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ANALYSIS OF SOME IMPORTANT DEMOGRAPHIC INDICATORS IN ALBANIAN POPULATION PROJECTIONS FOR THE FUTURE

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SUMMARY
Population projections are important in analyzing demography process as well as forecasting their future. In this paper we examine some of the most important indicators of population: mortality rate, nativity rate, growth rate and fertility rate for Albanian population using demographic methodology. By analyzing the birth number and death number time series during the period 1985-2008 (INSTAT) we examine their mathematical models then build a regression model and an ARIMA model to help projection for the future. Also, we forecast a time - varying index of mortality using regression and then compared with an autoregressive integrated moving average (ARIMA) framework using R software and programming language. After building these models based on information criteria and error measurements we study their accuracy and give explanations about the model that best fits the data. The result obtained is important for many policy development of Albanian government.
Key words: population projection, mortality, fertility, regression, ARIMA.

Introduction

Population projections are important for the development of demography, social, economic and climacteric indices in one country.

The demography indices for Albanian population over years have shown both an increasing trend for a specific period and a decreasing one for other periods. As seen from the plot of the annually data (INSTAT) [7], for number of births from 1935 to 2009, we notice a clear upward trend for the period after the Second World War (the data for the period 1942-1946 are missing) and a decreasing trend after 1985.

The paper is organized into two main parts: the first part analyzes the effectiveness of birth data and deaths in Albania for the period January 1985 to December 2008. Based on these indicators we look at the population growth rate over years and build models for prediction purposes. The second part deals with fertility rate; we build mathematical models (regression model and Autoregressive Moving Average) and used them to predict the progress of these indicators in the future.

At the end of the work we aim to choose between the models that best fit demography data of Albanian population and analyze their accuracy based on error measurements and information criteria (Akaike and Bayesian criteria).

1. Population Growth Rate per month in Albania (1985- 2008)

For better analysis of growth rate for Albanian population we look at the number of births and deaths for the period 1985 to 2008. Based on their characteristics (trend, seasonality, stationary) we build mathematical models for projection purpose.

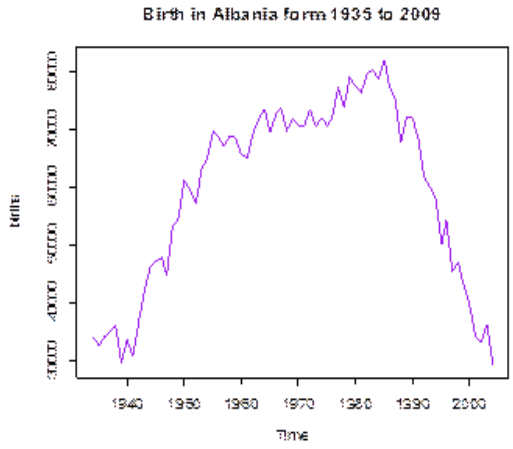

Figure 1. Number of birth by year, 1935-2009 [1]

Number of deaths in a country is just as important as the number of births and both these indicators are important to describe the fertility rates of that country.

a) Nativity

The time series for number of births for the 24 year period (Figure 2) show not only a decreasing trend but also a seasonal pattern [6].

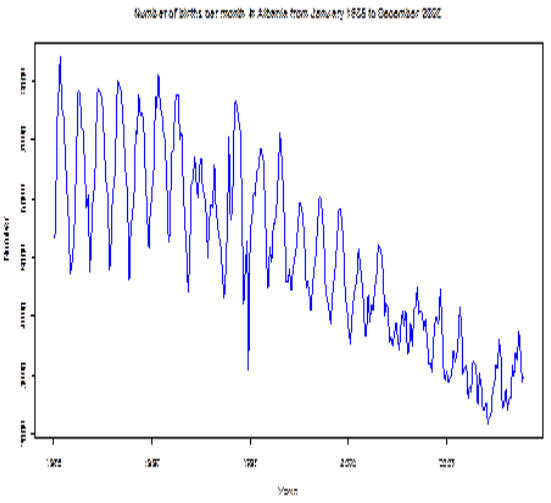

Figure 2. Birth's number per month in Albania, 1985-2008

Analysing carefully Figure 2 one might see that form January 1985 to December 1995 the data are stationary and they have seasonal regularity patterns which repeat themselves almost every year. After January 1995 a decreasing trend is present and also a seasonal pattern which becomes unstable and fluctuated in recent years.

To gain a deeper analysis of the population growth rate for Albania, we consider even the deaths' number for the period January 1985 to December 2008.

b) Mortality

Mortality rate is a measure of the number of deaths (in general, or due to a specific cause) in some population, scaled to the size of that population, per unit time. We analyze the number of deaths' by month as an indicator of mortality in Albania population.

