COMPARATIVE ANALYSES OF FERTILITY EVOLUTION IN IASI COUNTY

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Abstract: *Iasi County has seen, in the last twenty-three years, a decline of the general fertility rate both in the urban region and in the rural region which leads to a decrease in the number of inhabitants and the aging of the population. The purpose of this study is to compare the trend of the general fertility rate, GFR, among the main age groups of fertile women, between 1990 and 2013. In order to accomplish this goal, we use time series analysis. Our results show that the GFR series presents a decreasing trend, from 70.6 children at 1000 women in 1990 to almost half in 2013. Future studies should investigate the determinant factors of this decline for GFR in Iasi County, we will investigate the influence of income, of unemployment and of level of education on general fertility rate (GFR).*

Keywords: Fertility; GFR; Time Series Analysis; ARIMA
JEL Classification: J11; J13

Introduction

During the last twenty-three years, the General Fertility Rate (GFR), of Iasi County has witnessed a decrease: from 70.6 children at 1000 women in 1990 to 45.2 in 2013. GFR for women between 20 and 24 years in the urban region decreased from 129.1 to more than half, to 59.1 children at 1000 women. GFR for women between 20 and 24 years in the rural regions also decreased, but with a smaller percentage than in the urban region from 182.8 to 90.4. GFR for women between 25 and 29 years in urban region decreased from 99.6 to 82.4 children at 1000 women. GFR for women between 25 and 29 years in the rural region decreased from 165.0 to 83.8. GFR for women between 30 and 34 years in urban region increased from 47.0 to 73.5 children at 1000 women. GFR for women between 30 and 34 years in the rural regions decrease from 181.7 to 62.8.

The fertility evolution was analysed by Frejka and Sobotka (2008) for some European countries. They assumed that the „baby boom period (1950-1960) was replaced by delaying motherhood resulting in a decline of the fertility in Europe" (Frejka and Sobotka in 2008). There are several other studies which analysed the decrease in fertility in Europe (Billingsley, 2009; Bloom and Sousa-Poza, 2010; Hondroyiannis, 2010).

In Romania, the decrease of fertility was study by Ghetau (2007) and by Amariei (2013). Another important study, (Jaba *et al.*, 2008) shows a great decrease of the birth rate in Romania between 1990 and 2004, due to economic conditions.

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The purpose of this research paper is to quantify the level of fertility in Iasi County, between 1990 and 2013 using GFR, by developing the statistical model of fertility evolution that estimates the trend of GFR and quantifying the errors.

GFR measures the frequency of new born at 1000 women at fertile age (15-49 years) in a certain period, usually one year (INSSE, 2015). GFR is calculated for the whole fertile female contingent, as well as for age groups. It is calculated based on the mean of female population recorded by the mother's home.

1. Methods

This paper is focused on the fertile female population of Iasi County between 1990 and 2013. To measure the fertility, the General Fertility Rate was chosen, which indicates the average number of living new born at 1000 women in one year. The data for the total GFR and the GFR for the main fertility age groups were retrieved from the INSSE databases, covering the time span from 1990 to 2013.

In order to accomplish the study's goal, we use time series analysis to describe the fertility trend. The equations describing the GFR are:

$$GFR = \alpha_1 + \beta_1 t + e_1$$
$$GFRu_{20-24} = \alpha_2 + \beta_2 t + e_2$$
$$GFRu_{25-29} = \alpha_3 + \beta_3 t + e_3$$
$$GFRu_{30-34} = \alpha_4 + \beta_4 t + e_4$$
$$GFRr_{20-24} = \alpha_5 + \beta_5 t + e_5$$
$$GFRr_{25-29} = \alpha_6 + \beta_6 t + e_6$$
$$GFRr_{30-34} = \alpha_7 + \beta_7 t + e_7$$

(1)

