“Alexandru Ioan Cuza” University of Iasi

Doctoral School of Economics and Business Administration

PhD THESIS – Summary

Fertility determinants, effects and models

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Introduction

Economic and social development is strongly influenced by the population number. In turn, the population number is largely conditioned by fertility. On the other hand, fertility is influenced by economy and social development.

After 1990, Romania's population decreased by over 2.5 million inhabitants, according to the population censuses of 1992 and 2011. This decrease was mainly due to the drastic decline in fertility rates, to the increasing external migration and to the population ageing.

In the recent decades, there has been a growing concern at a European level in the demographic decline and the significant implications it would have on the economy, education and the pension system.

Decreased fertility is determined by economic, social and cultural factors, as well as the by the interaction of these factors.

Demographers, sociologists and economists such as Becker, Glaeser and Murphy (1999); Ahn and Mira (1999); Aassve, Mazzuco and Mencarini (2006); Gheţău (2007); Bloom and Sousa-Poza (2010); Bloom, Canning, Fink and Finlay (2010); Jaba et al. (2011) brought the issue of reduced fertility and birth to attention. Very low fertility rates in Europe have led to accelerated demographic ageing, reduced rate of native active population and workforce, reduced number of students, increased costs involved by the pension system and population decline.

The first literature studies state that fertility is influenced only by the living conditions. Nowadays, this idea is regarded as outdated. Several works (Anderson, 1986; Campione, 2008; Cigno, 1998; Weagley et.al. 2007; Rotariu, 2006) argue that fertility is influenced by socio-economic and cultural factors such as income, religion, desire to have better prepared children rather than a greater number of descendants, infant mortality, biological infertility, economic crisis, political regime, migration, delayed marriage and as a consequence delayed first pregnancy, education, human development index (HDI) and life expectancy.

The factors influencing the fertility of the human population will be identified in this thesis, and an estimate of the dynamics of this phenomenon will be done.

The studies conducted for the purpose of this paper aim at considering human fertility both at a European and at a national level, focusing on finding those methods and models that are best suited to analyse human fertility.
The thesis aims at studying the fertility issue in its evolution over time as well as at analysing the regional variation of this phenomenon.

The purpose of this paper is to identify the fertility model in Romania under the influence of fertility determinants. This paper has the following **objectives**:

- Defining concepts regarding fertility
- Presenting statistical methods for fertility analysis
- Identifying the main determinants of the human population fertility based on the determinants presented in the literature
- Adding knowledge in terms of fertility level evolution in Europe and in Romania
- Comparing the fertility in Romania with the fertility in Europe
- Studying fertility by age
- Presenting the fertility dynamics in Romania
- Setting the fertility model in Romania

The objectives of this thesis can only be achieved through the use of advanced statistical methods and adequate informational support.

By using panel analysis, we have identified the fertility model for Europe. This type of analysis has the advantage of being two-dimensional: temporal and spatial.

To gain an insight into the influence of factors on the population fertility in Romania during

1998-2012, we have used regression analysis. This analysis allowed us not only to identify significant factors influencing fertility, but also to create the fertility model at a national level.

To compare the fertility level in Romania with the fertility level in Europe, discriminant analysis has been used.

The work of internationally renowned researchers has been analysed: Malthus, Baltagi, Easterlin, Becker, Billingsley, Pressat, Haupt and Kane, Bloom, Sánchez-Barricarte and Fernández-Carro, Freedman, Moultrie and Dorrington, Morgan and Hagewen, Anderson, Campione, Cigno, Weagley, Kohler, Lee, Lesthaeghe and Neidert, Galor and Weil, Hondroyiannis, Bulatao and Lee. The work of Romanian researchers has also been discussed: Jaba, Roman, Gheţău, Asandului, Rotariu, Trebici, Voineagu, Căplescu and Mihăescu.

The PhD thesis is divided into four chapters, in addition to the Introduction, Conclusion, the Lists of figures and tables, References and Appendices.

Chapter 1 contains elements that define fertility and its indicators, fertility determinants and effects of this phenomenon on the economic development.

Chapter 2 presents a summary of the statistical methods used for measuring the size and dynamics of fertility.

Chapter 3 contains own empirical studies aiming to present the influence of the factors at a European level.

Chapter 4 presents fertility in Romania in relation to other European countries, as well as fertility in the county of Iasi.

Finally, Conclusions are presented.

