Causality relationship between economic development and fertility in Romania on regional level

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Abstract

The purpose of this paper is to evaluate the existence of a causality relationship between fertility and economic growth in Romania, on regional level. By using the VAR methodology and the Granger method we intend to highlight the type of causality between economic growth and fertility. The empirical results show that between fertility and economic growth exists a bidimensional causality relationship and that the innovation of each variable has a long term impact on the other one.

Keywords: Fertility, economic growth, causality, regional, VAR

1. Introduction

For Romania, the literature studying the relationship between economy and demographics and namely between economic growth and demographic transition, is not that rich. The types of approaches in the literature usually follow two directions: a theoretical one, concerning the theory of demographic transition (Rotaru, 2006; Mureșan 2007), and aiming at the explanatory models such as the growth models, Altar et al. (2008); an empirical one, having has a goal the evaluation of certain hypotheses formulated in the literature (Jemna, 2011, 2012; Mureșan et al, 2008). Romania’s situation is analyzed as well in studies that focus on the demographic and economic changes occurred after 1989 in the ex-communist countries from Central and East Europe. These studies attempted to

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highlight different explanatory theories for the negative demographic evolution as well as for the nature of the relationship between economic and demographic evolution. Thus, some studies explained the demographic decline as a natural evolution of the demographic transition phenomenon resembling the Western European states (J. Jóźwiak, I.E. Kotowska, 2008; Zakharov, 1997; Zakharov and Ivanova, 1996; Sobotka et al., 2003), in compliance with the theory of demographic transition. Other studies identified a more or less significant connection between economic growth in the post-communist countries and the accelerated demographic changes that took place here (Ranjan, 1999, Cornia and Paniccià, 1996, Sobotka, 2003, Billingsley, 2010). In some papers (Jemna, 2011, 2012), we advanced the hypothesis that after 1990 Romania’s demographic situation has not changed dramatically from the previous period but it has preserved the dynamics started several decades ago.

If demographic transition is a consequence of the process of modernization of the society, consisting in social and economic changes generally promoted by the industrial revolution, then the studies concerning the demographic trends use as independent variables some of the macro-social factors in order to measure the degree of modernization of the society: the education level, urbanization, economic growth, production structure, secularization etc. (Solsona i Pàirò, 1997). These changes also took place in the communist countries, starting from the second half of the XXth century through massive processes of industrialization and urbanization. The social and economic transformations generated a powerful drive for the subsequent modification of the population’s demographic behaviour in the Central and East European countries (Sobotka, 2003). In this respect, the debates between the followers of the Malthusian theory and those of the neo-classical theory show the crucial connection between fertility, mortality and economic growth. Some recent studies (Hondroyiannis and Papapetrou, 2002 for Greece, Savaș, 2008, for the Central Asian countries for instance) have investigated the dynamic interaction between demographic changes and economic growth with the aim to systematically explain the process of economic growth and the associated demographic changes.

The use of certain specific methods of analysis of the correlations between the economic variables and the demographic ones, such as co-integration and causality, highlighted that the fertility changes should be considered as endogenous for the infant mortality, the labour market and the economic growth process (Hondroyiannis and Papapetrou, 2002). The infant mortality, the labour market and the economic growth are more precisely responsible for the variations of fertility rate.

In the case of the ex-communist countries from Central and East Europe, Billingsley (2010) ascertained that the GDP changes are positively correlated with the fertility rates for all age groups above 20 years, in a model where the independent variables were inflation, wage growth and labour force occupation. The author also highlighted that an increase in the GDP is positively correlated with the postponement of marriage age and the birth of the first child. A similar result was obtained within an extended analysis model of the fertility rate performed for Hungary (Aassve et al. 2006).

In the approach of fertility and economic growth, the literature develops theories regarding the implications of unemployment, shaping thus the thesis which states that unemployment has different psychological influences on men and women (Sobotka et al., 2010). Thus, in the case of men, unemployment is perceived more acutely and represents a factor of postponement for a child’s birth, considering that the man is the main supporter of the family, while, for women, unemployment is not necessarily seen as a postponement factor for making a family and giving birth to a child. Thus, in numerous studies the relationship between unemployment rate on one hand, the formation of couples and the fertility rate on the other hand is quite tight (Sobotka et al., 2010).