The deaths' number by month seems to be stationary (Figure 3). There are months in which the values are higher and other months in which the values are lower. This can be explained as a seasonal pattern, similar to the birth' number time series.

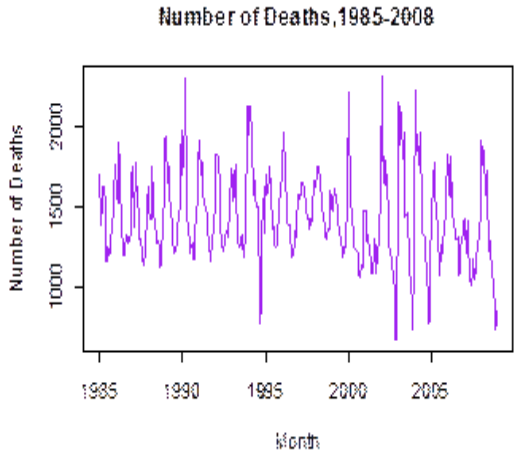

Figure 3. Death number per month in Albania, 1985-2008

We clearly see form Figure 3 that the series of data is stable until 1995 and after this year's seasonal tendency is preserved but the fluctuations become increasingly larger. These

changes in recent years will make it difficult to build a "good" model for forecasting purposes of deaths number.

Using population projection formulae we inspect Population Growth Rate (PGR) as the fractional rate at which the number of individuals in a population increases. Often it is expressed as:

$$PGR=\frac{\text{Population at end of period - Population at beginning of period}}{\text{Population at end of period}} \quad (1)$$

The above formulae can be written as follows (not in percentage):

$$\text{Growth rate}= B_t - D_t \quad (2)$$

Formulae (2) are derived from the population projection formulae:

$$\text{Population at moment } (t+1)= P_t + B_t - D_t \quad (3)$$

Where,

$$P_t = \text{Number of Population at moment t,}$$

B_t = Number of Births at moment t, D_t = Number of Deaths at moment t (4)

The complete model should take into consideration the number of Immigrants and Emigrants in the moment of time *t*, but the data for Albania are not sufficient to find or estimate these indices. So, we take into consideration only the birth and death number at moment of time *t*.

As seen from Figure 4, this series has a decreasing trend and this is mostly affected by the number of births which has decreased significantly after 1995. Also Figure 4 shows the presence of seasonal patterns that clearly lies almost over the years.

A regression model of PGR over time also indicates this decreasing trend:

$$PGR = 5839.3509 - 15.0671*t \quad (5)$$

Multiple R-squared: 0.6647, Adjusted R-squared: 0.6635

The value of R-squared and Adjusted R-squared are significant and indicate no stationary, this is also evident from the Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) plots in Figure 4. Autocorrelation values go outside the critical values.

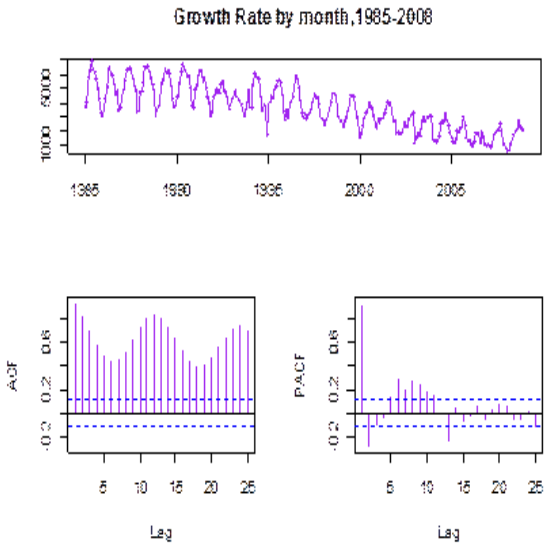

Figure 4. Population Growth Rate by month in Albania, 1985-2008

c) Population Growth Rate model and forecast

The model - ARIMA methodology

Population Growth Rate can modeled as a stochastic process and consequently we can use the standard Box and Jenkins methodology (identification, estimation, diagnostics and forecasting), [6, 7] , to generate an appropriate ARIMA(p, d, q) model for number of births per month in Albanian population [2,3].

The procedure of the ARIMA model goes through different iterative phases which we have used for building these models [4].

Based on the model of Box and Jenkins (1970), the seasonal autoregressive integrated moving average model is given by [5]:

$$\Phi_p(B^s)\phi(B)\nabla_s^D\nabla^d X_t = \alpha + \Theta_Q(B^s)\theta(B)w_t \quad (6)$$

Where,

s = seasonal lag,

□□ □□coefficient for AR process,

□ = coefficient for seasonal AR process,

□□ = coefficient for MA process,

□ = coefficient for seasonal MA process.

