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Population Forecast in the Socialist Republic of Romania until 1990

Setting out from the place and role of the population forecast in the system of social-economic prognosis, the author presents several variants of forecast of Romania's population until 1990, variants which are based on certain hypotheses about birth -and-death rate in the future. The comparison of the main demographic indices resulting from the forecast enables to infer the conditions (especially of a demographic character) in which Romania's population can reach about 25 million in 1990, as envisaged by the documents adopted by the Eleventh Party Congress.

The population forecast is an integral part of social-economic prognosis. The knowing of the probable growth of the population according to various characteristics, among which a special place is held by the knowing of labour resources and of the active population, is necessary for drawing up the plans and programmes for economic and social development, for ensuring the growth of the population in keeping with the requirements of building the manysidedly developed socialist society.

The main economic and social phenomena cannot be modelled without taking into account a number of demographic variables. Moreover, the population forecasts, in most cases, preceede the prognoses in other fields, representing their basic elements.

The population forecasts take into consideration the dual character of the population. Through its part which represents the active population, the population is the producer of material and spiritual assets, consequently of the social product and the national income, being the decisive factor of progress and of the continuous evolution of our society and, on the other hand, the population as a whole is the consumer, in a broad sense, of both material goods and spiritual assets.

This has led to the necessity of elaborating forecasts on the total population, in the first place and to prognoses on the structures of this population, fundamental and analytic structures which should serve the substantiation of various sectors of economic and social activity: production and consumption, education, culture, health protection, social insurance, urbanization and house building, etc.

The implications of a certain number of the population and of a certain structure of it are numerous and complex (of a demographic character inclusively). Therefore, as it is pointed out in the party and state documents, the problem of the number and structure of the population should be analysed with great sense of responsibility.

The population forecast in various variants is necessary (besides the beforementioned arguments) for knowing — by comparing the forecast variants — the conditions (especially of a demographic character) in which an optimum number and structure of the population can be ensured in relation to the economic, social and political objectives to be carried out in a certain period and for taking the necessary measures for the achievement of a demographic and economic policy corresponding to these objectives.

In order to meet with such requirements, several prognosis variants have been drawn up, setting out from the analytic prognosis on sex and age.

HYPOTHESES USED FOR THE FORECAST OF THE POPULATION ON SEX AND AGE

The population forecast which is presented in continuation was achieved in six variants. These variants are in keeping with the hypotheses about the death-rate law under whose incidence the population will fall in the years representing the prognosis period (1975—1990) and in keeping with the hypotheses on the regime of birth-rate, for the same period of time.

Two variants have been drawn up in keeping with the death-rate regime:

— Variant I, having as a hypothesis the death-rate law established on the basis of the 1970—1972 death-rate table for the population of Romania, a table elaborated by the author [1]), which corresponds to an average expectation of life at birth of 68, 62 years for both sexes, 66, 27 years for the male sex, 70,89 years for the female sex and on the basis of the death-rate table of Sweden in the 1963—1967 period [2]) which corresponds to an average expectation of life at birth of 71,72 years for males and respectively 76,13 years for females. For this variant, the long-range survival probabilities have been determined as a mean of the long-term survival probabilities calculated on the basis of the two tables. This means an under-estimation of specific death-rate on years of age for the first period of the prognosis horizon, an under estimation which is compensated, in exchange, by its over-estimation in the second period.

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1) The table was presented by the author in his report "Population Forecast in the Socialist Republic of Romania on Sex and Age in the 1973—1990 Period", at the Symposium on "Aspects and Trends of the Demographic Phenomena and the Factors Influencing Them", Bucharest, January 22—23, 1974.

2) Statistical Abstract of Sweden, Stockholm, 1971, pp. 77.

In accepting this hypothesis, one sets out from the premise of a continuous decrease of specific death-rate on years of age, especially at young ages, considering that towards 1990, infantile death-rate will ever more get near the threshold of endogeneous death-rate.

Variant II is based on the hypothesis on a constant death rate law for the entire 1974—1990 period, determined on the basis of the 1970—1972 death-rate table for the population of Romania.

Each of he two variants according to the death rate regime are combined with three variants each in keeping with the birth-rate regime for the future period, as follows:

Variant	I *a*	and Variant	II *a*
„	I *b*	„	II *b*
„	I *c*	„	II *c*

Symbols *a*, *b*, *c* refer to the birth-rate indices in keeping with which the number of live borns was calculated for each year of the prognosis horizon.

