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Some methodological aspects in forecasting the population size (on the example of Poltava region)

Abstract: Somemethodological features, methods to forecast population size in Poltava region by extrapolation are considered in the paper. A population size forecast for Poltava region by 2020 has been made based on the initial data on population dynamics over the period 2001-2014. The basic problems and causes of population number decline in the towns and districts of Poltava region have been determined.

Keywords: forecast, population number,dynamics, towns and districts of Poltava region.

Actuality of the research. Today in Ukraine we are witnessing inter-regional differentiation of geodemographic development caused by the complex influence of various natural and geographical, historical, socio-economic, political factors,etc. Geodemographic development of Poltava region as one of the regions of the Ukraine in crisis situation and demographic depopulation is characterized both by European, and post-Soviet tendencies. European tendencies include decline in natural increase despitethe longer life expectancy and the agingpopulation. The post-Soviet tendencies include fall in the number of young adults and rise in the difference between the average life expectancy of men and women. To control these negative demographic trends appropriate measures of regional policy should be planned. Such measures should be based on a clear vision of the future. Thus, long-term demographic forecasts have to be developed.

Analysis of previous studies. The study of geodemographic development and population size forecast is impossible without the analysis of the research on the subject. Analysis of the processed results and scientific work makes it possible to streamline the existing theoretical framework and clarify the practical application of the research results. A number of Ukrainian and foreign scientists including N. Baldych, I. Kurylo, E. Libanova, V. Mamonova, Z. Palyan, K. Sehida, D. Ediev, R. Fisher, A. Hinde, D.T. Rowland and others, studied the concept of demographic forecasting of the size and structure of the population.

The main material of the research. In demographic analysis we use various methods based on the knowledge, purpose and availability of data on demographics, geography, statistics, mathematics, social and natural sciences. Demographic forecast widely uses mathematical methods closely related to statistics. Using mathematical methods, we can obtain quite a complete and credible picture of the population reproduction conditions based on incomplete fragmenteddata. The main demographic forecasting methods are:

- Economic-mathematical methods of extrapolation;
- analytical method;
- expert method;
- cohort-component method (method of cohorts transportation).

This study has reviewed in detail forecasting by the extrapolation method, in particular, on the example of Poltava region, as a region of Ukraine with negative trends in geodemographic development.

Any forecast is based on the extrapolation of the past trends, in one form or another. When extrapolating, the predicted process serves as a function of time in which the effect of other factors determining the direction and intensity of the process,is accumulated. Application of extrapolation methods for future population estimates is based on the assumption that the identified trends in fertility, mortality, will not change over the forecast period [3].

Extrapolation methods are the simplest forecasting methods based on the prediction of average annual growth rate, average annual absolute and relative increments. They can be used in the calculation of the total populationsize only when there are no sharp fluctuations in fertility, mortality, migration.

One of the conditions of the forecast veracity is compliance of the dynamics with linear distribution; the closer approximation probability is to one, the more accurate is the forecast. Thus, a mathematical model of extrapolation according to the average absolute population growth is a linear function:

$Pt = P0 + \Delta \cdot t,$

where Pt is the population size projected for the end of the year,

P0 - population in the base year,

Δ - absolute average annual increase in population based on historical data,

t - number of years in the forecast period.

Real absolute increases can be stable only for a short period, so population forecasting based on a linear function can only be used in short-term projections (not more than 5 years).

Extrapolation methods are widely used in demographic forecast because the demographic processes are rather inert in their development. However, this leads to the major drawback in extrapolation models, namely the fact that they come from the idea of "average" growth and do not address the existing gender and age structure of the population: the annual fertility, mortality and migration. If there are data, the best estimate can be made based on the components of population change (fertility, mortality and migration) in the period between censuses.

Thus, as an example we forecast population size by 2020 for the towns and districts of Poltava region [2]. The initial data for the development of the forescast are the dynamics of the population size in Poltava region for the period 2001-2014 years. [4]. For the region, we forecast not only the total perspective population, but also the urban and rural population.

From the data dynamics analysis we can confirm that they comply with the linear distribution, and the prognosis is credible if other factors do not affect it. We can also determine the overall trend, optimistic and pessimistic values by determining the standard deviation. To determine the predictive value a trend line was constructed because the distribution of the population is linearly dependent and the probable approximation is - 0.98, indicating the veracity of the forecast.