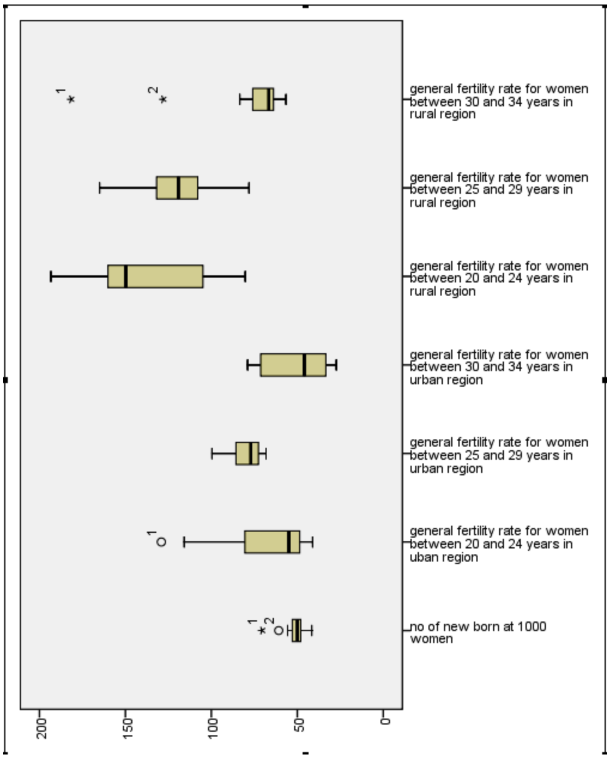
where GFR is the dependent variable, defined as the average number of new born at 1000 women, $GFRu_{20-24}, GFRu_{25-29}, GFRu_{30-34}$ are the general fertility rates for women between 20 and 24, 25 and 29, 30 and 34 years in urban regions; $GFRr_{20-24}, GFRr_{25-29}, GFRr_{30-34}$ are the general fertility rates for women between 20 and 24, 25 and 29, 30 and 34 years in rural regions, is the general fertility rate for women between in the urban region; *t* is the time, expressed in years, as an independent variable, e_i designates the error, as a random component and α_i, β_i are the estimated coefficients, i=1 to 7.

The determinist component, $\alpha_i + \beta_i t$, is estimated by the least squares method, and the random component, e_i, is estimated using the Box-Jenkins method, namely ARIMA.

2. Results

The data used to show the fertility trend, based on entries between 1990 and 2013, is analysed under SPSS 16.0 and under Eviews 7.1. The results indicate that all GFR analysed except for the GFR of women between 30-34 years in rural region, in Iasi County during the examined period, presents a normal distribution, slightly asymmetric, as seen in Figure 1.

