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Statistical analysis on population ageing

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Abstract. *The ageing process affects the lives of all of us throughout its duration and on all levels. At the moment, Europe is facing a new challenge. Europeans, in unprecedented numbers, are very long-lived. In the last 50 years, the life expectancy at birth has increased by about 10 years, for both men and women. For the first time in the history of Europe there are so many people who have such a long and healthy life. At the same time, the working age population in the European Union has been declining for a decade and this trend is expected to continue. As the total population remains constant, the risk of labour shortages will increase, with an increase in the burden on older people to cover the social costs needed for the elderly population for a range of services associated with it. In recent years, Romania is facing a major problem, namely the alarming decline in the country's population, while exacerbating the ageing phenomenon. Thus, the population over 65 years increased, while the number of young people decreased. Also, this article analyses the evolution of the average number of pensioners and the average monthly pension in Romania, in the fourth quarter of 2020 compared to the fourth quarter of 2019, using, in this regard, a series of statistical indicators and graphs.*

Keywords: birth rate, life expectancy, GDP per capita, pensioner, average monthly pension, real pension index.

JEL Classification: H55, J11, J14, J26.

Introduction

In general, for most people, the retirement is correlated with the declining incomes. There are situations in which some retired people even face the threat of poverty in old age. As the population ages, it faces increasing financial risks, such as the need for medical care and/or long-term care.

For most retirees, the pensions are the main, if not the only, source of income. In the conditions of increasing of the life expectancy, the population will have to stay in activity longer in order to have incomes that ensure the desired standard of living.

In the study, for the calculation and interpretation of indicators, we used other statistical methods, such as dynamic series or index method.

Literature review

Angel et al. (2017) examine how the age and sex structure in Mexico provides important information about current and future political and social stability, as well as economic development, as the young population gives way to a growing elderly population, which will inevitably need health care and social security. Anghel and Hașegan (2020) carry out an extensive study on the evolution of the public pension system in Romania. Anghel and Anghelache (2018) perform a comparative analysis of the growing number of pensioners in Romania and the active workforce. Anghelache et al. (2020) analyse the evolution of the world's population and its prospects. Attanasio et al. (2016) review recent literature on the effects of changing global demographic trends on consumption, factor prices, and social security and develop a model with overlapping generations (OLGs) with four regions of the world. Been et al. (2017) demonstrate that a higher relative importance of private pensions is associated with higher levels of income inequality and poverty among the elderly. Bikker et al. (2012) examine the impact of participants' age distribution on the allocation of assets to Dutch pension funds, using pension fund investments. Collins (2020) finds that the current structure of tax assistance favours, especially men over women. Fenge and Peglow (2017) analyse the impact of demographic developments on the German pension system by 2060, the results having a number of implications for efficiency and sustainable reforms. Goda et al. (2014) measures how the provision of pension income projections, together with enrollment information, affects individuals' contributions to employer-sponsored retirement accounts. Yong et al. (2018) present scenarios for future government spending in the main components of the social sector - education, healthcare and pensions in China. Pitheckoff (2017) presents the three main demographic factors that led to the rapid ageing of the population in Bulgaria: emigration, high mortality rate and low birth rate, thus appearing numerous political, social and economic challenges. Wahrendorf et al. (2017) describe the employment and working conditions of men and women working between the ages of 65 and 80 and compare them with the previous conditions of retirees in the same age group based on wave 4 data from the Study of Health, Ageing and Retirement in Europe (SHARE) with information collected between 2009 and 2011 from 17,625 elderly men and women in 16 European countries. Kudrna et al. (2019) investigates two policy options - pension cuts and tax increases - to alleviate the fiscal pressure that appears in the special context of Australia, whose population is ageing rapidly,