Based on the hypotheses elaborated in the literature, this paper aims to analyze the relationship between fertility and economic growth for Romania during the post-communist era at regional level in order to assess some of these hypotheses. From a methodological viewpoint, we use the methods of dynamic analysis based on causality relationships. The approach of this paper implies the following directions: the presentation of several empirical evidences of the economic growth and fertility in Romania after 1990; the presentation of certain methodological aspects regarding the causality analysis; the presentation of the results of the time series analysis by means of specific econometric methods.
2. Fertility and economic development in Romania at regional level after 1990

In this section we present in a descriptive manner some considerations on the evolution of fertility and economic growth at regional level in Romania, after 1990. In accordance with the demographic transition theory, the fertility drop in Romania has continued in the first years after 1990 and it has become stable starting with 1996 while the variations of the general rate have been small, around the value of 40 children for one thousand women of fertile age (see Figure 1).

Still, at regional level, we notice that there are significant differences of fertility evolution and three groups can be at least identified (see Fig. 2a): there are two regions where the decreasing trend can be noticed throughout the entire period analyzed (N-E and S-E Oltenia); other 3 regions, after a decrease period, follow a slightly ascending trend starting with the year 2001 (Center, S-W, S-Muntenia); the last group composed of two regions (V, S-W) maintains the national evolution, with a drop between 1990-2000 and slight variations starting with 2001. The North-East region is the region with the highest level of fertility in Romania but, at the same time, it is the region with an important and continuous decrease in the general fertility rate. At the opposite side there is the Western region which registers a slight increase starting with the year 2001.

As regards the evolution of the real GDP per capita by regions, we may notice that it has an ascending evolution, with variations and affected by the recent economic crisis occurred after 2008 (Fig. 2b). In this case, in comparison with fertility, the positions of the regions reverse: the N-E region has the lowest values for this indicator while the regions with the highest GDP per inhabitant is the West region. At least at visual level, it is verified that in the poor regions fertility is higher and in the developed regions there is a low level of fertility. We will perform the analysis regarding the existence of a causality relationship and its meaning in what follows.
In the literature an important explanatory factor of the fertility decline is the postponement of marriage and the birth of the first child (Philipov and Kohler 2001, Rodin 2011). As seen in Fig. 3a, the average age for the first marriage is an indicator having an increasing trend throughout the entire period. In this case as well, the N-E and W regions are at the opposite pole: as it was expected, in N-E there is a lowest average age for the first marriage, fact that is correlated with a higher fertility rate in this region.

In relation to the increase in the economic growth level, the literature considers that the fertility decline is closely connected with the increase in women’s participation on the labour market. Contrary to these expectations, at the level of Romania’s regions, the general trend is descending throughout the period with different intensities from one region to another (see Fig. 3b). This hypothesis is not met at the level of Romania’s regions and this can be explained by the fact that after 1990 the transition has reduced female employment and that during the communist period women were involved in economic activity in a high percentage without affecting the fertility rate.

3. Data and methodology

The data used in this study are provided by the National Institute for Statistics of Romania. For the fertility study we used the variable general rate of fertility because at the level of Romania, at regional level, there are no available data for the total fertility rate. As regards the level of economic growth we used the Gross Domestic Product per capita that we corrected by means of the GDP deflator in order to obtain the real GDP per capita. The study admits a constraint connected to the data availability at regional level and related to the length of time series (for the GDP variable, the data are available between 1993-2010). Taking into account this constraint and for the purpose of improving the results quality, the study is conducted by means of the panel analysis method.

A first stage in our empirical study is represented by the analysis of stationarity property of the time series used. In the case of panel data, we use the Levin, Lin & Chu test. The correction of non-stationarity, if it is needed, can be performed by means of the difference operator.

In the second stage, the analysis of causality between the two variables is performed by means of a VAR model where the optimal lag length is evaluated by means of the Schwarz information criterion.

\[
GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + ... + \alpha_m GDP_{t-m} + \beta_1 F_{t-1} + ... + \beta_m F_{t-m} + \mu_t \quad (1)
\]

\[
F_t = \gamma_0 + \gamma_1 F_{t-1} + ... + \gamma_m F_{t-m} + \delta_1 GDP_{t-1} + ... + \delta_m GDP_{t-m} + \nu_t \quad (2)
\]

For this model, the study of the causality of bivariate correlations is conducted by means of the Granger Causality VAR method. After testing, we can identify whether the level of economic growth (equation 2) has an impact on fertility or if the GDP Granger causes Fertility. The method also allows the evaluation in a reverse order, meaning if
Fertility Granger causes GDP. For each of the two equations, a Chi-square (Wald) test is performed which evaluates if the independent variables from each model are statistically significant. If after testing the correlations we ascertain that the variables in both equations are significant until the optimum number of lags set in the previous stage, then we have a bidirectional causality between economic growth and fertility.