B is the backward shift operator, $\nabla_s^D = (1-B^s)^D$ and $\nabla^d = (1-B)^d$, w_t is an uncorrelated random variable with mean zero and constant variance, [3].

The proposed model is: *ARIMA(3,1,3)(1,0,1)[12]*

Coefficients of the model are:

ar1 ar2 ar3 ma1 ma2 ma3 sar1 sma1

-0.7293 0.1947 0.4437 0.5336 -0.6467 -0.7974 0.9373 -0.5862

Information criteria: *AIC = 4301.25 AICc = 4301.9 BIC = 4334.19*

Our proposed model is a SARIMA model (Seasonal Autoregressive Moving Average) with seasonal coefficient *m=12*.

We selected the one with the lowest values of error measurements or information criteria between the proposed models, [9].

Using the above model we predict the values of PGR for the next three years (Figure 5).

The patterns of the model show that the predicted values will be stationary and will continue with the seasonal pattern over time.

We group the data annually by calculating the average value for every month, 24 data for the period 1985 to 2008. The annually data and a graphical regression analyze are shown in Figure 6/a and Figure 6/b

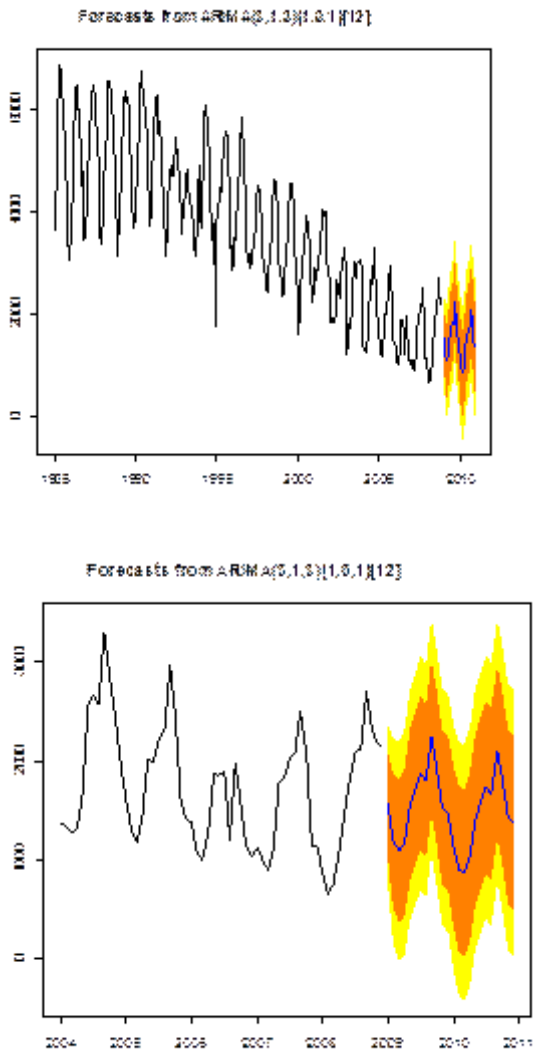

Figure 5. Monthly Population Growth Rate, 1985-2008 and the predicted values 2009- 2010.

Fertility rate for Albania (1985-2008)

The Total Fertility Rate (TFR) of a population is the average number of children that would be born to a woman over her lifetime. The TFR is an average because some women will have more, some fewer and some no children at all. This coefficient is a better index of fertility than the Crude Birth Rate (annual number of births per thousand populations) because it is independent

of the age structure of the population. The TFR for Europe in the recent years has been estimated to be 1.5 children per woman 9].

