THE STUDY OF THE EVOLUTION OF THE RESIDENT POPULATION IN ROMANIA ACCORDING TO NATURAL MOVEMENT

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ABSTRACT: *Starting from the fact that 2022 is the year in which Romania carried out the most recent population census in Romania, this article aims to analyze the evolution over time of the resident population in Romania, according to the main indicators that characterize the natural movement of the population, namely the born alive number, the dead number, the divorces number and natural growth. For this purpose, a multivariable dynamic model was applied in the analysis in which a linear increasing trend was taken into account. Following the analysis of the obtained data, it was found that, while the born alive had a positive impact on the number of the resident population in Romania, the dead number, the divorces number and natural growth led to a decrease in the number of residents, in Romania. At the end of the article, forecasts were made for a period of four years.*

KEY WORDS: *population, natural growth, econometric model, forecast.*

JEL CLASSIFICATIONS: *C1, J1.*

1. INTRODUCTION

The natural movement of the population is one of the main components characterizing the demographic statistics of a country. This is analyzed according to several specific indicators such as birth rate, mortality rate, marriage rate and divorce rate. Natural movement includes demographic events, which can affect to some extent the change in the population level of a country.

According to data provided by the National Institute of Statistics, our country has experienced a massive and continuous decrease in population over the past 32 years. The resident population in Romania reached a number of 19.038.098 people, with 4.154.176 people less than in 1990. This continuous decrease is based on several factors, among which we list the low birth rate and fertility, but also migration and the lack of trust in society of the population (Institutul Național de Statistică, 2023).

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Analyzing the data on the birth rate in Romania, it can be seen that it has decreased dramatically in recent years. The lowest number of births was registered in Romania in 2021, with a number of 180,735 new live births.

Sociologists from our country claim that there are a number of reasons for these decreases in the number of births in Romania, such as postponing the age at which women decide to procreate, infertility or poverty. A real problem of the population decrease is also the fact that half of the couples in Romania have only one child (Country Economy).

Regarding mortality in Romania, in the last 32 years, it had an oscillating evolution, showing a significant increase during the pandemic crisis period of the last years.

Recent studies by the Government of Romania, published by the National Institute of Public Health, state that among the main causes of mortality are cardiovascular diseases, tumors and diseases of the respiratory system. According to data provided by Eurostat, Romania has the second highest mortality rate in the EU27, after Bulgaria (Eurostat). These statistics are very worrying for our country. A much more strengthened health system and public health prevention services that need to do their job much better could reduce the mortality rate in the future. On the other hand, the population of the country must also be aware of the importance of regular medical check-ups.

An indicator that has a negative impact on the number of the resident population in Romania is the divorce rate. According to statistics, our country faces the lowest duration of the couple's relationship at the European level. This happens, either due to the fact that couple therapy is not practiced at an appropriate level in Romania, or due to the difficult periods we face in our daily lives. It seems that love is no longer an obstacle when it comes to divorce. Misunderstandings or incompatibility between couples lead to an unhappy ending. The natural increase of Romania's population remained negative in 2021 as well, reaching a historical maximum this year. It represents in absolute terms, the difference between the number of live births and the number of deaths in a reference period, and in relative measures it represents the difference between birth and mortality.

Depending on the evolution of the number of persons in Romania, it has a positive value if the number of live births is higher than the number of deaths, it has a negative value if the number of live births is lower than the number of deaths and is zero if the number of the two indicators demographic is equal. Unfortunately, in Romania, starting from the first years after the revolution, the natural increase has only negative values.

2. LITERATURE REVIEW

Browsing the specialized literature, from the multitude of articles addressing this topic, I selected only those articles that strictly refer to the population movement in Romania. Thus, in the article proposed by Mărginean, a series of data specific to the natural movement of the population, such as those related to birth, fertility, mortality, natural increase, life expectancy, are analyzed from a longitudinal perspective.

The author also considers the reporting of Romania to the other member states of the European Union from this perspective. The conclusion reached by the author is that unfavorable values were obtained in Romania in terms of the natural movement of the population (Mărginean, 2016).

Another article that analyzes the demographic data recorded at the end of May 2021, regarding the main demographic indicators (birth rate, mortality, marriages, nuptials and divorce rates) is the one proposed by Anghel. The authors present in detail the situation generated by the natural movement of the population and analyze the effect that the pandemic crisis had on the population at the national level (Anghel, et. al, 2021).