Eventually, the VAR methodology enables an analysis impulse response that evaluates the manner in which each independent variable from each equation responds to the shocks that are evaluated through the residual variables. These shocks spread from one variable to the other through the dynamic structure of the VAR model.

4. Empirical results

In this section, we present the results of empirical analysis on the relationship between economic development and fertility in Romania at regional level using the VAR methodology. The results are presented in what follows: stationarity tests, estimated VAR model, causality analysis and impulse response analysis.

4.1. Stationarity test

Applying Levin, Lin & Chu test we obtained the results in Table 1, confirming that the variables used are stationary (rejecting the unit root assumption), because the calculated probabilities are less than 0.05.

| Table 1. Levin, Lin & Chu test results for the unit root hypothesis. |
|------------------------|-----------|-----------|
| GDP                    | Statistic | Prob.     |
| Null: Unit root (assumes common unit root process) | -5.70613 | 0.0000 |
| Levin, Lin & Chu t     | -5.70613 | 0.0000 |
| Null: Unit root (assumes individual unit root process) |                   |
| Im, Pesaran and Shin W-stat | -3.07054 | 0.0011 | 7 | 119 |
| ADF - Fisher Chi-square | 31.0264  | 0.0055 |
| PP - Fisher Chi-square  | 29.1538  | 0.0100 |
| Fertility              | Statistic | Prob.     |
| Null: Unit root (assumes common unit root process) | -3.07814 | 0.0010 |
| Levin, Lin & Chu t*    | -3.07814 | 0.0010 |
| Null: Unit root (assumes individual unit root process) |                   |
| Im, Pesaran and Shin W-stat | -1.90420 | 0.0284 | 7 | 119 |
| ADF - Fisher Chi-square | 24.2077  | 0.0432 |
| PP - Fisher Chi-square  | 35.8358  | 0.0011 |

Consequently, the analysis will continue with the help of the variables analyzed without recurring to their transformation.

4.2. Estimated VAR model

The relationship between economic development and fertility at regional level in Romania is estimated by means of the VAR model. In this respect, firstly we determined the optimal lag length and the results, based on the Schwarz information criterion, showed that this number is equal to 5. The estimated models for fertility and level of economic growth are presented below.
The fertility equation is:

\[
F_t = -0.77 + 1.00 F_{t-1} - 0.04 F_{t-2} - 0.01 F_{t-3} - 0.32 F_{t-4} + 0.34 F_{t-5} + \\
+ 0.0008 GDP_{t-1} - 0.0005 GDP_{t-2} + 0.0005 GDP_{t-3} - 0.0007 GDP_{t-4} + 0.0009 GDP_{t-5}
\] (3)

Under each coefficient, the value of the appropriate Student test is presented. For this model, another value of the determination coefficient was obtained, of 0.95 as well as a value of the Fisher test equal to 180.84.

The equation of economic development is:

\[
GDP = 3058.95 - 0.13 GDP_{t-2} - 0.23 GDP_{t-3} - 0.014 GDP_{t-4} + 0.42 GDP_{t-5} + 0.22 GDP_{t-6} - \\
-159.92 F_{t-1} + 99.77 F_{t-2} + 214.15 F_{t-3} - 122.55 F_{t-4} - 69.49 F_{t-5}
\] (4)

In this case, the estimation of the determination coefficient is 0.57 and the value calculated for the Fisher test equals 10.66.

As a conclusion, the two equations are statistically significant (the calculated value of the Fisher test is higher than the critical value for a risk of 5%), while the independent variables explain the dependent variable for the maximum number of lags identified.