Variants I *a* and *II a* were calculated in the hypothesis of a specific fertility at the level of 1970, corresponding to a general birth-rate index of 21.1‰.

— Variants I *b* and II *b* were calculated in the hypothesis of a specific fertility at the level of 1971, corresponding to a general birth-rate index of 19.5‰.

— Variants I *c* and II *c* were calculated in the hypothesis of a specific fertility at the level of 1973 corresponding to a general birth-rate index of 18.2‰.

All these variants do not take into consideration external migration.

DESCRIBING THE MATHEMATICAL MODEL

The elaboration of the mathematical model was done in keeping with the prognosis method used, the analytic method.

According to this method, the number of the population at a certain age i for a year in the prognosis period j is equal to the product between the population at age $i-1$ of the year $j-1$ and the long-range survival probability from age $i-1$.

Thus, if λ_i represents the longrange survival probability for age i and if p_{i_k} represents the population at age i in the year k, we have:

$$p_{i,\,k+1} = \lambda_{i-1} \cdot p_{i-1,\,k}$$

$$p_{i+1,\,k+1} = \lambda_i \cdot p_{i,\,k}$$

$$p_{i+2,\,k+1} = \lambda_{i+1} \cdot p_{i+1,\,k}$$

In view of describing the mathematical model, the following is considered to be given:

— Matrix $\Lambda = ((\lambda_{ij}))\ i = j = 0,\ 1,\ 2,\ \ldots,n$

$(n+1) \times (n+1)$ where the elements on the main diagonal are the long-range survival probabilities corresponding to age, the rest of the other elements being zero.

Thus, for any λ_{ij}, where ratio $i \neq j$ exists, we have $a_{ij} = 0$.

— The column vector $P = \begin{pmatrix} p_0 \\ p_i \\ \vdots \\ p_n \end{pmatrix}$ whose elements

represent the population corresponding to the age on the lst of January of the year constituting the calculus basis (in the present case 1974).

— The line vector $R = (r_1, r_2, ..., r_l)$ which comprises the population at the age of zero years for each year k belonging to the population forecast horizon.

Besides these elements which represent the initial data, the following should also be specified:

— Matrix $P = ((p_{i,k}))$ $\begin{matrix} i = 0, 1, 2, ..., n \\ k = 1, 2, ..., l \end{matrix}$ $(n \times l)$,

having as components, the population planned at age i in the year k.

— Matrix $X = ((x_{h,k}))$ $\begin{matrix} h = 1, 2, ..., s \\ k = 1, 2, ..., l \end{matrix}$ $(s \times l)$

made up of the population on groups of age h within each year k of the prognosis horizon.

— Matrix $Z = ((z_{h,k}))$ $\begin{matrix} h = 1, 2, ..., s \\ k = 1, 2, ..., l \end{matrix}$ $(s + l)$,

whose elements contain the percentage values of the share of each total on groups of age h, in the year k, in comparison with the total population in the year k.

— The line vector $T = (t_1, t_2, ... ,t_l)$ comprising the total population for each year k of the prognosis horizon.

— the population forecast was achieved on age sex, from 0 to 100 years ($n = 100$).

— the prognosis horizon is of 17 years, thus until January 1 st 1991 (respectively December 31,1990).

— the groups of age h are five-year groups (0—4; 5—9; 10—14;...; 80—84), except the last group $s(s = 18)$, which is made up of the population between 85 and 100 years of age, thus 85 + years).

On the basis of those shown above, the population forecast was achieved in the following steps:

1. The population was calculated for the first year of the horizon, as follows:

$$P_{0,1} = r_1 \qquad i = 1, 2, 3, ..., n$$

$$P_{i,1} = \Lambda_{i-1,\ j-1} \cdot P \quad j = 1, 2, 3, ..., n$$

As a result of these operations, a column vector is obtained representing the population planned beginning with the age of zero years until that corresponding to age $n + 1$ years for the first year of the prognosis horizon.

It is noticed that the first element of this vector was obtained by attaching the first component of the line vector R, instead of the first missing element corresponding to the age of zero years. At the same time, at the same vector $P_{i,1}$, the last element corresponding to age $n+1$ is excluded.

Following this operation, the first column vector of matrix P was completely formed.