Chapter 1. Conceptual elements regarding fertility

1.1 Concepts regarding fertility

- ***The fertility*** *of the human population refers to the number of live births in a given region at a specific time* (Rotariu T., 2010). This differs from *fecundity*, which refers to a woman's physiological ability to procreate.
- ***The birth rate*** is the average number of newborns per 1,000 inhabitants in a clearly defined geographical space within a certain period of time, usually a year (NIS, 2014). In Romania, the birth rate has declined in recent years from 13.6 births per 1,000 inhabitants in 1990 to 9.3 newborns in 2013 (NIS 2014).
- ***The total fertility rate (TFR)*** is the ratio between the number of living children and women population in fertile age (between 15 and 49 years old), in a region in a given year (Pressat, 1974). To calculate the total fertility rate, the specific fertility rates by years of age are cumulated, thus obtaining a synthetic image of the fertility intensity.
- ***The general fertility rate*** is the average number of newborns per 1,000 women in fertile age in a particular geographic area at a specific time (NIS, 2014).
- ***The population replacement level*** is the average number of children that a woman should give birth to so that the population should remain relatively constant, taking into account mortality rates. Population replacement level in developed countries is 2.1 children per woman.

1.2 Types of fertility

- Malthus's model, formulated in 1798 – fertility increases as long as food resources are sufficient.
- The European systematic model for the lowest fertility proposed by Bloom et. al., in 2010 – it divides the European states according to pregnancy delay, increased average age for first childbirth and low desire for having more children.
- Sánchez-Barricarte and Fernández-Carro's model, 2007 – it categorises the European states according to maternal age at birth, with the threshold at 30 years old.

- The Asian model proposed by Freedman in 1995 – it divides the Asian countries in countries with TFR > 2.1 children / woman (Muslim countries) and countries with TFR < 2.1 children.

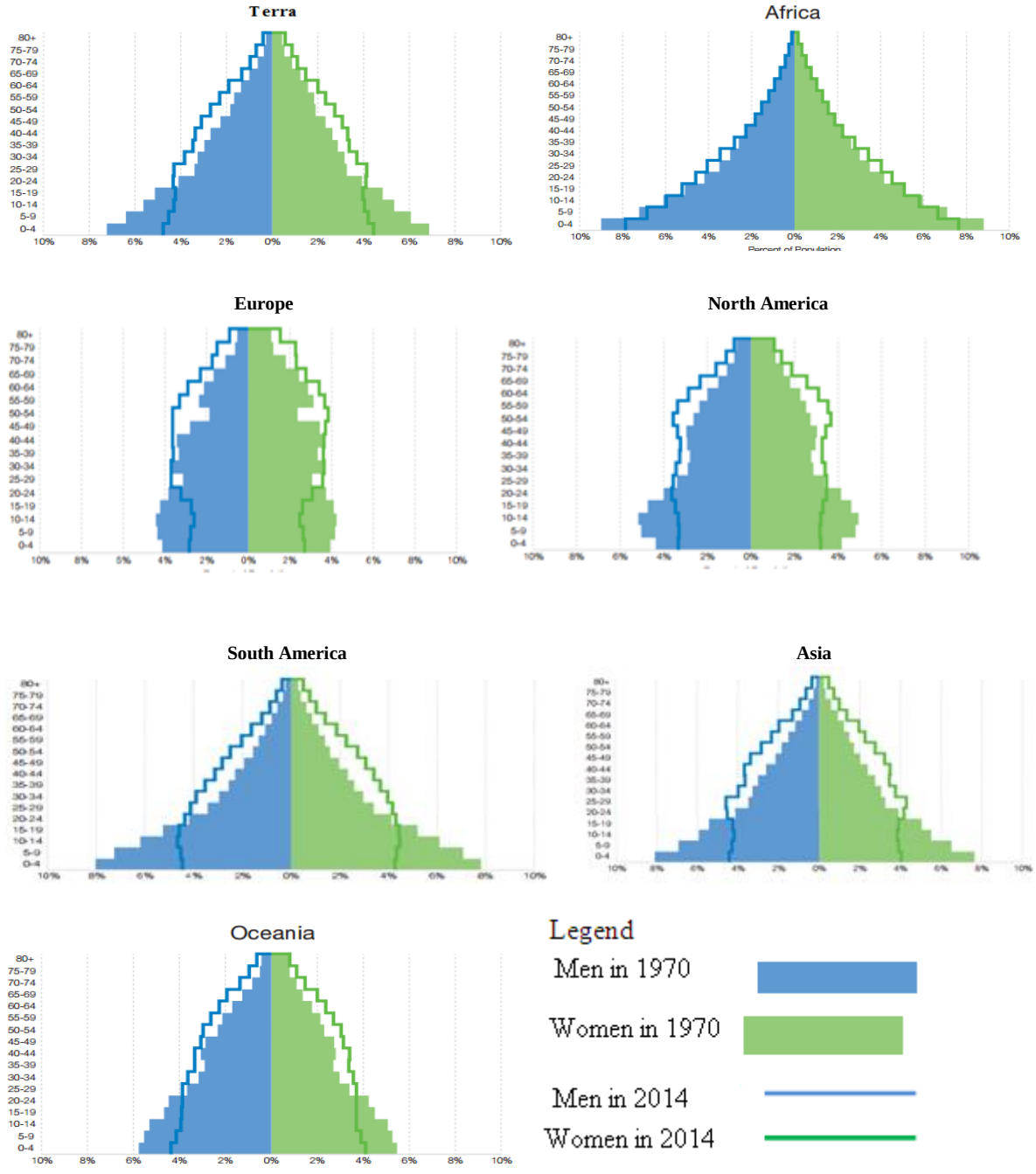
1.3 Determinants of fertility and demographic policy