while growing substantially due to immigration. Cooley and Henriksen (2018) argue that demographic change, especially an ageing population combined with increased life expectancy, may be part of the explanation for the slower economic growth, declining interest rates and declining productivity growth. Dolls et al. (2019) assess the effect of key demographic changes (population ageing and education growth) that are expected by 2030 on the distribution of income in the EU-27 and examine the potential of tax benefit systems to offset negative developments. Henkens et al. (2018) review literature on issues related to the impact of technology, the role of housing in retirement, human resource strategies, adaptation to changing retirement policies, the pension industry, and the role of ethnic diversity in retirement. Ofori-Asenso et al. (2018) uses annual historical and projected population figures from the UN population perspective to describe changes in Australia's population for the period 1950–2050, the implications of these changes being extensive and raising major challenges for the economy and infrastructure. Yunus et al. (2019) estimate the effect of demographic changes on the long-term trends of key macroeconomic variables using a panel VAR model for 21 OECD economies from 1970–2014. Cruz and Ahmed (2018) describe the main mechanisms by which demographic change can affect economic outcomes and estimate the association between changes in the share of the working age population with economic growth per capita and the poverty rate. Taylor-Gooby (2011) investigates whether the risk society dissolves the traditional solidarity of the welfare state and how much it provides a basis for new solidarity in order to maintain support for vulnerable groups.

Data, results and discussions

Life expectancy is the key indicator for assessing the health of the population, which shows the average age of death for a population. If in the past, in a pre-modern poor world, life expectancy was about 30 years in all regions of the world, since 1900, global life expectancy has doubled and now exceeds 70 years. However, there is a fairly high inequality of life expectancy in countries. In 2019, the Central African Republic was the country with the lowest life expectancy, respectively 53 years, while in Japan, the life expectancy is over 84 years.

The following table presents the estimate of the evolution of life expectancy at birth, by continents, in the period 2020-2099, taking into account the average fertility variant.

Table 1. *Life expectancy at birth, both sexes, on continents during 2020-2099*

-years-

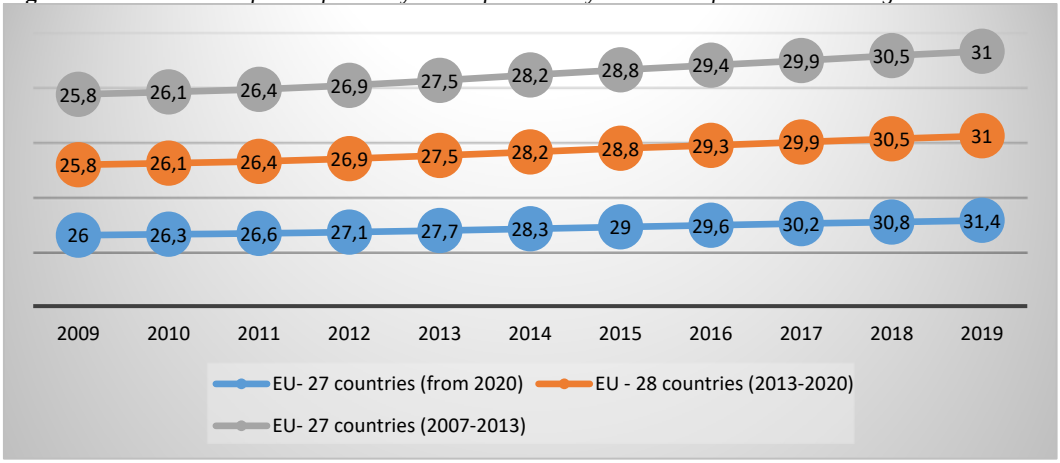
Year	Australia and New Zealand	North America	South America	Africa	Asia	Europe
2020	83.396	79.269	76.090	63.472	73.787	78.740
2030	84.712	80.771	77.964	66.060	75.450	80.236
2040	85.917	82.400	79.732	68.253	76.896	81.666
2050	87.072	83.763	81.411	70.069	78.206	82.992
2060	88.205	84.969	82.902	71.606	79.413	84.254
2070	89.344	86.076	84.202	72.947	80.558	85.545
2080	90.464	87.115	85.388	74.167	81.690	86.814
2090	91.592	88.147	86.515	75.350	82.849	87.952
2099	92.596	89.074	87.498	76.404	83.910	88.945

Source: https://ourworldindata.org, own systematization.

The ratio of economic dependence of the elderly will increase continuously. If in 2010, at the level of the European Union, there were four people of working age for each person over the age of 65, it is estimated that by 2060 there will be only two people of working age for each person older 65 years old. The dependency ratio of the elderly for the EU-27 was 31.4% on January 1, 2019, as seen in figure no. 1. Thus, for every person aged 65 or over, there were just over three people of working age.

As defined by Eurostat, the demographic indicator of the dependency ratio of older people is the ratio between the number of people aged 65 and over (the age when they are generally economically inactive) and the number of people aged between 15 and 64 years old. The value is expressed per 100 people of working age (15-64).