In the article proposed by Anghelache, carried out a concrete analysis on the demographic phenomenon in Romania. Thus, starting from the birth rate evolution trend, the authors present an econometric model for establishing correlations and interdependencies between the birth rate, the active population, the employed population, the number of employees, on the one hand, and the reference indicator, Gross Domestic Product, on the other side. Also, a series of reference indicators were calculated based on which the evolution of the population in Romania was forecast (Anghelache et. al, 2017).

An interesting article is that of Guran-Nica, in which the correlations between the evolution of the Romanian population in the last 20 years and the changes in family behavior are analyzed. Thus, both the natural movement in all its complexity is analyzed, as well as the development of indicators such as marriage and divorce rates. The author of the article comes to the conclusion that, given the lack of a policy to support demographic growth, in Romania the decrease of the population is forecast until 2050 (Guran-Nica, 2015).

Compared to other authors, this article analyzes from an econometric point of view, the evolution of the number of people resident in Romania over the last 32 years, according to the main indicators of natural movement considered in absolute terms.

For this, the dependence between the number of people resident in Romania and the number of live births, the number of deaths, the number of divorces and the natural increase will be analyzed from an econometric point of view. A dynamic multivariable model will be applied, where the population is the output of the model (the dependent variable) and the inputs to the model (the independent variables) are the characteristics mentioned above regarding the natural movement of the population. Within the model, the linear increasing trend of the population is also taken into account. Based on the analyzed model, in the last section, forecasts will be made over a period of four years (2022-2025).

3. DATA SERIES AND SPECIFICATION OF THE MODEL

As specified above, this article analyzes from an econometric point of view the evolution of the total population in Romania according to the main demographic indicators specific to the natural movement. Thus, in the analysis, account was taken of the number of live births, the number of deaths, the number of divorces and the natural increase of the population in Romania, for the period 1990-2021 (32 years).

Table 1. The data series of the analyzed variables

Years	The resident population [persons]	The born alive Infants [persons]	The dead [persons]	The divorces [persons]	Natural growth [persons]
1990	23192274	314746	247086	32966	67660
1991	22810035	275275	251760	37031	23515
1992	22778533	260393	263855	29290	-3462
1993	22748027	249994	263323	31193	-13329
1994	22712394	246736	266101	39663	-19365
1995	22656145	236640	271672	34906	-35032
1996	22581862	231348	286158	35586	-54810
1997	22526093	236891	279315	34752	-42424
1998	22488595	237297	269166	39985	-31869
1999	22455485	234600	265194	34408	-30594
2000	22430457	234521	255820	30725	-21299
2001	21833483	220368	259603	31135	-39235
2002	21627509	210529	269666	31790	-59137
2003	21521142	212459	266575	33073	-54116
2004	21382354	216261	258890	35225	-42629
2005	21257016	221020	262101	33193	-41081
2006	21130503	219483	258094	32672	-38611
2007	20635460	214728	251965	36308	-37237
2008	20440290	221900	253202	35685	-31302
2009	20294683	222388	257213	32341	-34825
2010	20199059	212199	259723	32632	-47524
2011	20095996	196242	251439	35780	-55197
2012	20020074	201104	255539	31324	-54435
2013	19947311	214932	250466	28507	-35534
2014	19870647	202501	255604	27188	-53103
2015	19760585	206190	262981	31527	-56791
2016	19643949	209641	258896	30497	-49255
2017	19533481	214928	262811	31147	-47883
2018	19414458	214614	265494	30857	-50880
2019	19328838	215467	261445	30197	-45978
2020	19201662	201849	298651	22785	-96802
2021	19038098	180735	334910	27024	-104175

The data series of the analyzed variables were taken after consulting the website of the National Institute of Statistics (2023) and the Country Economy website for the number of people resident in Romania. No changes were made to the data series. The analyzed data can be found in Table 1 and refer to residence environments, macro-regions, development regions and sexes.

In figure 1, the graphs of the evolutions over time of the number of live births, the number of deaths, as well as the number of divorces and the natural increase in Romania, in the period 1990-2021, are represented. While, in the last year under analysis, the number of live births decreased compared to the previous year, by 10.46%, the number of deaths increased by 12.15%. On the other hand, the number of divorces increased in 2021 compared to the previous year.