- **The determinants of fertility** are income, infant mortality, delayed pregnancy, education, degree of urbanisation, children's education, the conflict between aspirations and resources, religion, women's time devoted to career, human development, unemployment
- **Demographic policies** should cover three areas: social protection for the family, education and family planning, balance between career and parenthood (Trebici, 1995).

1.4 Effects of Fertility

- The most important effects of changes in the level of fertility are felt in the increase / decrease of the population on Earth.
- Fertility influences the age pyramid.
- Fertility is self-determining.
- "The double process of ageing" (Billingsley, 2009).
- Long-term fertility can influence the economic development, the pension system and the health care system
- "The fertility trap" – when TFR falls below 1.5 children per woman, fertility is extremely difficult to increase because of normative changes and preferences in terms of number of wanted children (McDonald, 2008); in addition, below this threshold, fertility declines and consolidates itself (Skirbekk et al. 2006).

Figure 1: Distribution of global population by gender and by continent (in percentage) in 1970 and 2014



Source: 2014 World Data Sheet, United Nation

Chapter 2. Methods for measuring human fertility

Chapter 2 presents fertility indicators and statistical methods used for measuring human population fertility dimensions and dynamics.

The methods for identifying the influence of the determinants on fertility are also presented.

To set the fertility model in Romania, multiple regression analysis has been used. The estimated equation for the model is as follows:

$$y = a + b_1 x_1 + b_2 x_2 + \cdots + b_n x_n$$

where *y* is the dependent or predicted variable
x_i stands for independent variables or determinants
$a,\ b_i$ are regression coefficients
n = the number of independent variables considered in the model

Chapter 3. Empirical studies at a European level

3.1 The evolution of fertility in the European population under the influence of determinants between 1970 and 2010

The analysed sample includes 22 European countries considered between 1970 and 2010.

The variables used in the model are total fertility rate (TFR) and birth rates as dependent variables, infant mortality, mortality rate, gross domestic product (GDP) per capita and life expectancy in women.
TFR average in Europe in 1970 was 2.4 children per woman. Forty years later, there is a decrease of this indicator by almost a unit; thus, TFR average is 1.66 children / woman.
To study the evolution of the human fertility under the influence of determinants, panel data analysis has been used.

Using panel data analysis to study the above variables involves checking series, choosing fixed or random effect models, estimating model parameters and interpreting the results.

The results obtained following the fertility panel analysis, represented by the total fertility rate and by the birth rate, have shown significant influence of infant mortality, life expectancy and total mortality, but not of GDP.

Based on these results, we can say that for the 22 countries under discussion, the variables included in the model have a negative impact on fertility, expressed both by TFR and by BR (birth rate). The exception is infant mortality that has a positive impact.

The results included in this subchapter were presented at the national conference organised within the POSDRU/159/1.5/S/142115 project entitled "*Comparative analysis of the European population fertility between 1970 and 2010*" (Amariei, 2014).

3.2. Estimation of the influence of income and education on fertility in Europe between 1999 and 2012

The study aims at estimating the influence of income and education on fertility.