Figure 1. *The evolution of the dependency ratio of the elderly in the European Union during 2009 -2019*



Source: own representation.

In table no. 2 are presented data on life expectancy in several European countries, but also on other continents, namely: Romania, Bulgaria, Hungary, Poland and the Czech Republic. These countries were taken into account because Bulgaria is Romania's neighbour and joined the European Union at the same time (2007), Hungary was selected because it is also Romania's neighbour, Poland ranks first in transposing European Union directives, with positive results, and the Czech Republic is among the first states in Central and Eastern Europe to introduce voluntary private pensions (1994). The research also refers to the countries where there are communities with a large number of Romanians, such as Italy, Spain or England, but also to Chile, which introduced for the first time the private pension system "multi-pillar", also adopted by Mexico or Colombia. The analysis included the countries with the strongest private pension systems in the world, namely Denmark, the Netherlands and Australia.

Table 2. *Life expectancy in selected countries in 2020*

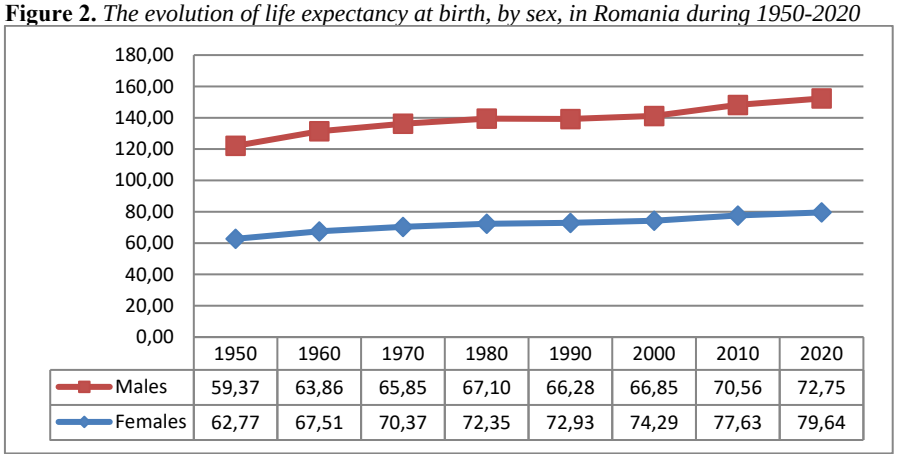
Country	**Females**	**Males**	**Population in 2019** (millions)
Australia	85.52	81.67	25.20
Chile	82.52	77.99	18.95
Colombia	80.17	74.72	50.34
Czech Republic	82.06	76.94	10.69

Country	Females	Males	Population in 2019 (millions)
Denmark	82.97	79.10	5.77
Hungary	80.43	73.42	9.69
Italy	85.67	81.51	60.55
Mexico	77.93	72.30	127.58
Netherlands	84.07	80.77	17.10
Poland	82.72	75.03	37.89
Slovak Republic	81.08	74.19	5.46
Spain	86.37	80.96	46.74
United Kingdom	83.06	79.76	67.53
Bulgaria	78.78	71.68	7.00
Romania	**79.64**	**72.75**	**19.36**

Source: https://ourworldindata.org, own systematization.

The demographic problem is also found in Romania. Thus, lately, in Romania there is a continuous decrease in the number of population, generated by the decrease in birth rate, so that the number of young people has decreased, but at the same time there is a permanent increase in life expectancy of the population over 65 years.

Figure 2. *The evolution of life expectancy at birth, by sex, in Romania during 1950-2020*



Source: own representation based on data from https://ourworldindata.org.

In figure no. 2 is graphically represented the evolution of life expectancy at birth, in women and men, in Romania in the period 1950-2020. As it turns out, if in 1950, the life expectancy at birth in women was 62.77 years, in 2020 it reached almost 80 years.

Table 3. *Population structure by age groups in 2009 and 2019*

(% of total population)

	0–14 years		15–64 years		65 years and over	
	2009	2019	2009	2019	2009	2019
EU-27	15.4	*15.2*	67.0	*64.6*	17.4	*20.3*
Romania	**15.8**	*15.7*	**68.1**	*65.8*	**16.1**	*18.5*

Source: Eurostat, statistics-explained, own systematization.

