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Econometric Modeling of Fertility Rate

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***Abstract*—Fertility Rate study has a great importance for quantity studies, because it has a great impact on changeable economic decisions as in pension market. The study in this analysis consists in fertility rate for Balkan's countries, 2006-2015 period. For the evaluation of a panel model there are used fixed effects models and random effects models. The unit root test is used to study the stationarity of the series and Cointegration test is used to identify the variables' connection in long term periods. Granger causality test is used to identify the direction of this connection. The evaluated models are tested on their importance and validity.**

Keywords— TFR, panel, Cointegration, effect.

I. INTRODUCTION

The Total Fertility Rate (TFR) is a measure of the average number of live births a woman would have (SIS, 2000) and this is important in population changes. Sibley & Hone, (2002) claim that fertility is one of the main indicators of population change, which is crucial to future projections. Pick, Jones, Butler, & Nag, (1990) further emphasizes the importance of fertility prediction to recognize the future trend of the population. Factors affecting fertility are different in different places and also at different times. In 1990, Albania was considered to be the poorest country in Europe and was little known by the rest of the world. Due to the lack of information for the previous period, significant improvement in life expectancy and lowering the birth rate has been studied by many researchers (Watson, P.1995).

In Albania

Political and economic changes brought about major demographic changes, especially in lowering the overall birth rate. Fertility in Albania has declined over the last two decades, which experts associate with the emigration of young people.

It is estimated that fertility in Albania, an indicator that measures the number of children per woman of reproductive age, has dropped to 1.4, from 2 in 2000 and three in 1990 (Gjonca 2006).

This means that children born today in Albania are not enough to replace their parents. But this is expected to take effect after several decades leading to an aging population that creates both social and economic problems.

The aging of the population is a direct consequence of the decline in the number of births. However, aging of the population has been recognized as an acute economic and social problem only in the last 30 years. This is because countries are experiencing such levels of population aging that are much higher than the forecasts made 30 years ago. McDonald (2007)

Compared with the rest of Europe, birth rates in Albania have been higher than in Europe, at least until 2001. While before the 1990s, a woman was on average about 6.8 children. The visible changes occur after the political and economic changes in 1990 (Sinaj, Tushaj). However, this is expected to take effect after several decades that lead to an aging population that creates social and economic problems.

In Balkans

Fertility changes in Balkan countries over the past 60 years also are observed through trends in the above mentioned time periods but with particular emphasis on the period since 1990 up until now. All available data (The United Nations data from the 2012 Revision of World Population Prospects; Eurostat data, national statistics etc.) shows that in the observed periods all Balkan countries were faced with continuous decrease of the total fertility rates but with different intensity.In next two decades (1975-1995) fertility patterns, initially characterized by early and almost universal childbearing and by a strong attachment to the two-child family norm, in the majority ofthe Balkan countries have changed rapidly. Radical social and economic transformation since the beginning of the 1990s generated a strong impetus for the subsequent change in demographic behavior of populations in the Balkan region. United Nation estimates shows that in the time period 1990/1995-2005/2010 as a result of different intensity of the fertility changes, a gradual convergence of total fertility rates, especially since 2005, has happened. It is confirmed and by one-year Eurostat data. Substantial fertility decline in the period 2005-2010, brought the total fertility rate down to very low levels in the range from 1.3 to 1.5 children for each woman of reproductive age in all Balkan countries, except Albania and Montenegro where it was around 1.7 (Figure 1). Eurostat data also shows that in last year's a moderate rebound was observed, with the TFR increasing slightly. Irrespective of these changes, all Balkan countries today belong in the group of low fertility regions in the world, with the TFR ranging between 1.29 (Greece) and 1.77 (Albania) in 2013.(7)

II LITERATURE REVIEW

The fertility and mortality study is important because births and deaths have a significant impact on population growth. The difference between fertility and mortality is the natural growth of a population. Theories that try to explain the changes in the fertility rate in different economic situations are numerous. In recent decades, with demographic changes there has been a steady increase in female participation in the workforce, and changing the role of women has brought a number of changes to the family structure.
Rindfuss and Brewster (1996) stated that with increasing female participation in the workforce, the total fertility rate decreases. Increasing their role in the workforce and hence increasing female independence has led to changes in fertility rates, based also on changes in the number of marriages, increased divorce rates, higher family planning, abortions, and absenteeism. Voluntary fertility. All of these factors have reduced the fertility rate.