For this study, a sample of 24 European countries has been chosen.

The analysis covers 14 years, the period between 1999 and 2013. The year 1999 was chosen as the first year of research due to data availability for the variables under analysis.

Variables: TFR – dependent variable; tertiary education level and GDP – independent variables.

The method used is panel data analysis.

Equation of the obtained model:

$$TFR_{it} = 1.184925 + 0.0000121GDP_{it} + 0.338773EDU_{it} + e$$

where *TFR* = total fertility rate

GDP = gross domestic product

EDU = the percentage of women with tertiary education

e = error

The hypotheses proposed in this analysis are:

H1: Fertility is influenced by women's income and education level

H2: There is a reverse link between fertility and the proportion of women who have completed or are in course of completing tertiary education

H3: There are significant differences among the European countries in terms of level of fertility

According to this study, the influence of education on fertility levels is positive, which contradicts the second hypothesis of this study as well as the literature in this respect.

The results of this study show that there are differences in terms of human fertility among the countries under discussion and that the 24 states can be divided into two groups, confirming the third hypothesis of this research.

3.3. Analysis of total fertility rate depending on income and religion

In this study, a sample of 103 countries on all continents has been used to demonstrate the influence of religion on fertility. The applied methods are General Linear Model (GLM) and ANOVA. Data for the year 2011were collected from Nation Master.

After analyzing the results, it can be concluded that there is no significant difference in terms of TFR for the three Christian religions and Buddhism. There are no significant differences between

Muslims and Animists. There are considerable differences between the Animist and the Christian religions to which Buddhism is added. Fertility is significantly lower in the case of the Protestants and the Orthodox than for the Muslims and the Animists.

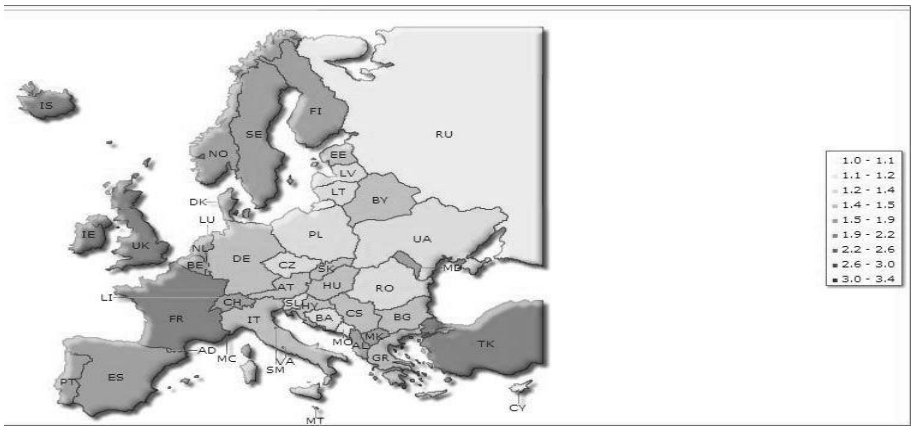
The average of the total fertility rate in 2011 was 2.4917 children per woman, which is more than the population replacement level, which automatically leads to an increase in the population of the Earth. This is mainly due to African countries.

The results of this section were published under the title "*World Religions and Their Influence on Fertility*" (Amariei, 2013).

3.4. Classification of European countries with regard to TFR and demographic policies – cluster analysis

The fertility level in Europe in 2011 differs from country to country, as can be seen in Figure 2.

Figure 2: TFR in Europe



Source: Index Mundi, 2011

This research focuses on a sample of 13 EU Member States as well as EU neighbours.

Variables – TFR, which is a dependent variable, has been chosen as indicator of fertility. For demographic policies, the chosen independent variables are indicators such as parental/maternity leave (0 – leave < six months, 1 – six months to one year leave, 2 – more than 1 year leave) and

abortion's legality (1- illegal abortion, 2 – abortion that is legal only under certain circumstances, 0 – legal abortion) considered as categorical variables.

The used method – cluster analysis – allowed the countries under analysis to be grouped into two categories:

- The group of countries with low fertility characterised by abortion's legality and parental leave for raising children older than 1 year.
- The group of countries with moderate fertility where abortion is illegal or allowed only under special circumstances and paid parental leave for less than six months.

The results of this section were published under the title "*Fertility and Demographic Policies*" (Amariei, 2013).