The effects of the demographic ageing process, caused, in large part, by the decrease in the birth rate, led to the decrease of the segment of the young population, found in the age group 0-14 years. At the same time, the increase of life expectancy generated the increase of both the number and the share of the elderly population, respectively of the population aged 65 and over, as can be seen from the data in table no. 3.

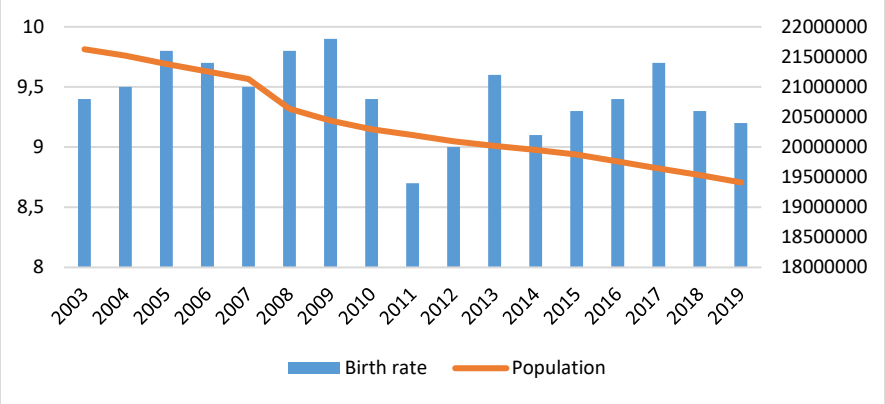
Table 4. *Birth rate and population in Romania during 2003-2019*

Year	Birth rate (live births per 1000 inhabitants)	Population (persons)	Year	Birth rate (live births per 1000 inhabitants)	Population (persons)
2003	9.4	21627509	2012	9	20095996
2004	9.5	21521142	2013	9.6	20020074
2005	9.8	21382354	2014	9.1	19953089
2006	9.7	21257016	2015	9.3	19875542
2007	9.5	21130503	2016	9.4	19760585
2008	9.8	20635460	2017	9.7	19643949
2009	9.9	20440290	2018	9.3	19533481
2010	9.4	20294683	2019	9.2	19414458
2011	8.7	20199059			

Source: National Institute of Statistics, tempo online

In table no. 4 are highlighted data regarding the evolution of the birth rate and the population in Romania, in the period 2003-2019, which are represented graphically in figure no. 3. If the birth rate had a fluctuating evolution during the analysed period, the same cannot be said about the evolution of the population, this being in a continuous decrease.

Figure 3. *The evolution of the birth rate and of the population in Romania during 2003-2019*



Source: own representation, based on data published by the National Institute of Statistics, tempo online.

In order to analyse the relationship between life expectancy and gross domestic product per capita, both statistical-mathematical and – especially – econometric regression models can be used. In table no. 5 presents a series of data (with annual frequency) regarding the two indicators analysed during 2002-2019.

Table 5. *Gross Domestic Product per capita and life expectancy in Romania during 2002-2019*

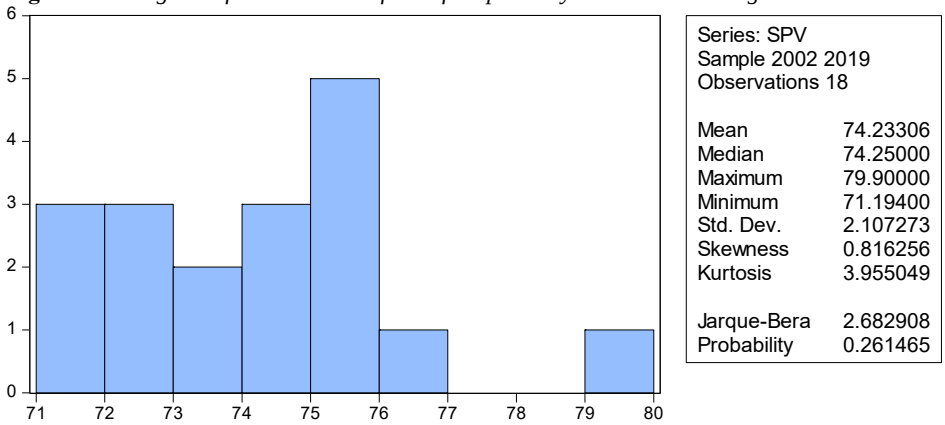
Years	GDP per capita* (euro)	SPV** (years)	Year	GDP per capita* (euro)	SPV** (years)
2002	4,260	71.2	2011	6,350	74.4
2003	4,380	71.6	2012	6,500	74.7
2004	4,860	71.9	2013	6,770	75.0
2005	5,120	72.3	2014	7,040	75.3
2006	5,560	72.6	2015	7,290	75.5
2007	6,050	73.0	2016	7,670	79.9
2008	6,730	73.3	2017	8,280	75.8
2009	6,410	73.7	2018	8,700	75.9
2010	6,200	74.1	2019	9,110	76.1

