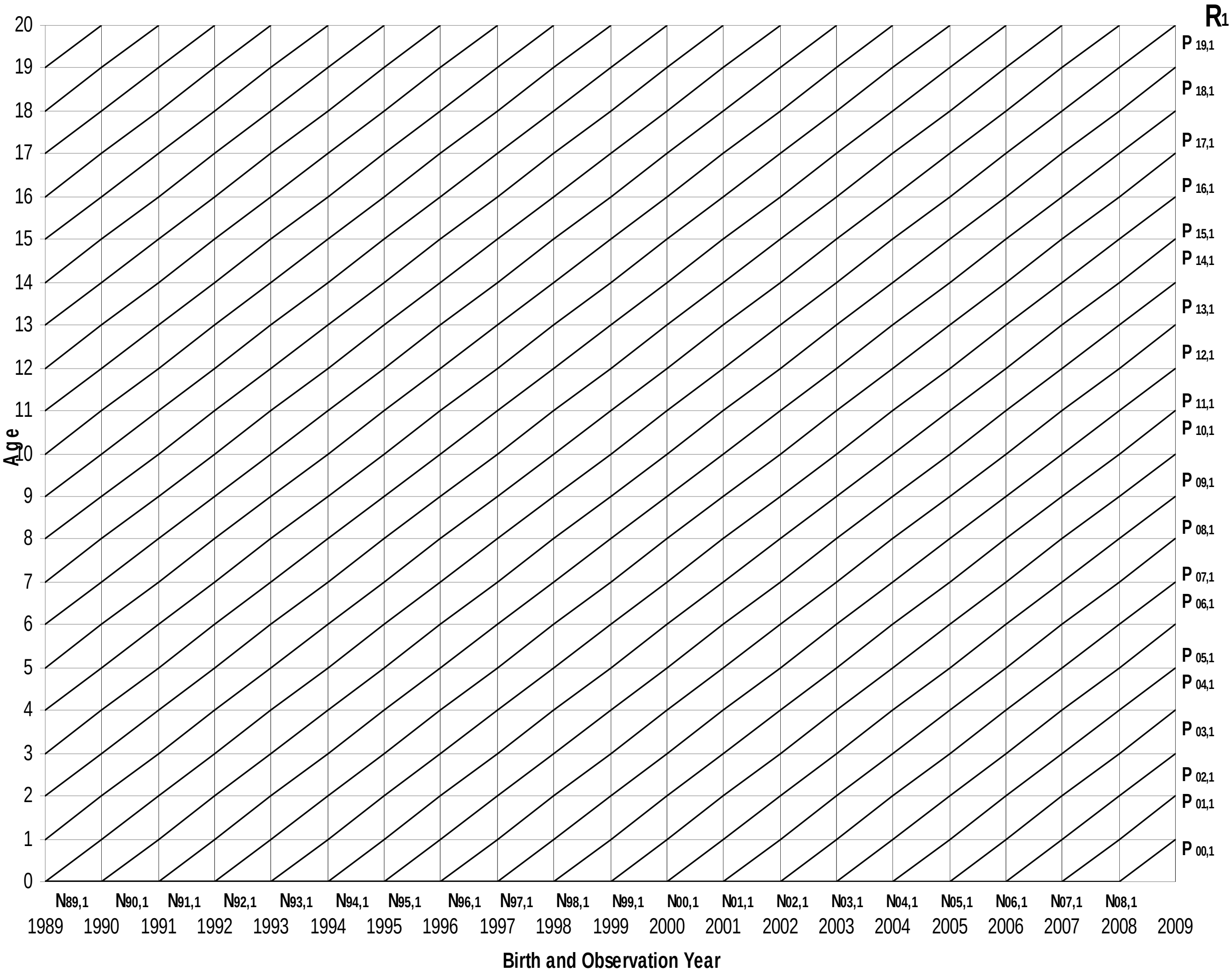

Figure 2b. Lexis Diagram for the population aged 0-19 years on 1st January 2009

In order to simplify things, we will consider the influence of the migratory gain insignificant (closed-type population), especially since the main purpose regards the quantification of the influence exerted by the intensity of the natality on the demographic ageing process.