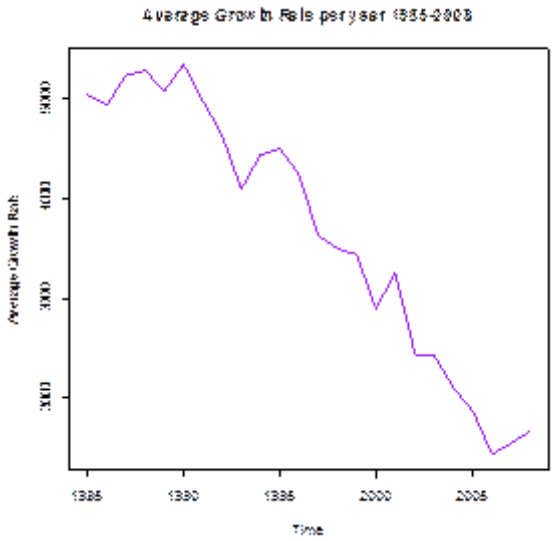

Figure 6.a Annually average of PGR, 1985-2008

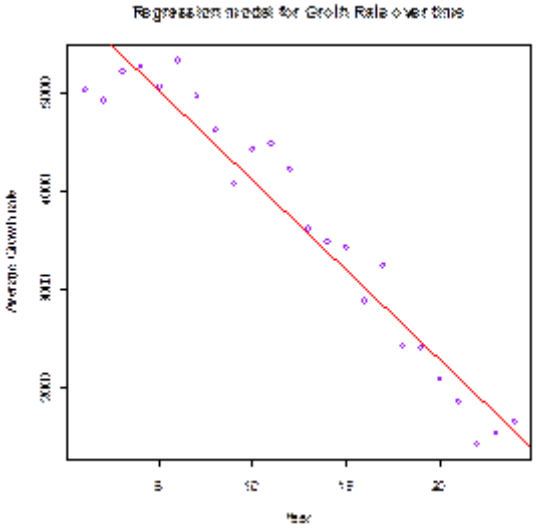

Figure 6.b Regression line of the average values of PGR, 1985-2008

For Albanian population we take into consideration the number of births and number of marriages to evaluate the TFR. Because in every marriage there is one woman that is responsible for giving birth and, thinking that mostly in every marriage there is high possibility (probability) that the woman gives birth and survive from birth we evaluate the TFR as follows:

$$\text{TFR} = \frac{\text{Number of births per month}}{\text{Number of marriages per month}} \quad (7)$$

The graphical view of the TFR series is shown in Figure 7.

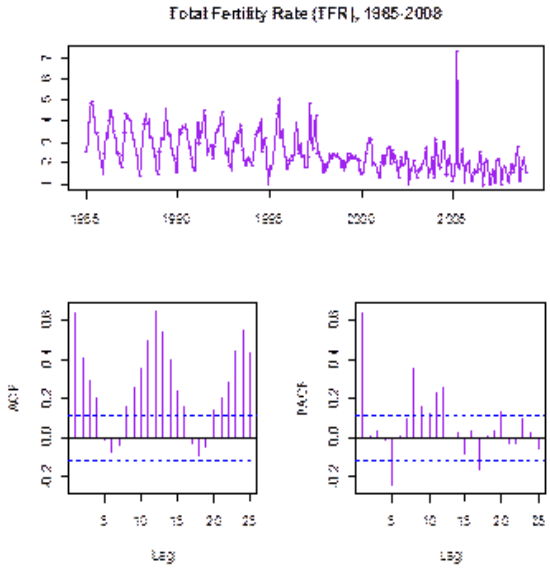

Figure 7. Total Fertility Rate by month, ACF and PACF

Analyzing the ACF and PACF plots of the TFR time series we might say that: the TFR time series seems to be stationary and at the same time it has a smoothed decreasing trend. Using the proposed SARIMA model [8], the predicted values of this coefficient show that our assumption for a decreasing trend is justified.

The average value for the next five years is approximately 1.5, which is lower than the border value of TFR (equal to 2), but at the same level of the average predicted value in Europe [9]. Figure 8, shows the predicted values for TFR and the confidence intervals.

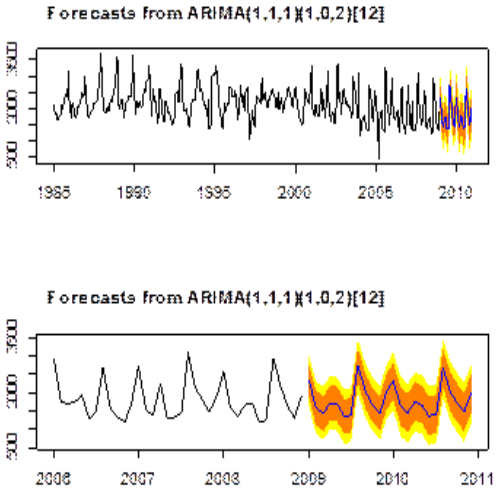

Figure 8. Prediction of TFR, 2009-2010

CONCLUSIONS

Demographic projections are important not only in the social field of one country but also in the economic , cultural, environmental field. In this paper we used the monthly data and construct a Seasonal Autoregressive Moving Average model with seasonal patterns which was used to predict the values for the next years of PGR (Population Growth Rate) and TFR (Total Fertility Rate) for Albania.

We want to emphasise that Albanian population has entered in a decreasing period which may affect the economic, social parameters and not only. Emigrants (which we have not taken into consideration) are also another factor, which might accelerate the decreasing rates in Albania.

Total fertility rate is another important coefficient we should be concerned about, because the predicted values are decreasing.

Albanian government policies need to look carefully the course continuity of these indicators and forecasts for the future in order to improve the conditions for a sustainable demographic situation in the region and not only.

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