Chapter 4. Empirical studies on fertility in Romania

4.1. Romania's position in relation to European countries using discriminant analysis

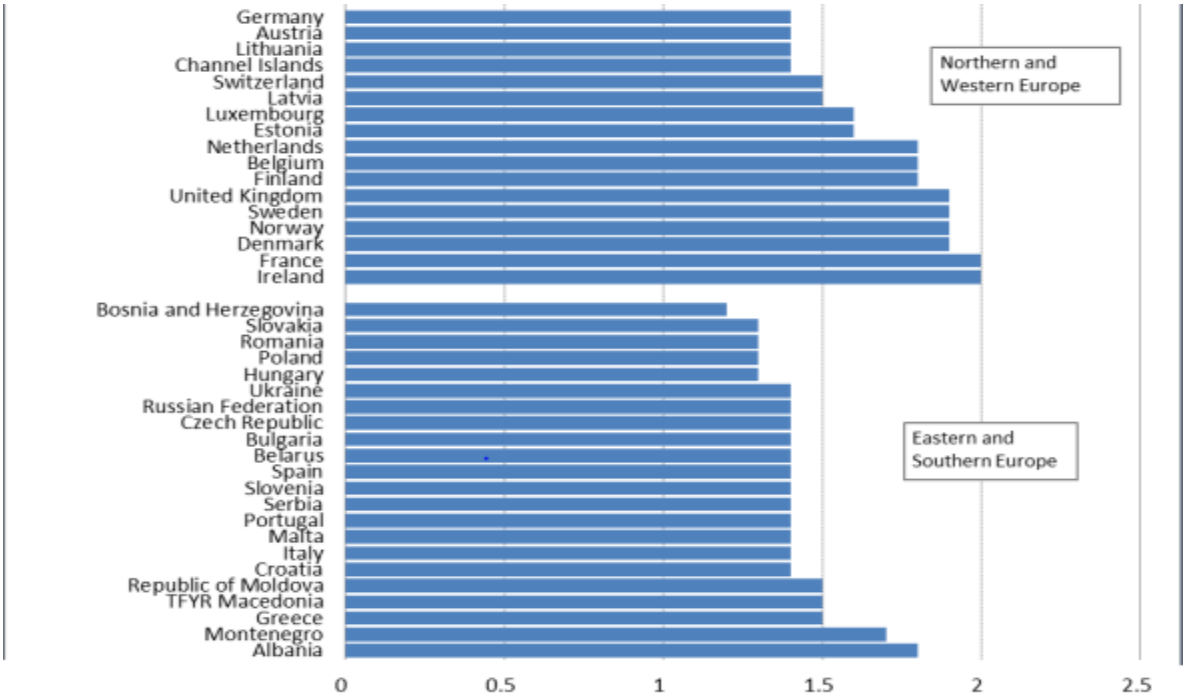
The analysed sample consists of 34 European countries considered in the year 2012. The variables used in the model are: the dependent variable – the total fertility rate with three categories (very low fertility – TFR less than 1.5 children / woman, low fertility – TFR belonging to the interval $(1.5,\ 2]$, normal fertility – TFR more than 2 children) and the independent variables – the average age of the mother at birth, the average of the schooling years, the net rate of migration, the income represented by GDP / capita, the economic uncertainty identified by unemployment, abortion and infant mortality.

Fertility determinants are represented by **income**, defined by *GDP / capita* according to the theory of Maltus (1798), Bulatao and Lee (1983), Freedman (1995), Galor and Weil (2000) and Docquier (2004); **economic uncertainty**, represented by the unemployment rate consistent with the theory of Hondroyiannis (2010), Neels (2010), Jaba et al., 2008; Eberstadt, 1994; Gauthier and Hatzius, 1997; Goldstein, Sobotka and Jasilioniene 2009, Jaba, 2015; **abortion rate**, which has a direct impact on the number of births; **infant mortality,** according Handa's theory (2000);

delayed pregnancy, which refers to the average age of the mother at birth (Billingsley, 2009; Sánchez-Barricarte and Fernández-Carro, 2007; Skirbekk et. al, 2006; Frejka and Sobotka, 2008).

Using the discriminant analysis, the European countries have been classified in terms of total fertility rate and its determinants.