Source: * Eurostat, statistics-explained, ** https://ourworldindata.org, own systematization.

In a first stage of the analysis of the considered data series, the Eviews software package was used to generate a series of statistical tests specific to each of the two considered indicators.

The statistical tests applied for the data series on the evolution of life expectancy during the period under analysis reflected the fact that its average value is 74.23 years. It can also be seen that the distribution of this data series does not exactly correspond to the normal distribution, given the value of 0.82 of the Skewness test and is also relatively sharper, given the value of 3.96, higher than 3, of the Kurtosis test.

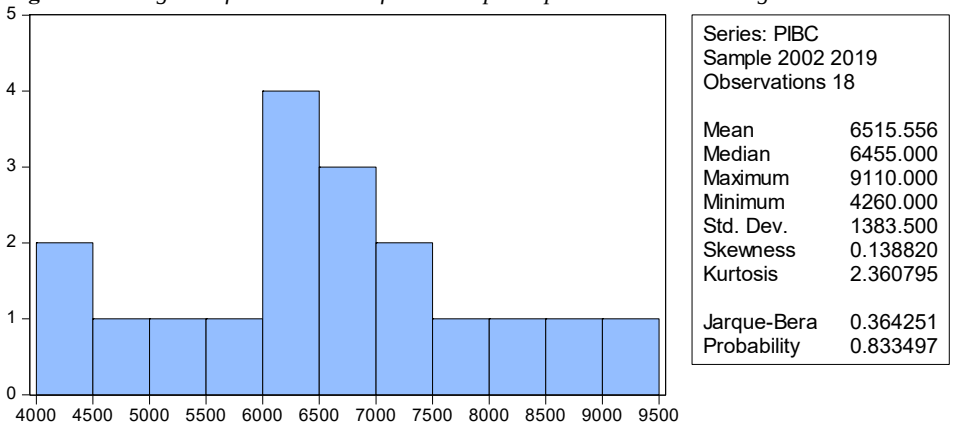
Figure 4. *Histogram of the evolution of the life expectancy in Romania during 2002-2019*



Source: EViews, own representation.

In the case of the analysis of the data series regarding the evolution of the Gross Intense Product per capita, it can be observed that this indicator registers an average value of 6515.56 euros, the distribution of the registered values being also different from the normal distribution.

Figure 5. *Histogram of the evolution of the GDP per capita in Romania during 2002-2019*

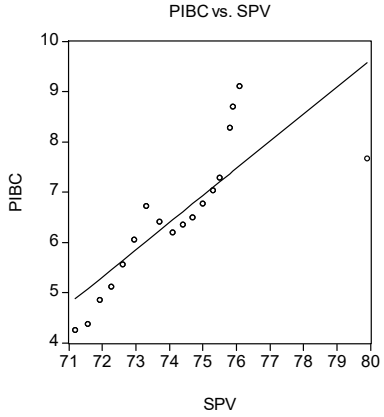


Source: EViews, own representation.

The distribution is not perfectly symmetrical given the value of 0.13 of the Skewness test and it is relatively flatter, given the value of 2.36, less than 3, of the Kurtosis test.

In order to determine the type of regression model to be used in order to establish the dependence between life expectancy and GDP per capita, the two data series were represented in the form of a graph by points, on which the regression line was also drawn.

Figure 6. *Correlogram Life expectancy_Gross domestic product per capita*



Source: EViews, own representation.