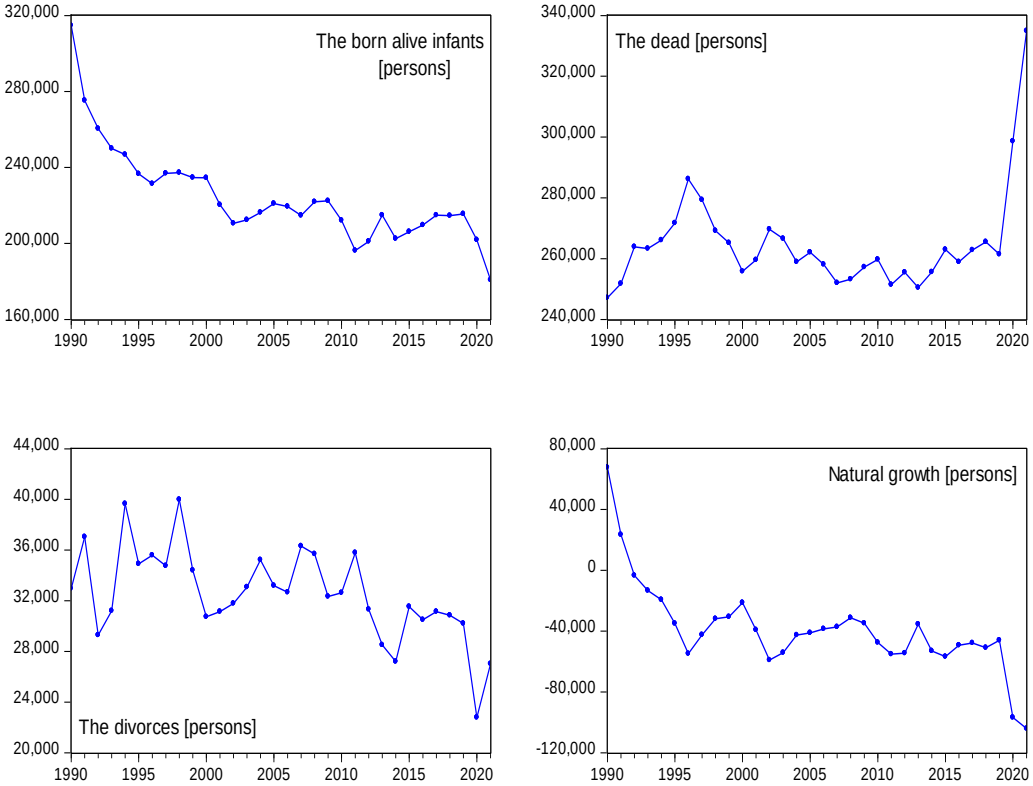

Figure 1. The evolution over time of the analyzed variables in Romania

Figure 2 shows the graph of the evolution over time of the number of people resident in Romania, in the period 1990-2021. As can be seen, the resident population in Romania had a downward evolution over time, for the analyzed period.

Comparing the number of the population in Romania in 2021, with that of the first year after the 1989 revolution, we notice that we have a considerable decrease in the number of the population, by approximately 18%.

Several econometric models were analyzed with the help of the Eviews 10.1 program. To measure the performance of the analyzed model, the results obtained according to a series of specific characteristics and indicators were compared.

Thus, in the end, it was concluded that the model that best approximates the data series is a dynamic multivariable one, with a linear increasing trend of the population, of the following form:

$$y_t = \beta_1 + \beta_2 T + \beta_3 x_{1t} + \beta_4 x_{2t} + \beta_5 x_{3t} + \beta_6 x_{4t} + \beta_7 y_{t-1} + \varepsilon_t \quad (1)$$

where it was noted with

- $Y = (y_t)_{t=\overline{1,T}}$ the resident population in Romania, represents the dependent variable;
- $X_1 = (x_{1t})_{t=\overline{1,T}}$ the number of live births in Romania;
- $X_2 = (x_{2t})_{t=\overline{1,T}}$ the number of dead in Romania;
- $X_3 = (x_{3t})_{t=\overline{1,T}}$ the number of divorces in Romania;
- $X_4 = (x_{4t})_{t=\overline{1,T}}$ the natural growth of the population in Romania;
- $t = \overline{1,T}$ the time period analyzed, between the years 1990-2021;
- T the number of terms in the series;
- ε represents the residual variable.