The dynamics of the population from the 0-19 year old group during R_0 and R_1 (or, concretely, January 1st 1989 and January 1st 2009) (P_i^1), compared to the previous period

(January 1st 1969 and January 1st 1988) (P_i^0), taking into account the previous mentions, will be computed as an aggregated index, as follows:

$$I_{P_{1/0}} = \frac{P_{0-9}^1}{P_{0-9}^0} = \frac{\sum_{i=0}^{9} P_i^1}{\sum_{i=0}^{9} P_i^0} = \frac{\sum_{\substack{k=1 \\ i=n-k}}^{n} N_k^1 \cdot s_i^1}{\sum_{\substack{k=1 \\ i=n-k}}^{n} N_k^0 \cdot s_i^0}$$

$$\Delta_{P_{1/0}} = \sum_{i=0}^{9} P_i^1 - \sum_{i=0}^{9} P_i^0 = \sum_{\substack{k=1 \\ i=n-k}}^{n} N_k^1 \cdot s_i^1 - \sum_{\substack{k=1 \\ i=n-k}}^{n} N_k^0 \cdot s_i^0$$

Considering the concepts of the statistical indexes theory, we determine:

$$I_{P_{1/0}}^N = \frac{\sum N_k^1 \cdot s_i^0}{\sum N_k^0 \cdot s_i^0}$$ respectively,

$$\Delta_{P_{1/0}}^N = \sum_{\substack{k=1 \\ i=n-k}}^{n} N_k^1 \cdot s_i^0 - \sum_{\substack{k=1 \\ i=n-k}}^{n} N_k^0 \cdot s_i^0$$

The relations above quantify the influence of the natality variation on the dynamics, respectively on the absolute change of the population from the 0-19 year old age group in R_1 (January 1st 2009), compared to a conventional population size, obtained by holding mortality intensity constant at base period levels.

The influence of the change in time of the mortality intensity in forming population effectives in the same 0-19 year old age group, will be given by:

$$I_{P_{1/0}}^s = \frac{\sum N_k^1 \cdot s_i^1}{\sum N_k^1 \cdot s_i^0}$$ respectively,

$$\Delta_{P_{1/0}}^s = \sum_{\substack{k=1 \\ i=n-k}}^{n} N_k^1 \cdot s_i^1 - \sum_{\substack{k=1 \\ i=n-k}}^{n} N_k^1 \cdot s_i^0$$

According to the statistical indexes theory, the following relations are true:

$$I_{P_{1/0}} = I_{P_{1/0}}^N \cdot I_{P_{1/0}}^s$$ and respectively,

$$\Delta_{P_{1/0}} = \Delta_{P_{1/0}}^N + \Delta_{P_{1/0}}^s$$

Taking into account our aim, we are firs interested in $\Delta_{P_{1/0}}^N$ and only secondary in $\Delta_{P_{1/0}}^s$, limited to the age group 0-19 year old, because between the two observation moments the intensity of mortality acts upon the entire population, while the variation of the live births is exclusively found in the change of population effectives of the 0-19 year old age group, influencing the demographic ageing process through the base of the pyramid.

The information necessary for computation are relatively easily found. The current evidence of the natural movement allows establishing the number of live births for each year, for the two symmetrical periods.

For determining the survival indexes, we recommend two methods:

- for closed-type populations, or in the case of insignificant migratory movement for the 0-19 year old age group, one may use data from the mortality tables for each generation or group of generations (mortality tables for 3 years in a row) regarding the average number of survivors by age:

$$s_i = \frac{L_i}{S_0}$$

- having data regarding the population sizes by age (P_i^0 and P_i^1) available for the two moments of analysis and population sizes for the generations involved, the surviving index is established based on the following relations:

$s_i^0 = \frac{P_i^0}{N_{n-i}^0}$ and correspondingly, $s_i^1 = \frac{P_i^1}{N_{n-i}^1}$

The second variant is more at hand, since for the computations there is no need for information from the mortality tables. However, the surviving indexes calculated like this do not allow for separate identification of the surviving chance and of the chance not to emigrate. The size of S_i will globally reflect the chance of each member of the N_{n-i} generations to be found in the population reported at each observation moment under the combined effects of death and emigration risks.

The inconvenient is only formal because, as we appreciated before, we are interested firstly in the influence of the natality change on the ageing process ($\Delta_{P_{1/0}}^N$).

Appreciation of the stage of the demographic ageing process is usually done by weighting the elder population (65 year old and over) in the entire population.