Lappegård (2000) and Kravdal, Education and fertility in Sub-Saharan Africa: Individual and Community Effects (2002) have studied the effects of educating women on their fertility. The two came to the conclusion that women who finish high school experience a delay in the birth of their first child and thus fewer cases of two or three or more children being born due to their age. Women's education and fertility lead to the conclusion that women's education leads to a decline in fertility, with higher levels of education, the number of children born to a woman decreases (Guilkey, Angeles, & Mroz, 1998); -Porath, 1973).

III EMPIRICAL ANALYSIS

Based on economic theories, prior research and available data, this study proposes an econometric model with panel data to assess the fertility rate in the region. The data have been obtained from Statistical Institutes of the 5 countries of the region; Albania, Greece, Romania, Bulgaria and Macedonia for a 10-year period (2006-2015). Data is a balanced panel, because for each selected state the number of observations is the same.
Based on the literature review, the independent variables we have chosen to study the impact on the fertility rate are; Unemployment (UN), migration (MGR) and infant mortality (IMR)

A. Unit root test

The unit root test used in the panel data are ADF (1999), Levin, Lin & Chu (2002). For all the basic hypothesis tests is that there is a unitary root versus the alternative that there is no unit root, Are stationary. The test scores for the birth rate and infant mortality rates are given in the table below:

TABLE I. THE RESULTS OF THE UNIT ROOT TEST

Variable	TFR		IMR	
Method	Stati	Prob	Stat	Prob
Levin, Lin & Chu	-12.5	0.00	-8.9	0.00
ADF - Fisher Chi-square	84.9	0.000	57.56	0.0.
PP - Fisher Chi-square	72.25	0.000	45.23	0.00

Author calculation

Both TFR and IMR variables were found to be stationary and with a difference they were returned to stationary, ie they are stationary in the first difference, ie (1). For this reason, the appropriate form of the model will be that shown below:
ΔTFR = β1 + β2 ΔIMRi; t + εit
When it is known that the variables are I (1), then there is a possible cointegration among them, so there may be a link between them in the medium to long term.

B The Cointegration Test

For the purpose of realizing the cointegration test between the dependent variables and the independent variables, Pedroni's cointegration test data panel was used.

TABLE II. RESULTS PEDRON'S COINTEGRATION TEST

	Statistics	Probability
Group rho-Statistic	1.23	0.85
Group PP-Statistic	-0.65	0.12
Group ADF-Statistic	-2.165	0.055

Author calculation

From the test results we note that in all three statistics, the basic hypothesis is. In this way it results that TFR and IMR do not cointegrate among them in the long run.

C Granger test of causality

In order to discover the relationship between TFR and IMR, we carry out the Granger test of causality.
The basic hypothesis is that TFR does not (Granger) cause IMR. The second basic hypothesis is that IMR does not (Granger) causes TFR.

TABLE III. THE RESULTS OF GRANGER CASUALITY TEST

H_0	Lag	Stati. F	Prob	Result
TFR not casuality IMR	2	2.51895	0.0890	Eject
IMR not casuality TFR.	2	0.20635	0.8141	Eject

Authors calculation

From Fisher's static values it is clear that the basic hypothesis falls down in both cases, so we say that causality is twofold between TFR and IMR.

D Model evaluation

The randomly assessed model is presented in Table 1A in the appendix where it appears that the unemployment rate seems to have no significant impact on SFRY. Attempted to improve this model has been tested the elimination of the unemployment rate. Test results are shown in table 1.A in the appendix and testing encourages the elimination of the unemployment rate variable from the model.

The estimated final model for TFR in the region is of random effects and its overall shape is:

ΔTFR = β1 + β2 ΔIMRit + β2MGR + uit

$$u_{it} = \mu_{it} + v_{it}$$
$$\mu_{it} \sim i.i.d(0, \sigma_\mu^2)$$
$$v_{it} \sim i.i.d(0, \sigma_v^2)$$

For i = 1 ... .., N, and t = 1, ...T, μ and v are mutually independent.

The rated model is:

^DTFR = 1.25 - 0.0954*MGR + 0.00941*DIMR
(0.104)(0.0281) (0.00444)
n = 50, loglikelihood = -0.477

The full model is presented in table 3A in the appendix.

According to the model estimated if the rate of migration increases by one percent, then the birth rate will be reduced by 0.09 percent and if the nominal infant mortality increases by one percent, then the birth rate increases by 0.009 percent. From the analysis it is understood that parents who lose a child tend to replace them at a low rate. This may come as a result of the stress and the emotional state of the parents, but it may also come from the mother's ill health. As the trend for mothers to grow older, they tend to have more risk at birth, and are more responsible for the decision they will take.