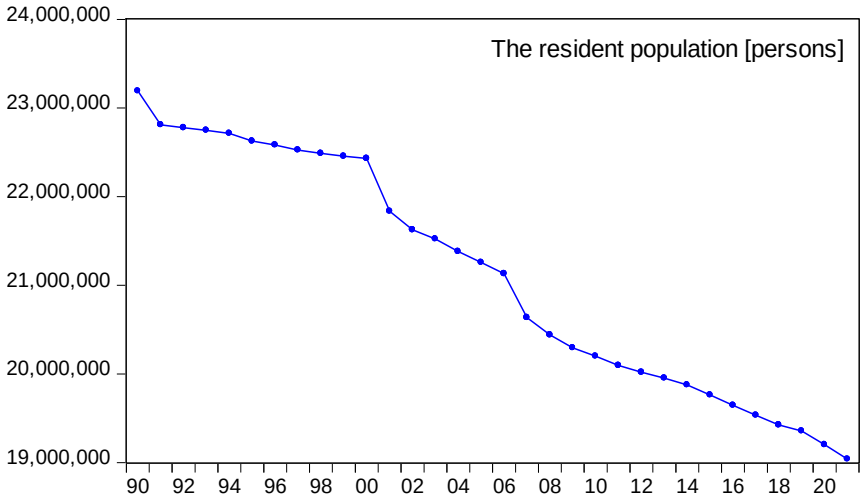

Figure 2. The evolution over time of the number of people resident in Romania

The parameters of the model defined in relation (1), $\beta_1, \beta_2, ..., \beta_7$ are determined by the least squares method, their values can be found in the following table (Coefficient column bolded in yellow).

Table 3 lists the values of the main descriptive indicators of the analyzed variables, for a number of 32 observations. Data were obtained by running Eviews 10.1.

Thus, for the five analyzed variables, the main indicators that give information about the central tendency of the data series (average values, medians), the dispersion indicators (standard deviations), but also the indicators that give information about the shape and distribution of the data series.

Table 2. The results obtained in Eviews

Dependent Variable: Y
Method: Least Squares
Sample (adjusted): 1991 2021

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	71330485	38924820	1.832519	0.0793
T	-33690.89	18161.19	-1.855104	0.0759
X1	6.897071	4.831201	1.427610	0.1663
X2	-1.890876	3.037562	-1.622498	0.5395
X3	-0.770709	8.577890	-1.089848	0.9292
X4	-6.512285	4.463974	-1.458854	0.1576
Y(-1)	0.756500	0.116899	6.471372	0.0000
R-squared	0.992246	Mean dependent var		21044007
Adjusted R-squared	0.990308	S.D. dependent var		1311144.
S.E. of regression	129079.0	Akaike info criterion		26.56992
Sum squared resid	4.00E+11	Schwarz criterion		26.89372
Log likelihood	-404.8337	Hannan-Quinn criter.		26.67547
F-statistic	511.8925	Durbin-Watson stat		1.898666
Prob(F-statistic)	0.000000			

Table 3. The values of the descriptive indicators

	Y	**X1**	**X2**	**X3**	**X4**
Mean	21111141	224624.3	264834.9	32543.50	-38648.09
Median	21193760	217872.0	261773.0	32486.50	-41752.50
Maximum	23192274	314746.0	334910.0	39985.00	67660.00
Minimum	19038098	180735.0	247086.0	22785.00	-104175.0
Std. Dev.	1344568.	25250.94	16554.48	3583.068	30104.75
Skewness	0.015963	1.583807	2.711053	-0.238588	1.199013
Kurtosis	1.483381	6.585569	11.50743	3.622747	7.108852
Jarque-Bera	3.068204	30.52012	135.7008	0.820681	30.17759
Probability	0.215649	0.000000	0.000000	0.663424	0.000000
Sum	6.76E+08	7187979.	8474718.	1041392.	-1236739.
Sum Sq. Dev.	5.60E+13	1.98E+10	8.50E+09	3.98E+08	2.81E+10

In the following figure, the graphs of the real values and those adjusted by the multivariable dynamic model with increasing trend are represented. As can be seen the two graphs are close enough to say that the model analyzed here approximates the data series very well.