Figure 1 – GFR distribution in Iasi County between 1990 and 2013



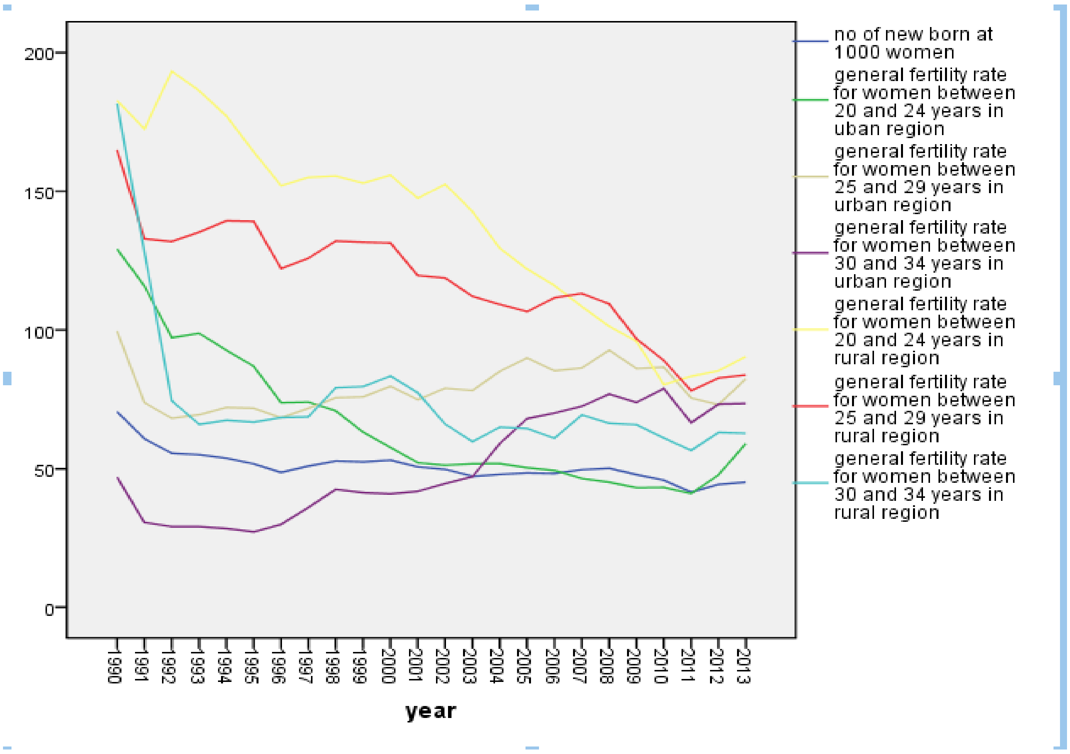
Source: Authors' results using SPSS

The average GFR in Iasi County, in the considered period, is 50.97 new born at 1000 women, the average $GFRu_{20-24}$ is 66.38, the average $GFRu_{25-29}$ is 79.22, the average $GFRu_{30-34}$ is 51.23, the average $GFRr_{20-24}$ is 137.62, the $GFRr_{25-29}$ is 117.36, the $GFRr_{30-34}$ is 75.12. The minimum value for GFR is 41.6 recorded in 2011, and the maximum GFR is 70.6, reached in 1990. The minimum value for $GFRu_{20-24}$ is 41.1 recorded in 2011, and the maximum $GFRu_{20-24}$ is 129.1, reached in 1990. The minimum value for $GFRu_{25-29}$ is 68.2 recorded in 1992, and the maximum

$GFRu_{25-29}$ is 99.6, reached in 1990. The minimum value for $GFRu_{30-34}$ is 27.3 recorded in 1995, and the maximum $GFRu_{30-34}$ is 78.9, reached in 2010. The minimum value for $GFRr_{20-24}$ is 80.3 recorded in 2010, and the maximum $GFRr_{20-24}$ is 193.3, reached in 1992. The minimum value for $GFRr_{25-29}$ is 78.1 recorded in 2011, and the maximum $GFRr_{25-29}$ is 165 reached in 1990. The minimum value for $GFRr_{30-34}$ is 56.6 recorded in 2011, and the maximum $GFRr_{30-34}$ is 181.7 reached in 1990.

In this article we examined only the trend and the errors for all GFR in Iasi County between 1990 and 2013. Using the scatter plot diagram we identify the models of the fertility evolution in Iasi.

Figure 2 – The general fertility rate evolution in Iasi between 1990 and 2013



Source: Authors' results using SPSS

Through an analysis of Iasi County's general fertility rate for the period 1990-2013, as seen in Figure 2, while GFR, $GFRu_{20-24}$, $GFRr_{20-24}$, $GFRu_{25-29}$, $GFRr_{25-29}$, $GFRr_{30-34}$ series show a downward trend, the series for $GFRu_{30-34}$ show an upward trend. For additionally examining the nature of these trends - based on the determination coefficient - R^2, we prefer the cubic model for describing the dynamic of the GFR, $GFRu_{20-24}$, $GFRu_{25-29}$, $GFRu_{30-34}$, $GFRr_{20-24}$ and for $GFRr_{25-29}$, and the inverse model for $GFRr_{30-34}$.

The equations of the models are:

$$\text{GFR} = 69.721 - 4.425 * t + 0.318 * t^2 - 0.008 * t^3,$$

$$GFRu_{20-24} = 134.214 - 10.226 * t + 0.331 * t^2 - 0.002 * t^3$$

$$GFRu_{25-29} = 94.588 - 8.294 * t + 0.836 * t^2 - 0.022 * t^3$$

$$GFRu_{30-34} = 48.707 - 8.144 * t + 0.946 * t^2 - 0.024 * t^3$$

$$GFRr_{20-24} = 182.044 + 0.288 * t - 0.382 * t^2 + 0.008 * t^3$$

$$GFRr_{25-29} = 153.533 - 4.765 * t + 0.278 * t^2 - 0.009 * t^3$$

$$GFRr_{30-34} = 56.438 + 118.8/t$$

(2)

where GFR is the dependent variable, defined as the average number of new born at 1000 women; $GFRu_{20-24}, GFRu_{25-29}, GFRu_{30-34}$ are the general fertility rates for women between 20 and 24, 25 and 29, 30 and 34 years in the urban regions, $GFRr_{20-24}, GFRr_{25-29}, GFRr_{30-34}$ are the general fertility rates for women between 20 and 24, 25 and 29, 30 and 34 years in the rural regions, t are the years ordered in ascending order, $t = 1990, \ldots, 2013$.