We notice in the graph above that the point cloud related to the values recorded by the two indicators studied in their evolution describes a straight line, which allows us to continue the study. In this sense, we will approach a statistical-econometric analysis, using a simple linear regression model, which has the following relation:

$SPV = a + b \cdot PIBC + \varepsilon$

where:
SPV = life expectancy (resultant characteristic);
PIBC = Gross Domestic Product per capita (factorial variable);
a and b = regression parameters;
ε = residual variable.

Both for estimating the parameters a and b, respectively $\hat{a}$ and $\hat{b}$, using the least squares method, and for testing the significance of the model, the statistical-econometric analysis program EViews was used, and the results are presented in the following table:

Table. 6. *Estimation of the regression model Life expectancy_Gross Domestic Product per capita*

Dependent Variable: SPV Method: Least Squares Date: 05/25/21 Time: 13:02 Sample: 2002 2019 Included observations: 18				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	66.08591	1.446550	45.68519	0.0000
PIBC	0.001250	0.000217	5.750783	0.0000
R-squared	0.673945	Mean dependent var		74.23306
Adjusted R-squared	0.653567	S.D. dependent var		2.107273
S.E. of regression	1.240311	Akaike info criterion		3.373040
Sum squared resid	24.61394	Schwarz criterion		3.471971
Log likelihood	-28.35736	Hannan-Quinn criter.		3.386681
F-statistic	33.07151	Durbin-Watson stat		1.662641
Prob(F-statistic)	0.000030			

Based on the data presented in the table above, we can establish the values of the parameters of the regression model, *a* and *b*, as follows: a = 66.08591 and b = 0.001250.

Thus, the regression model that characterizes the relationship between life expectancy and Gross Domestic Product per capita can be transcribed as follows:

$$\text{SPV} = 66.08591 + 0.001250 \cdot \text{PIB per capita}$$

The connection between the two variables is a direct one, and the value recorded by Prob (0.0000) reveals that the variable is statistically significant. R-squared (R2) shows the proportion in which the dependent variable is explained by the independent variable, the values recorded being between 0 and 1. In the present case, the value recorded by R-squared shows that, in proportion of 67.39%, of the life expectancy is explained by the level of economic development indicated by the macroeconomic indicator GDP per capita, the difference of up to 100% representing the influence of other factors not included in this model.

The validity of the analysed regression model is studied using the tests implemented in the Eviews software package. Thus, based on the value of the R-squared test and the F-statistical and t-Statistic tests, whose values are higher than the tabulated ones, it is stated that the model describing the relationship between hope and value of gross domestic product per capita is correct.

In order to highlight the overall picture, of the last period, of the public pension system in Romania, in the following is analysed the evolution of the average number of pensioners and the average monthly pension in Romania, in the fourth quarter of 2020 compared to the fourth quarter of 2019, using there are, in this sense, a series of statistical indicators and graphical representations.

In order to understand the content of the analysed indicators, some aspects of the methodology used by the National Institute of Statistics and Eurostat are presented below. Thus, the average number of pensioners in the social insurance system consists of state social insurance pensioners; pensioners from the former insurance system for farmers; social insurance retirees from the Ministry of National Defense, the Ministry of Internal Affairs (MAI) and the Romanian Intelligence Service (SRI); social insurance retirees from the records of the Ministry of Culture and National Identity and social insurance retirees from the records of the Lawyers' Insurance House.

The pension represents the monetary right established by the pension decision. From a methodological point of view, the average monthly pension is calculated by taking into account the amounts for pensions of all categories of pensioners, paid by the pension funds specified above. The average monthly pension is determined as the ratio between the amounts due, according to the decisions, of the pensioners existing in payment in the reference quarter/year and their average monthly number multiplied by 3 (months), respectively 12 (months). Pensions are classified into several categories, namely: old-age pension, early retirement, partial early retirement, invalidity pension, survivor's pension, social assistance type pension, IOVR pensions.

In table no. 7 presents the average number of pensioners registered in Romania in the fourth quarter of 2019 and in the third and fourth quarters of 2020.

Table 7. *Average number of pensioners in Romania (thousand people)*

	Quarter IV 2019	Quarter III 2020	Quarter 2020
Total	**5140**	**5125**	**5123**
of which, by retirement level:			
Social insurance	5138	5124	5122
of which, state social insurance	4669	4675	4679
of which, social insurance by pension categories:			
▪ age limit	3992	4028	4039
▪ early retirement	19	15	14
▪ partial early retirement	92	90	92
▪ disability	503	468	456
▪ survivorship pension	532	523	521

Source: National Institute of Statistics, Press release no. 69/16 March 2021, own systematization.