2. The population was calculated for the rest of $k+1$ years of the prognosis horizon, as follows:

$$\begin{aligned} P_{0,k} &= R_k && i = 1, 2, ..., n \\ P_{i,k} &= \Lambda_{i-1,\ j-1} \cdot P_{i-1,\ k-1} && j = 1, 2, ..., n \\ P_{n+1,k} &= 0 \end{aligned}$$

3. The total population for each year k of the horizon was calculated.

$$T_k = \sum_{i=0}^{n} p_{i,k} \quad k = 1, 2, ..., l$$

4. The population planned for all groups of age $h = 1, 2, ..., s\text{-}1$, was calculated, as follows:

$$X_{h,k} = \sum_{i=5(h-1)}^{5 \cdot h-1} p_{i,k} \quad k = 1, 2, ..., l,$$

For the last group of age, $h = s$, ratio

$$X_{18,k} = \sum_{i=85}^{100} p_{i,k} \quad k = 1, 2, ..., l$$

was used.

5. The share of the population of each group of age h in the year k in relation to the total population in the year k was calculated.

$$Z_{h,k} = \frac{X_{h,k}}{T_k} \quad \begin{matrix} h = 1, 2, ..., s \\ k = 1, 2, ..., l \end{matrix}$$

Together with this mathematical modelling which was used in the population forecast on sex, the following matrix ratios were also used for obtaining the total population

$$P^* = P^m + P^f$$

$$X^* = X^m + X^f$$

$$T^* = T^m + T^f$$

$$Z^* = \frac{X^*}{T^*}$$ where symbols P, X, T, Z preserve their significance and

m, f, and * signify the male, female and respectively the total population (both sexes).

All ratios presented above represent the mathematical modelling necessary for the population forecast in the hypothesis of a single birth-rate index and of a certain death-rate regime.

As the population forecast was made according to three birth-rate indices (21.1‰, 19.5‰ and 18.2‰) and two hypotheses on death-rate, this modelling was used several times.

The solving of the above described model was achieved with the aid of the electronic computer I.B.M. 370/135 of the Department of Economic Cybernetics of the Academy of Economic Studies based on the elaboration of adequate programmes symbolically called "PROGPOP".

Prognosis of the population of 0 years old. In the mathematical model used for the population forecast, the line vector R which comprises the population at age 0 for each year k belonging to the prognosis horizon is considered as a given size which was determined on the basis of the data about the number of women of the fertile contingent on five-year groups of age in the previous year $(k-1)$ and in the corresponding hypothesis concerning the specific fertility on age.

Thus

$$N_k = \sum_{i=15-19}^{45-49} F_{i_{k-1}} \cdot f_i,$$

where:

N_k — the number of live borns in the year k;

$F_{i_{k-1}}$ — the number of women of the fertile contingent on five-year groups of age in the year $k-1$;

f_i — specific fertility on five-year groups of age.

To achieve the population forecast on sex, the number of live borns thus obtained was distributed on sex, the following ratio being used: per hundred of live borns, 512 born male and 488 female. The number of live borns on sex was then ammended with the corresponding probabilities of decease (q_0), the number of the deceased at the age of 0 being established.

$$M_0 = N \cdot q_0$$

Since the decease occurs not only in the year of birth, but, part of the live borns will die in the following year, it was considered (this is an ascertained fact) that approximately 2/3 of the deceases are registered in the year of birth and the rest in the following year. Consequently, we have taken into consideration in the calculus:

$$M_0' = 2/3 \; M_0 \text{ where,}$$

M_0' — the number of the deceased in the year of birth.

The number of the population of 0 years of age which was included in the prognosis was finally established for each year, as follows:

$$P_0 = N - M_0'$$

Final Results of the Forecast. The population forecast in the six variants is a conditional prognosis, based on the above described hypotheses.

A brief presentation of the global results of prognosis (table 1) and of the main demographic indices resulting from the prognosis of the population in the 1976—1990 period (table 2) allows us to formulate the following conclusions:

Prognosis of the population of Romania at the end of 1975, 1980, 1985 and 1990 (respectively the 1 st of January 1976, 1981, 1986 and 1991).