For the current moment R_1 (January 1st 2009):

$y_{65\to\omega} = \frac{P_{65\to\omega}^{R_1}}{P_t^{R_1}}$, where:

$y_{65\to\omega}$ = weight of elder population in total population (in percentages);

$P_{65\to\omega}^{R_1}$ = effective of elder population in current moment, R_1;

$P_t^{R_1}$ = effective of total population recorded in R_1;

Change in the population size for successive generations is involved only within the young population segment (0-19 year old) and, indirectly, in the change of the total population. Thus, in a first stage we will establish a corrected effective of the young population, based on data existent at the present moment and on the influence of generations size change:

$$P_{0-19,R_1}^* = P_{0-19,R_1} - \Delta_{P_{1/0}}^N$$

In the following stage, a corrected effective of the entire population will also be established by summing the effectives from the present moment, R_1, in the adult and elder population segment with the recomputed effective of young population:

$$P_{t,R_1}^* = P_{0-19,R_1}^* + P_{20-64,R_1} + P_{65\to\omega,R_1}$$

A recomputed weight of elder population will be established correspondingly, where we include the influence on the changes in the dimension of the new-born generations for the period between the two observation moments:

$$y^{*}_{65\to\omega} = \frac{P_{65\to\omega,R_1}}{P^{*}_{t,R_1}}$$

The percent difference between $y_{65\to\omega}$ and $y^{*}_{65\to\omega}$ will quantify the influence of the change in the number of live births in the acceleration or attenuation of the demographic ageing process.

In the end, we may establish the extent to which natality change contributed to the change of the elder population weight between the two observation moments R_0 and R_1:

$$\Delta^{N}_{y_{65\to\omega}} = \frac{y_{65\to\omega,R_1} - y^{*}_{65\to\omega,R_1}}{y_{65\to\omega,R_1} - y_{65\to\omega,R_0}}$$

The difference up to 1 or 100% will represent the change in the weight of the elder population between the two observation moments, based on mortality and population migration, as these phenomena manifested themselves at the level of the entire population.

If the intention is to distinctly quantify the influence of the last two components on the demographic ageing process, we will have to know the repartition of the migrants by age between the two observation moments, to amend these effectives with the death risk (projection of survivors among the migrants between the moments R_0 and R_1), afterwards establishing recomputed population effectives taking into account the separate influence of migratory movement and mortality. Within closed-type populations such an operation is senseless because the ageing process is determined exclusively by change of natality and mortality of the population.

Results

The method was applied on generous demographic data sets available now, respectively the effectives of the *live births generations* from symmetric periods 1969-1898 and 1989-2009, as well as the population from the *0-19 year old age group* at the observation moments of January 1st 1989 and January 1st 2009. The data cover a period of two decades loaded with divergent transformations and events (see Annex 1).

The results obtained are synthesized below:

- had natality after 1990 maintained the levels it registered between 1969 and 1988, the young (0-19 year old) population size would have been on January the 1st 2009 almost 7.5 million persons.

$P^{*}_{0-14,R_1} = P_{0-14,R_1} - \Delta^{N}_{P_{1/0}}$ **= 7,498,669 young people aged between 0 and 19 years**

- under these circumstances, the total size of the population on January 1st 2009 would have exceeded 24 million inhabitants:

$$P^{*}_{t,R_1} = P^{*}_{0-14,R_1} + P_{15-64,R_1} + P_{65\to\omega,R_1}$$ **= 24,361,171 persons**

- the recomputed weight of the elder population, taking into account the influence of the changes in the new-born generations' dimension during 1989 and 2008:

$$y^{*}_{65\to\omega} = \frac{P_{65\to\omega,R_1}}{P^{*}_{t,R_1}}$$ **= 13.13%**

$$y_{65\to\omega} - y^{*}_{65\to\omega} = 14.88\% - 13.13\% = \mathbf{1.75\%}$$

- in the end, we may establish the extent to which the change in natality contributed to the change in weight of the elder population between the 1st of January 1989 and the 1st of January 2009:

$$\Delta^{N}_{y_{65\to\omega}} = \frac{y_{65\to\omega,R_1} - y^{*}_{65\to\omega,R_1}}{y_{65\to\omega,R_1} - y_{65\to\omega,R_0}} = \mathbf{90.8\%}$$

The results obtained indicate a **2,862,555** person decrease of the young segment from the 0-19 year old age group, caused by the strong retrogression of natality (see Annex 1). In relative figures, the population aged between 0 and 19 years diminshed by **38.25%** as a direct consequence of natality plunge.