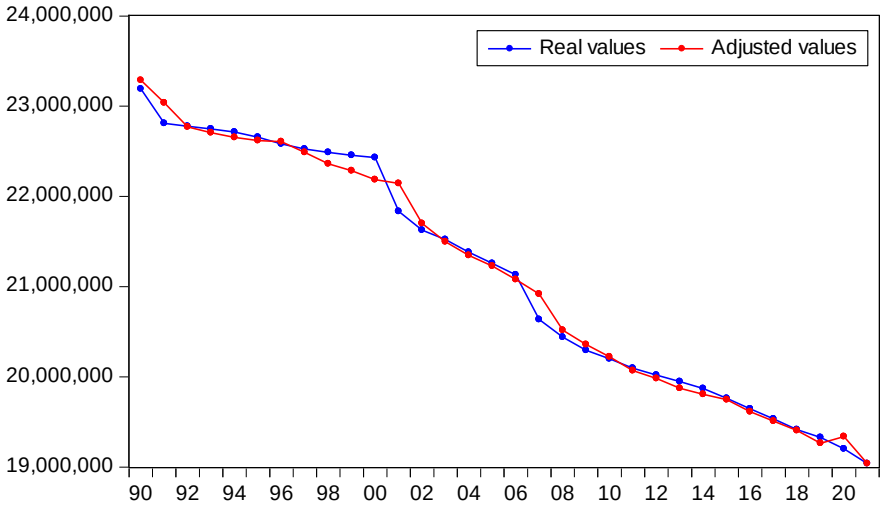

Figure 3. The real and adjusted values corresponding to the Romanian population

In order to be able to validate the model defined in relation (1) and to verify the specific hypotheses of multivariable econometric models, in the next paragraph we will analyze the data obtained after running the Eviews 10.1 program.

4. INTERPRETATION OF THE RESULTS

Analyzing the data obtained following the running of the Eviews program, it is observed that the linear trend of population evolution, but also the number of deaths, divorces and natural increase lead to a decrease in the number of people resident in Romania. On the other hand, the number of live births has a positive effect, as expected, on the population of Romania.

The very high value of the determination coefficient R^2 and of the adjusted coefficient of determination, shows that there is a very strong, direct linear dependence between the variables. On the other hand, Table 2 shows the value of the Durbin-Watson statistic, which is calculated to detect the first-order autocorrelation phenomenon of calculation errors. Comparing this value with the two critical values $d_1 = 1,09;\ \ d_2 = 1,83$, for a significance threshold of 5% and $k = 5$, we note that the double inequality $d_2 < dw < 4 - d_2$ is satisfied. In other words, we can say that the residuals are not correlated with each other.

To detect heteroscedasticity, we apply the Breusch-Pagan-Godfrey test through the statistic $LM = n \cdot R^2$. By checking the inequality $LM = 17,46 < \chi^2_{6;0,01} = 18,48$ for a significance threshold of 1%, it is observed that the variance of the residual is constant (Table 3).

To check the normality of the residuals, the Jarque-Bera test is applied, which consists in comparing the value of this test with the critical value of the statistic $\chi^2_{6;0,05} = 12,59$. Thus, it can be seen that the inequality $JB = 8,089 < \chi^2_{6;0,05} = 12,59$ is

satisfied, therefore we say that the hypothesis of normalization of residuals is accepted (Table 4). We also observe a slight asymmetry of the series of residuals to the left, and a value of the vaulting coefficient of 4,56.

Table 4. Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	5.158642	Prob. F(6,24)	0.0016
Obs*R-squared	17.46088	Prob. Chi-Square(6)	0.0077
Scaled explained SS	18.67566	Prob. Chi-Square(6)	0.0047

An important problem in multivariable models is the detection of multicollinearity. This can be done either by calculating the inflation factor or by calculating the covariance matrix.

In the following table, the values of the inflation factor are entered for each analyzed parameter. As all the values are lower than five, we can say that the multivariable model does not present the phenomenon of multicollinearity.

Table 5. Jarque-Bera Test

Skewness	-0.974822
Kurtosis	4.568953
Jarque-Bera	8.089354
Probability	0.017515

Table 6. Variance Inflation Factors

Variable	***C***	***T***	***X₁***	***X₂***	***X₃***	***X₄***
Coefficient Variance	3.52	3.30	2.33	3.99	3.58	4.92

To test the validity and quality of the multivariable dynamic model with an increasing trend, the analysis of variance is applied. For this, the calculated value of the Fisher-Snedecor statistic $F = 511{,}893$ (Table 3), it is compared with the critical value of the same statistic, for a significance threshold of 5%. So, if $F > F_{0,05;5;26} = 2{,}5871$, then the model is correctly specified, being considered valid from an econometric point of view.