Table. 1

in thousands

	Variant I			Variant II		
	a (n=21.1‰)	*b* (n=19.5‰)	*c* (n=18.2‰)	*a* (n=21.1‰)	*b* (n=19.5‰)	*c* (n=18.2‰)
1 I 1976	21446	21381	21316	21391	21326	21263
1 I 1981	22768	22534	22303	22580	22350	22125
1 I 1986	23965	23556	23153	23657	23256	22863
1 I 1991	25112	24524	23948	24699	24123	23560

The number of the population resulting from the prognosis in the six variants for the end of 1990 is situated between the maximum limit of 25,112 thousand and the minimum limit of 23,560 thousand thus a difference of 1,552 thousand persons.

The differences existing between the number of the population provided by the six prognosis variants are due, in the first place, to the birth-rate regime adopted for the prognosis horizon and, to a smaller extent, to the hypotheses on death-rate.

Thus, at the difference of 1552 thousand persons between the two extreme variants (Variant I *a* and Variant II *c*) the adoption of a different death-rate law which corresponds to a difference of the average expectation of life at birth of 1.64 years, contributes with 388 thousand persons, whereas the hypotheses on birth-rate (an index of general birth-rate of 21.1‰ for Variant I *a* and respectively 18.2‰ for Variant II *c*) contributes to this difference with 1164 thousand persons.

According to the prognosis Variant I *a* the population of Romania will exceed 25 million in 1990, amounting to 25,112 million on the 1st of January 1991. This means an average rate of the population growth of 1.1% in the 1976—1990 period, possible in the conditions of a natural growth (annual average) of 244,000 persons, corresponding to an index of natural growth of 10.5‰, much higher to that achieved in 1973 (8.4‰).

This natural growth is possible only in the conditions of a number of annual live borns which should exceed 450,000, that is under the conditions of a general birth-rate index of at least 20‰ for this whole period and the death-rate index being maintained below 10‰.

This means the promotion of such a demographic policy in our country which should lead, in the first place, to the stimulation of natality. Thus, in the documents adopted by the Eleventh Congress of the Romanian Communist Party, besides the objectives concerning the number of the population

(about 25 million in 1990) and its structure, concrete measures are envisaged for increasing natality, for consolidating the family, for aiding children and. the large families, etc., measures whose implementation will be consistently pursued by the party and state leadership.

The main demographic indices resulting from the population forecast in the 1976—1990 period.

Table 2

	Variant I			Variant II		
	a	*b*	*c*	*a*	*b*	*c*
1 Number of live borns (thousands)	7004	6459	5926	6995	6450	5918
— annual average	467	431	395	466	430	394
2 Number of deceased (thousands)	3338	3316	3295	3688	3653	3621
— annual average	223	221	220	246	244	241
3 Natural growth (thousands)	3666	3143	2631	3307	2797	2297
— annual average	244	210	175	220	186	153
4 Birth-rate index (‰)	20.0	18.5	17.4	20.2	18.9	17.5
5 Death-rate index (‰)	9.5	9.6	9.7	10.7	10.7	10.7
6 Natural growth index (‰)	10.5	8.9	7.7	9.5	8.2	6.8
7 Average rate of population growth (%)	1.1	0.9	0.8	1.0	0.8	0.7

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PREVISION DE LA POPULATION DE LA R.S. DE ROUMANIE D'ICI 1990

Prenant comme point de départ le lieu et le rôle de la prévision démographique dans le système de la prévision sociale économique, l'auteur présente plusieurs variantes de prévision de la population de Roumanie, d'ici 1990. Ces variantes ont pour fondement certaines hypothèses concernant le régime de la natalité et de la mortalité en perspective.

La comparaison entre les principaux indicateurs démographiques qui résultent de la prévision offre la possibilité d'en extraire les conditions (surtout d'ordre démographique) requises pour que la population de la Roumanie atteigne les 25 millions d'habitants au cours de l'année 1990, selon les documents adoptés par le XI-ème Congrès du Parti Communiste Roumain.

ПРОГНОЗ НАСЕЛЕНИЯ СОЦИАЛИСТИЧЕСКОЙ РЕСПУБЛИКИ РУМЫНИИ ПО 1990 г.

Исходя из места и роли демографического прогноза в системе социально-экономического прогноза, автор представляет несколько вариантов прогноза населения Румынии по 1990 г., имеющих в своей основе определенные предположения в отношении режима рождаемости и смертности в перспективе. Сопоставление вытекающих из прогноза основных демографических показателей дает возможность выявить условия (в особенности, демографического порядка), при которых население Румынии может достигнуть в течение 1990 г. примерно 25 млн. чел., как предусматривают документы, принятые на XI-ом съезде Румынской коммунистической партии.

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