D Validation of model validity

The birth rate model evaluated in the preceding paragraphs should be seen in relation to its value. In the analysis of the panel data we have to test in relation to the assumptions:

Testing on constant variances

The test that was used in this case of Breusch-Pagan and its results show that residual variances are constant.

Breusch-Pagan test -
Null hypothesis: Variance of the unit-specific error = 0
Asymptotic test statistic: Chi-square(1) = 45.8742
with p-value = 1.26096e-011

The Hausman test

To determine the model chosen between the one with fixed effects and the effects of the case, we use the Hausman test. The underlying hypothesis is that the effects of the case will be consistent and efficient, as opposed to the alternative that the case effects are not sustainable.

Hausman test -
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(3) = 6.86509
with p-value = 0.0763245

From the results emerges that the basic hypothesis lies and the most appropriate model is the one with random effects.

Testing for independence between the sections.

According to this test, analysis is shared between pooled regressions and effects effects. The countries taken in the study have the same overall characteristics among them, but in the Hellasic and very distinct and characterizing specifications among them, so we expect our model to have midi-sectional independence in the analysis. The results of the Pesaran CD test are outlined in the following table:

Pesaran CD test for cross-sectional dependence
Test statistic: z = 1.730728,
with p-value = P(|z| > 1.73073) = 0.0835
Average absolute correlation = 0.653

Just as we expected, we have concurred with an 8% level of importance that the panel sections are independent of each other.

Normal Distribution of resids

While testing the normal distribution of residuals is given in graph 1A in the appendix. Test results favor the basic hypothesis and the residuals have normal distribution.

IV. Conclusions

The fertility and mortality study is important because births and deaths have a significant impact on population growth. The difference between fertility and mortality makes the natural growth of a population. The population growth is a direct consequence of the decline in the number of births. In the recent decades, with the demographic changes there has been a steady increase in female participation in the workforce, and the changing role of the women have brought a number of changes in the family structure. Increasing their role in the workforce and hence increasing female independence has led to changes in fertility rates, based also on changes in the number of marriages, increased divorce rates, higher family planning, abortions, and absenteeism of voluntary fertility. All these factors have reduced the fertility rate. Studies on female education and fertility lead to the conclusion that female education leads to a decline in fertility. It turns out that TFR and IMR do not to integrate between them in the long term and the causality is bilateral between TFR and IMR. From the analysis it is understood that parents who lose a child tend to substitute them at a low rate. Trending that mothers of older age tend to have more risk at birth, as well as more responsibility for the decision they will take.From the study it was found that the most appropriate model is the one with the occasional effects.

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Apendix

Table I.A A typical TFR model with occasional effects:

Model : Random-effects (GLS), using 50 observations:

Included 5 cross-sectional units
Time-series length = 10
Dependent variable: DTFR

	Coefficient	*Std. Error*	*Z*	*p-value*	
Const	1.19958	0.139	8.6025	<0.0001	***
MGR	−0.109	0.0306	−3.5790	0.0003	***
DIMR	0.00973	0.0043	2.2223	0.0263	**
UN	0.0021	0.0039	0.5365	0.5916	

Mean dependent var	1.50160	S.D. dependent var	0.220142
Sum squared resid	3.32636	S.E. of regression	0.266033
Log-likelihood	−3.1933	Akaike criterion	14.38668
Schwarz criterion	22.0347	Hannan-Quinn	17.29911

Table II A the results of the test of the rate among the elimination of TFR model

Null hypothesis: the regression parameter is zero for UN
Test statistic: F(1, 42) = 0.00148253, p-value 0.969469

Omitting variables improved 3 of 3 information criteria**.**

Table II A Temporary TFR model with random effects

Model Random-effects (GLS), using 50 observations

Included 5 cross-sectional units
Time-series length = 10
Dependent variable: dTFR

	Coefficient	*Std. Error*	*Z*	*p-value*	
const	1.2541	0.10383	12.0785	<0.0001	***
MGR	−0.0954	0.0280	−3.3993	0.0007	***
dIMR	0.0094	0.00443	2.1207	0.0339	**

Mean dependent var	1.5016	S.D. dependent var	0.2201
Sum squared resid	2.98392	S.E. of regression	0.2493
Log-likelihood	−0.4773	Akaike criterion	6.9546
Schwarz criterion	12.690	Hannan-Quinn	9.13898

Graph 1A Normal waste distribution