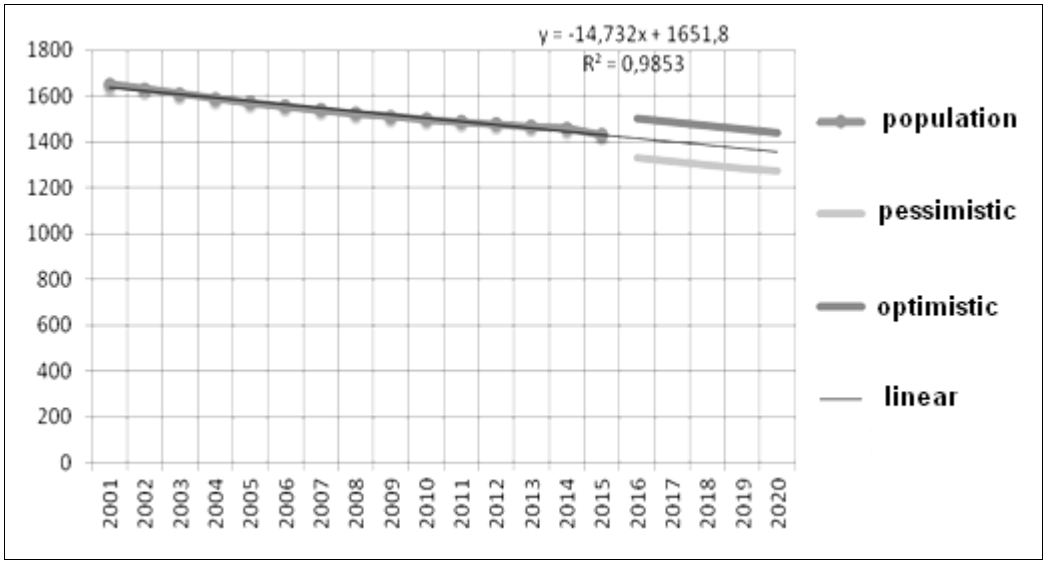

Figure 1. Forecast of the population size in Poltava region by 2020 by extrapolation method (calculated and constructed by the authors [4])

By 2015 there was a tendency to the population decline, and this trend will also persist by 2020. According to estimates, the population of Poltava region will be 1357.2 thousands people. Based on the pessimistic forecast, the population of the region will be 1272.1 thousands people, we see that deviation is in permissible values, indicating that we have the normal distribution of the sample data. According to optimistic forecasts the population in 2020 will be 1442.3 thou-sandspeople; consequently, the increase in population growth is impossible by 2020 only due to natural movement. The population of Poltava region tends to decrease, so we need to apply measures of population policy to improve the demographic situation and approach optimistic population size.

Let's consider the forecast of urban and rural population in Poltava region for 2020. Before 2015 there was a tendency to the urban population decline. As a result, in 2020 the population will be 859 thousands people, which is 31 thousands people

fewer than in 2014. Based on a pessimistic forecast urban population of the region will be 827 thousands people, the optimistic forecast is 891 thousands people.

Rural populations also havea tendency to gradual decrease. Distribution has a slight deviation from the linear distribution, where approximation is 0.97. In 2020 rural population will be 495 thousands people. As for the pessimistic forecast, the rural population will be 438 thousands people, meaning that the difference from the forecast value is by 57 thousands people. According to optimistic forecasts, there will be 552 thousandspeople of the rural populationin 2020.

Forecasts for all the towns of regional subordination and districts of Poltava region correspond to a linear dependence, indicating the normal distribution of the population by year, due to predominance in areas with the highest level of approximation for the rural population, because these areas have their City Councils, whose population was not taken into account. The areas with a relatively low value of approximation are characterized by a large number of urban population. Common to all areas is a tendency to the population decline, the largest differences between pessimistic and optimistic outlook have Chornuhynskyy, Shyshatskiy, Dycansky, Mashivsky, Kotelevsky areas, this is explained by the sharp drops in growth from one year to the next. The smallest difference is in Poltava, Globinskiy, Hadiach, Kobeliatsky, Lokhvytsky and Khorol areas. These areas have a very high value of approximation.

Considering the dynamics of natural increase for the 2009-2014, it has been determined that there is a tendency to reduction in the populationin all areas. In predictive values the most depressed is Chornuhynskyy district characterized by a rapid decrease in population due to natural and mechanical reduction.

Thus, the obtained forecast results indicate unfavorable demographic prospects for the region. Under any scenario, Poltava region population will steadily decrease. The main cause of the population decline is a very low level of fertility. Moreover, weak points of extrapolation method are in connecting the data for the near future to past demographic events when the shape of the curve (future trend) is not defined, which may cause significant errors. The extrapolation method gives a very rough average estimate of future population size, but this forecast can be used in the planning of socio-economic development of the country and its individual administrative units.

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