Figure 3: Distribution of European countries in 2013 in terms of TFR



Source: Report of the United Nations in 2013

Figure 3 reveals that fertility in the countries situated in the North and North-West of Europe is higher than that in the countries situated in the East and South-East, but it is still below the population replacement level of 2.1 children.

Equations for the scores of the three groups - very low fertility, low fertility and normal fertility – are:

$$y_0 = -4.743 + 0.5 * x_5 + 6.526 * 10^{-5} * x_6$$

$$y_1 = -3.976 + 0.332 * x_5 + 9.477 * 10^{-5} * x_6$$

$$y_2 = -4.734 + 0.368 * x_5 + 7.856 * 10^{-5} * x_6$$

where x_5= unemployment rate, x_6= GDP / capita, y_0= very low fertility, y_1= low fertility, y_2= normal fertility

Using the discriminant analysis, the variables that significantly contribute to the differentiation between groups have been identified, namely unemployment and GDP per capita.

4.3 The fertility model in Romania

According to the 2011 census, Romania's population seemed to have declined by over 1.5 million inhabitants, compared to the previous census in 2002 .

The influence of determinants on fertility was determined using multiple linear regression analysis.

The variables considered in the model are the same used to position Romania in relation to other European countries by using the discriminant analysis.

Following the analysis, the equation for the model was obtained:

$$RTF = 0.833 + 0.062 * x_1 - 0.053 * x_2 - 0.006 * x_3 + \varepsilon$$

where TFR = total fertility rate, the dependent variable, x_1, x_2, x_3 = independent variables and

$\varepsilon = modelling\ error$

$x_1 = average\ number\ of\ schooling\ years$

$x_2 = unemployment\ rate$

$x_3 = GDP\ growth\ rate$

The results of this research are consistent with the literature and show that fertility declines when job instability increases, in other words when unemployment is rising.

Based on this regression model, we can estimate the total fertility rate in Romania in 2014. Depending on the three remaining independent variables in the model, we can estimate that TFR is 1.49 children / woman.

Unemployment rate = 6.5 (Eurostat statistics)
GDP growth = 2.4 (Eurostat statistics)
No schooling = 16.5 years (own estimate based on available data)

$$TFR = 0.833 + 0.062 * x_1 - 0.053 * x_2 - 0.006 * x_3$$
$$= 0.833 + 0.062 * 16.5 - 0.053 * 6.5 - 0.006 * 2.4 = 1.49$$

$x_1 = average\ number\ of\ years\ of\ schooling$
$x_2 = unemplyment\ rate$
$x_3 = GDP\ growth\ rate$

4.4 Empirical studies on the fertility in the county of Iasi

A single case study on the human fertility in the county of Iasi will be presented in this summary.

Fertility has fallen in the county of Iasi, just like in the entire country, leading to a negative vital index and to population ageing, and culminating with the decreasing number of inhabitants.

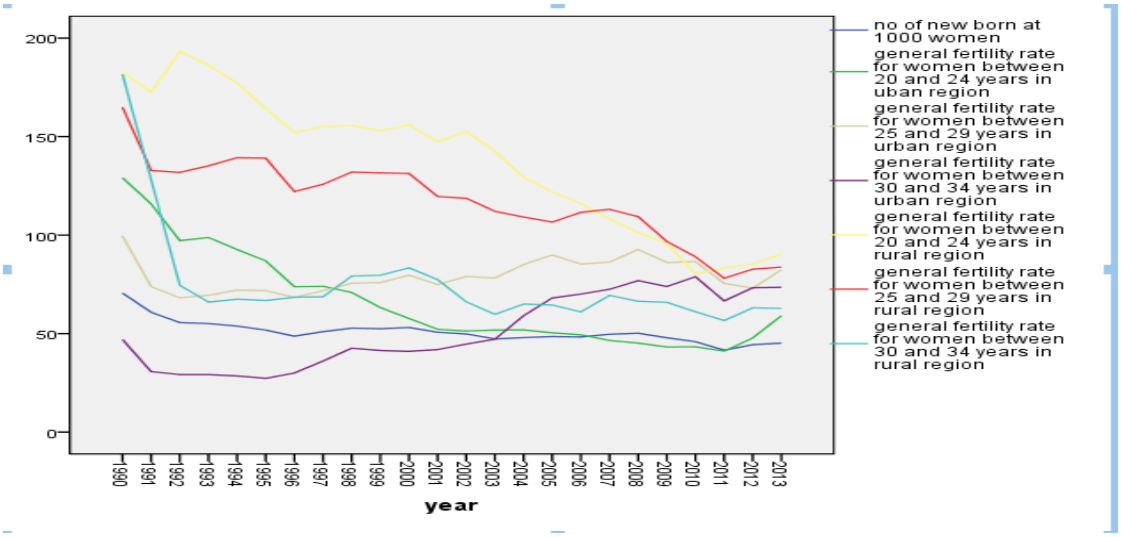
The study on the fertility in the county of Iasi aims to analyse the evolution of the general fertility rate on fertile age groups between 1990 and 2013.
The method used in this case is ARIMA and time series analysis.