Based on the data for the fourth quarter of 2020 in the table above, it is found that the average number of retirees registered in Romania was 5123 thousand people, down by 2 thousand people compared to the previous quarter and by 17 thousand people compared to the quarter IV 2019. We mention that the social insurance pensioners hold the majority share (99.98%) in the total number of pensioners.

The average number of state social insurance retirees was 4679 thousand people, representing 91.4% of the total social insurance pensioners. Compared to the third quarter of 2020, there was an increase of 4 thousand people, and compared to the fourth quarter of the previous year, the increase was 10 thousand people.

In the fourth quarter of 2020, the number of beneficiaries of the provisions of the Emergency Ordinance no. 6/2009 on the establishment of the social allowance for pensioners was 947.7 thousand persons, distributed according to the data in the table below:

Table 8. *Distribution of beneficiaries of the provisions of the O.U.G. no. 6/2009, in the fourth quarter of 2020*

No.	Category	**Persons** *(thousands)*
1.	State social insurance system	797,2
2.	Former system for farmers	146,0
3.	Military system	4,5
Total		**947,7**

Source: National Institute of Statistics, Press release no. 69/16 March 2021, own systematization.

Depending on the type of pension due, the number of pensioners for old age was 78.9% among social insurance pensioners, pensioners included in the categories of early and partially early pensions representing 2.1%.

In the time period under analysis, the total ratio between the average number of state social insurance retirees and that of employees was 9 to 10. We specify that this ratio shows important variations in territorial profile. Thus, if in Ilfov county the ratio is 4 pensioners to 10 employees, there are counties where the number of pensioners exceeds the number of employees, for example in Teleorman county there are 16 pensioners per 10 employees, in Giurgiu and Vaslui counties 15 pensioners per 10 employees And in Botoșani county 14 to 10.

Table 9. *Average monthly pension (lei)*

	Quarter IV 2019	Quarter III 2020	Quarter IV 2020
Total	**1412**	**1505**	**1636**
of which, by retirement level:			
Social insurance	1413	1505	1637
of which, state social insurance	1372	1454	1590
of which, social insurance by pension categories:			
▪ age limit	1586	1685	1829
▪ early retirement	1675	1836	2070
▪ partial early retirement	1294	1455	1623
▪ disability	723	728	783
▪ survivorship pension	771	819	883

Source: National Institute of Statistics, Press release no. 69/16 March 2021, own systematization.

The average monthly pension was, in the fourth quarter of 2020, in the amount of 1636 lei, which means an increase of 8.7% compared to the third quarter of 2020. Regarding the average state social insurance pension, it was 1590 lei and varied with significant discrepancies in territorial profile. The gap between the minimum value (registered in Botoșani County: 1262 lei) and the maximum (registered in Hunedoara County) was 848 lei. We further reproduce the values registered in several counties in the country.

Tabel 10. *Average state social insurance pension in the fourth quarter of 2020*

County	Value (lei)
Botoșani	1262
Giurgiu	1272
Vrancea	1291
Brasov	1883
Bucharest	2008
Hunedoara	2110

Source: National Institute of Statistics, Press release no. 69/16 March 2021, own systematization.

Regarding the ratio between the average net nominal state social insurance pension for the full-age contribution period (excluding tax and the social health insurance contribution) and the average net earnings, there is an increase from 51.9 in quarter III 2020 to 54.2% quarter IV 2020.

Compared to the third quarter of 2020, the average monthly pension and the average state social insurance pension increased by 8.7% and 9.4%, respectively.

Compared to the same quarter of the previous year, both the average monthly pension and the average state social insurance pension increased by 15.9% each.

The average net nominal pension for the calculation of the real pension is established by deducting the tax from the amounts due as pensions and the social health insurance contribution. According to Law no. 2/2017 for the amendment and completion of Law no. 227/2015 regarding the Fiscal Code and for the amendment of Law no. 95/2006 on health care reform, the monthly taxable income from pensions is established by deducting from the pension income the monthly non-taxable amount of 2,000 lei, and for individuals with pension income, the social health insurance contribution is borne by the budget Of the state.