The random component is calculated as the difference between the empirical values from the model described above and the theoretical values. The random component is analysed by employing the Box-Jenkins method. From the Augmented Dickey Fuller test, included in Table 1, with an assumed risk of 5%, the series are non-stationary and therefore we need to differentiate once. All series are becoming stationary after estimating first difference, meaning that they are order 1 integrated, symbolically denoted by *I (1)*.

$$\Delta e = e_{t+1} - e_t$$

(3)

Where *e*=error; e_t=error at time *t*; e_{t+1}=error at time *t+1*.

Table 1 – Testing the unit root for all general fertility rates

Analysed series	Augmented Dickey-Fuller test statistic	
	t-Statistic	**Prob.***
GFR	-2.517569	0.3163
GFRu_20_25	-0.904206	0.9383
GFRu_25_29	-3.286157	0.1090
GFRu_30_34	-2.085893	0.5235
GFRr_20_24	-2.445603	0.3489
GFRr_25_29	-3.020381	0.1501

GFRr_30_34	-2.820568	0.2065
*MacKinnon (1996) one-sided p-values		

Source: Authors' results using Eviews

The GFR series presents an autoregressive component, but it has no moving averages. This stands for an ARIMA (1, 1, 0) model as in table 2.

Table 2 –Equation estimates

Analysed series	Method: Least Squares - Sample (adjusted): 1991 2013					
	Coefficient		Std. Error		Prob.	
	C	AR(1)	C	AR(1)	C	AR(1)
GFR	48.15485	0.639912	1.239138	0.068897	0.000	0.000
GFRu_20_25	49.41383	0.823980	6.669071	0.038964	0.000	0.000
GFRu_25_29	77.64054	0.484531	2.480403	0.153239	0.000	0.047
GFRu_30_34	0.00	1.017844	0.00	0.024057	0.000	0.000
GFRr_20_25	0.00	0.971436	0.00	0.012008	0.000	0.00
GFRr_25_29	97.12782	0.837262	16.00192	0.088824	0.000	0.000
GFRr_30_34	66.07375	0.461025	2.900569	0.055438	0.000	0.000

Source: Authors' results using Eviews

The errors series have to simultaneously fulfil three conditions:

1. Normality- tested via the Jargue-Berra test. Because all Sig. values are greater than 0.05, the normality hypothesis is accepted. The mean of errors is zero and so the estimated parameters are unbiased.

2. The homoscedastic hypothesis is tested using the Breusch-Godfrey Serial Correlation LM Test. The null hypothesis of this test is: the error series has no serial correlation up to a certain number of lags. Because the correlation coefficient does not significantly differ from zero, all Sig values being bigger than 0.05, we conclude that errors are homoscedastic.

3. The independence of errors is proved using the corelogramme of partial autocorrelation function (FACP).

Based on the above results we can conclude that our model is robust and well fitted. All GFR series are described by a cubic trend except for $GFRr_{30-34}$, general fertility rate for women between 30 and 34 years in rural region, which is described by an inverse trend.

Conclusions

The models of fertility in Iasi County from the last two decades show a decrease in all age groups' GFRs except for the series of general fertility rate for women between 30 and 34 years in the urban region which has a notable increase, smaller than the decrease of general fertility rate for women between 20 and 24 years in the urban region.

The analysis of the GFR in Iasi County in the last 23 years shows a decline in fertility with one exception: general fertility rate for women between 30 and 34 years in urban region increased. In the analysed period no cyclic component could be identified, which confirms the theory that for Romania, there is no natural fertility cycle (Jaba et *al*., 2013).

The number of children that a woman or a couple decide to have is the result of a complex combination of factors. Job's uncertainty, unemployment and stress are all factors that led to the decline of fertility in Romania in general, thus also affecting the North-Eastern region. The results obtained by time series analysis for TFR and by ARIMA for testing the errors are consistent and well fitted. The year 2011 represents a turning point for all analysed series. All of these series reached one of the smallest fertility levels in 2011. From 2012, when Romania began to recover from the economic crisis, the fertility seams to recover slightly. If this trend is maintained for a longer period, we believe that the fertility will increase, and the aging of population will diminish. Therefore, future studies should focus on analysing the influence of job uncertainty, unemployment and education on female fertility in Iasi County, both in urban and in rural region.

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