The results show a downward trend of fertility. The general fertility rate has halved in just 23 years. The decline of the fertility has occurred both in urban and in rural areas. GFR (general fertility rate) was on average 70.6 children per 1000 women.

The results of this research indicate that all general fertility rates, except GFR for women in the

30-34 age group in urban areas of the county of Iasi during 1990-2013 recorded a downward trend.

Figure 4: Evolution of GFR by age in Iasi between 1990 and 2013



Source: own results obtained in SPSS

A cyclical component could not be identified in the analysed period, which confirms the theory that there is no natural cycle of fertility in Romania. (Jaba et al., 2013)

The number of children that a woman decides to have is a result of a complex combination of factors, which could represent a new direction for research.

Conclusion

Recent decades have brought a sharp decline in fertility in Europe and the drastic reduction in the number of children ranked higher or equal to two.

In our country, just as in Europe, the figures for the birth rate, mortality rate and marriage rate are low, while the average age at marriage, the average age at first birth and the divorce rate are rising.

The factors which influence human population fertility have been identified in this thesis, which allows us to forecast the dynamics of fertility.

Among the factors analysed here, and which can positively influence fertility, it is worth mentioning religion, especially the Muslim one, social norms and the income in some cases.

The income can increase fertility in the short term, but it can also have a negative effect on it in the long term.

Empirical studies conducted in this research on the issue of fertility in Europe reveal that fertility is negatively influenced to a somewhat extent by income; yet, in certain cases, it does not have a significant influence on fertility.

In most countries, women with higher education tend to have fewer children than those who have benefited from less education. This conclusion was not validated by this research which considered 24 EU countries over a period of 15 years – 2009-2013; on the contrary, it has been shown that education has a positive impact on fertility.

Economic factors (income, opportunity of getting proper housing, social protection) are determining factors in the decision of starting a family.

The results of this research show that there is a strong, reverse link between fertility and unemployment. As a result, increased job stability and new job opportunities, especially for young people, could result in increased fertility.

In addition, the results of this research show that infant mortality has a positive effect on fertility; in other words, if infant mortality grows, fertility will grow as well, as families want to replace the lost son or daughter. However, life expectancy and mortality rates have a negative impact on fertility.

It has also been proven here that fertility in the 20-24 age group in urban areas has decreased by 54.22% in the county of Iasi. The only increase has been recorded in the 30-34 age group in urban areas – 35.64%.

The results of this research contradict the literature in the field, showing that the level of tertiary education has a positive impact on fertility, and not a negative one as expected.

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The limitations of this research refer to the number of countries that have been included in the analysis, as well as to the relatively short time for analysing a demographic phenomenon.

Another limitation concerns the fertility determinants that were not included in the model, such as sterility, sexual orientation, preference for a particular family model.

Another limitation is the fact that research has been conducted only at the macro level and not at an individual level, which might reveal not only the rational decisions for delayed pregnancies, but also the emotional ones.

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The contribution of this thesis to the literature is justified by the relevance of the chosen theme in the present-day world. In addition, it continues the already existing research. In terms of personal contribution, the following can be mentioned:

- Documenting and clarifying the concepts related to human population fertility
- Synthesizing determinants identified in the demographic literature
- Presenting statistical methods that were used to analyze human population fertility
- Collecting data and creating a database required for each proposed empirical study
- Selecting and applying statistical methods appropriate for the objectives set by this research
- Classifying the European countries according to the TFR figures using discriminant analysis
- Identifying models of fertility in the European countries
- Identifying the religions which have the strongest influence on fertility

- Determining the fertility model in Romania by considering the fertility determinants selected from the literature
- Setting the fertility seasonality model in the county of Iasi
- Analysing the fertility evolution by age groups in the county of Iasi
- Conducting critical analysis, testing hypothesis and interpreting results