The real pension expresses the equivalent value of the goods and services that can be bought, respectively used, with the average nominal nominal pension in a certain period of

time, compared to another period, taking into account the evolution of consumer prices and service tariffs. The indicator is determined taking into account the corresponding amounts for the pensions paid to the state social insurance pensioners, to the pensioners of the Ministry of National Defense, MAI, SRI.

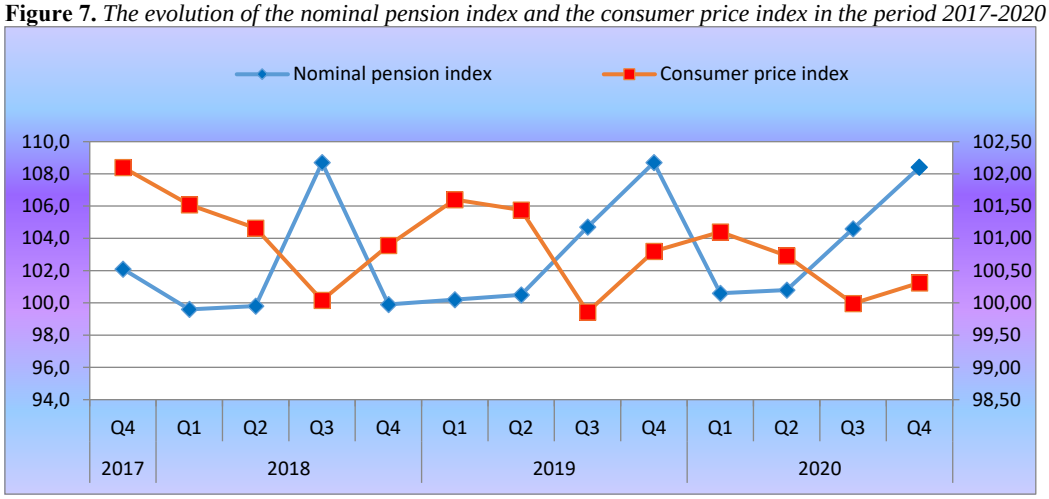
The real pension index is calculated as the ratio between the nominal pension index (for the calculation of the real pension) and the consumer price index.

Table 11. *Nominal pension index and consumer price index during IV quarter 2017 - quarter IV 2020*

previous quarter = 100			(%)
Year	**Quarter**	**Nominal pension index**	**Consumer price index of the population**
2017	Quarter 4	102.1	102.10
2018	Quarter 1	99.6	101.52
	Quarter 2	99.8	101.16
	Quarter 3	108.7	100.04
	Quarter 4	99.9	100.89
2019	Quarter 1	100.2	101.60
	Quarter 2	100.5	101.44
	Quarter 3	104.7	99.86
	Quarter 4	108.7	100.80
2020	Quarter 1	100.6	101.10
	Quarter 2	100.8	100.73
	Quarter 3	104.6	99.99
	Quarter 4	108.4	100.31

Source: National Institute of Statistics, Press release no. 69/16 March 2021.

Figure 7. *The evolution of the nominal pension index and the consumer price index in the period 2017-2020*



Source*:* own representation.

The previous figure shows graphically the quarterly evolution of the nominal pension index and the consumer price index in the period IV quarter 2017 – quarter IV 2020. In the quarter IV 2020, compared to the previous quarter, the average real pension index was 108.1%.

Conclusions

The main influencing factors of the demographic ageing process are the increase of the average life expectancy at birth, the decrease of the birth rate, as well as the development of the migration phenomenon. The ratio of economic dependence of the elderly is constantly increasing. The total dependency ratio, calculated at the country level, in the middle of 2019 was 52 young people and elderly people per 100 adults, a growing ratio, considering that in 2015, it was 49 young people and elderly people per 100 adults, and in 2012 it was 47 young people and the elderly, amounting to 100 adults.

The continuous degradation of demographic indicators will have negative implications for the constantly declining labour market and, implicitly, for the pension systems that will be constantly hit by constraints.

Given current trends, the situation is worrying, given the implications of demographic ageing for pension systems. The impact of the demographic challenge exacerbated by the economic and financial crisis of 2007-2008, which caused negative consequences for budgets, financial markets and, implicitly, economic entities, as well as the current Covid-19 pandemic, will accentuate the tendency to slow down the economic growth and to put pressure on public finances.

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