Taking the above into account, in the following next paragraph we will make forecasts for a period of four years.

5. FORECASTS

Based on the dynamic multivariable model defined in relation (1), we will make forecasts for a period of four years. It should be noted that, for the forecasts made

in the period 2022-2025, no particular changes are made to the evolution of the resident population in Romania, which would disturb the quality of the forecasts.

The values of the input variables used to make forecasts were obtained following the analysis of econometric models specific to time series. Thus, the evolutions over time of the number of live births, the number of deaths, the number of divorces and the natural increase in Romania were analyzed. Based on these models, forecasts were made over a period of four years.

The values predicted using these models were used within the multivariable model defined in relation (1). These input variable values are entered in table 7.

Table 7. The values of the input variables used in making forecasts

Years	X_1 [persons]	X_2 [persons]	X_3 [persons]	X_4 [persons]
2022	223810	329056	27135	-105246
2023	219302	329944	26922	-107342
2024	213709	333654	26452	-109945
2025	210093	334125	26025	-110032

Figure 4 shows the evolution over time of the resident population in Romania, highlighting the forecasted period (blue color). Also, the values of the main statistical measures specific to assessing the quality of the forecasts are listed in the adjacent table. The lower the values of these statistical measures, some close to zero (Theil coefficient, bias proportion, variance proportion, covariance proportion), the more the quality of the forecasts made by the model is appreciated.

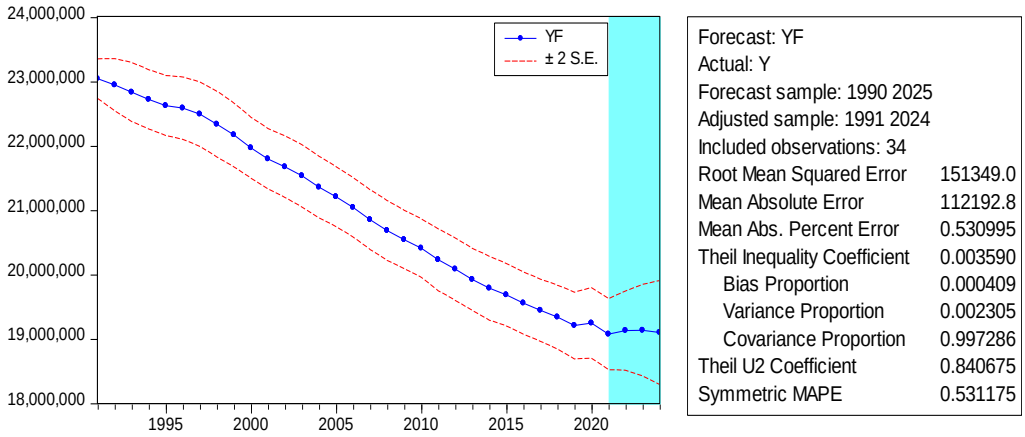

Figure 4. The graphic of the forecast values for Romanian resident population in 2022-2025

Comparing the forecasted value based on the dynamic multivariable model with the value provided by the National Institute of Statistics regarding the resident population in Romania in 2022 (19042455 people), it can be seen that they are quite close.

Thus, we can say that the forecasts made in this article regarding the number of the resident population in Romania until 2025 are plausible, but we must take into account the fact that they are made only according to the natural movement of the population.

In the following table, the forecasted values for the number of the resident population in Romania from the period 2022-2025 are entered.

Table 8. The forecast values of the resident population in Romania

Years	The forecast values by the multivariable model (1) for Romanian resident population [persons]
2022	19065381
2023	19120852
2024	19130340
2025	19099418

6. CONCLUSIONS

In this article, the evolution of the number of people resident in Romania was analyzed from an econometric point of view according to the main indicators specific to the natural movement of the population. For this, a multivariable dynamic model with an increasing trend was used. The analyzed period is 32 years (1990-2021).

The obtained results show that the number of live births has a positive influence on the total number of the resident population at the national level. On the other hand, the number of deaths, the number of divorces and the natural increase lead to the decrease of the resident population in Romania.

In addition, if we compare the results obtained in this article with those provided by Population Pyramid [10], regarding the forecasts of the evolution of the population in Romania from the year 2025 (19424322 people), we notice that they present differences of 324309 people. But these differences can be justified by the fact that in the article they are made only according to the natural movement of the population, while those provided by the Population Pyramid are obtained according to all demographic indicators.

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