As a matter of fact the impact of natality decrease is suggestively given by the 1.75% difference between the real weight of the elder population on january 1st 2009 and the one where natality would have maintained the levels it had durig 1969 and 1988. Under these circumstances, the increase in the weight of the elder population is predominantly (**90.8%)** determined by the decrease of natality, the remaining percents up to 100% being caused by the other two factors (mortality and migration).

Final remarks

The statistic model obtained measures the actual impact of natality on the advance of the demographic ageing process in Romania. It is a meritorious step, with valuable results, especially since such quantifications have never been realized so far in the field literature.

The results obtained through the application of the method proposed here confirm the fact that after 1990 the natality played a decisive role in triggering and accelerating two of the demographic processes that affect Romania's population: **demographic decline** and **demographic ageing**.

As a consequence, we subscribe to the opinion of the specialists from the academic environment who claim that nothing but increasing fertility, respectively natality of the population, for long periods of time can significantly contribute to the rehabilitation of the age structure of the population. These are evolutions that concern not only demographers, but economists, sociologists, as well as specialists in the area of social policies, who elaborate strategies and policies regarding family, work, health and education.

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Annex 1.

Computation of the impact of natality on the demographic ageing process in Romania

Age x	Initial live births for the survivors on 1 jan 1989	Survivors on 1 jan 1989	Generation	Initial live births for the survivors on 1 jan 2009	Survivors on 1 jan 2009	sx 1 jan 89	sx 1 ian 09	P*1 jan 09
0	380043	372625	2008	222797	219929	0.98048	0.98713	218448
1	383199	371689	2007	214728	212261	0.96996	0.98851	208278
2	376896	365029	2006	219483	216455	0.96851	0.98620	212572
3	358797	346779	2005	221020	217523	0.96650	0.98418	213617
4	350741	338080	2004	216261	212455	0.96390	0.98240	208454
5	321498	309884	2003	212459	208500	0.96388	0.98137	204784
6	344369	330802	2002	210529	206159	0.96060	0.97924	202235
7	381101	364131	2001	220368	211337	0.95547	0.95902	210555
8	398904	380659	2000	234521	222104	0.95426	0.94705	223795
9	410603	390685	1999	234600	222573	0.95149	0.94873	223220
10	416598	396418	1998	237297	224328	0.95156	0.94535	225802
11	423958	402596	1997	236891	219162	0.94961	0.92516	224955
12	417353	395984	1996	231348	217504	0.94880	0.94016	219503
13	418185	394231	1995	236640	222572	0.94272	0.94055	223085
14	427732	399177	1994	246736	231010	0.93324	0.93626	230264
15	378696	359975	1993	249994	233935	0.95056	0.93576	237635
16	389153	369151	1992	260393	250387	0.94860	0.96157	247009
17	400146	372781	1991	275275	256361	0.93161	0.93129	256450
18	427034	396598	1990	314746	292798	0.92873	0.93027	292313
19	465764	427211	1989	369544	338761	0.91723	0.91670	338955
total		**7484485**			**4636114**			**4621930**

Source: Computation of the authors based on the data available in the on-line Tempo database of the **National Statistics Institute** https://statistici.insse.ro/shop/index.jsp?page=tempo2&lang=ro&context=10 and **EUROSTAT** http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

IP0-19	61.94%	**P*0-19 2009**	**7,498,669** persons 0-19 years
DP0-19	-2,848,371 persons 0-19 years	P*tot 2009	**24,361,171 inhabitants**
IP0-19/N	61.75%	y 65+ recalc 2009	**13.13%**
DP0-19/N	**-2,862,555 persons 0-19 years**		**90.8%**
IP0-19/s	100.31%		
DP0-19/s	14,184 persons 0-19 years		
P**0-19	4,621,930 persons 0-19 years		

Source: computation of the authors

[1] Main published books:

- Statistics for SME (2007);
- Demographyc statistics (2007);
- Small and Medium Enterprises in Contemporary Society (2006);
- Quantitative methods in market research (2003, 2000).

[2] Website: www.idcfp.ase.ro

[3] The field literature records two age intervals for the young population: 0-14 year old and 0-19 year old. We opted for the second variant because it allows for the observation of 20 generations starting with 1990, the turning point for the demographic evolution in Romania.

[4] In reality the process is much more complex because the adult population, subject to migration, influences the evolution of the young population through the effective of live births – lost or gained – from the migratory contingent.