4.3. Granger causality test

If we consider two variables \(Y_t\) and \(X_t\), for which we can build variables with a certain lag \((Y_{t-\delta}, X_{t-\delta} \text{ etc.})\), according Granger [1981] we say that \(X_t\) Granger causes \(Y_t\) if and only if \(M(Y_t / Y_{t-\delta}, X_{t-\delta}) \neq M(Y_t / Y_{t-\delta})\), that means the past values of \(X_t\) are necessary for the prediction of \(Y_t\).

Once we have highlighted the existence of long run relationship between fertility and GDP per capita, we test the directions of these relationships. In particular, we are interested to observe unidirectional causality for fertility. Using the Pairwise Granger Causality Test, we obtain the results presented in Table 2.

| Table 2. Results of Pairwise Granger Causality test. |
| --------------------------------- |
| **VAR Granger Causality/Block Exogeneity Wald Tests** |
| Included observations: 91 |
| Dependent variable: FERT |
| Excluded | Chi-sq | df | Prob. |
| GDP | 63.02387 | 5 | 0.0000 |
| All | 63.02387 | 5 | 0.0000 |
| Dependent variable: GDP |
| Excluded | Chi-sq | df | Prob. |
| FERT | 46.57692 | 5 | 0.0000 |
| All | 46.57692 | 5 | 0.0000 |

According to the result of the tests listed above it is clear that between Fertility and GDP we have a bidirectional causality. The first causality relationship between fertility and GDP supports the hypothesis stated in the paper of the influence of economic growth on fertility. Nevertheless, as the first equation also shows, assuming the time variation and between regions offered by the panel data, we may notice that the sign of the influence of economic development on fertility is positive (the sum of coefficients for lagged GDP variables is a positive number). For the second result, the dependence of the variable economic growth at regional level for fertility variation could be explained namely by the variations and socio-economic differences between regions after 1990. Indeed, the demographic decline is a significant one in some of Romania’s regions and this can influence the level of economic
growth. According to the second equation estimated in the previous section, fertility has also a positive impact on economic development.

4.4. Impulse responses

In Fig. 4a and 4b we may observe the responses of each of the two variables analysed to the innovations produced by the other variable. Thus, in Fig. 4a it can be noticed that the fertility responses to the GDP innovations are positive for a 20 year period and they do not diminish in time. On the other hand, according Fig. 4b, the GDP responses admit an alternation between positive and negative values without diminishing in time and they manifest the trend to reduce the positive values and increase the negative ones.

![Fig. 4. (a) Innovations expected in Fertility; (b) Innovations expected in GDP](image)

5. Conclusions

The approach from this paper aims at highlighting the causality relationships between economic development and fertility in Romania after 1990. The short length of time series as well as the lack of data determined us to use panel data at regional level.

The results obtained highlight the existence of a bidirectional causality relationship between fertility and economic growth. On one hand, taking into account the variation in time as well as that among regions, the result is that fertility is positively influenced by economic growth. This outcome is important for the decision-makers at regional level as regards the elaboration of policies focusing on demographic revival. On the other hand, in the position of a dependent variable, the level of economic development was negatively influenced by fertility, which indicates a situation corresponding to the transition period of the post-revolutionary Romanian society where the fertility drop may have favoured the economic growth. The identified causality relationships also need a more complex approach in order to better explain the manner in which the relationships between the two variables stand as it was shown above.

References

Aassve, A., Billari, F. C., and Spéder, Z., 2006. Societal transition, policy changes and family formation: Evidence from Hungary, European Journal of Population 22(2), 127, 52.

Altăr, M., Necula, C., Bobeică, G., 2008. Modeling the Economic Growth in Romania. The Role of Human Capital”, Romanian Journal of Economic Forecasting, 3, 115, 28.

Billingsey, S., 2010, The post-communist fertility puzzle, Population Research and Policy Review 29, 193, 231.

Cornia, G. A., and Paniccià, R., 1996. The Transition's Population Crisis: An Econometric Investigation Of Nuptiality, Fertility And Mortality, In Severely Distressed Economies, UNICEF ICDC's Innocenti Occasional Paper no. 49

Granger, Clive W. J., 1981. Some properties of time series data and their use in econometric specification, Journal of Econometrics 16, 121, 30.

Hondroyannis, G., Papapetrou, E., 2002. Demographic transition and economic growth: Empirical evidence from Greece, Journal of Population
Economics, 15, 221, 42.
Jemna, D.V., 2012. A Comparative Analysis of Demographic Transition in the Central and Eastern European Countries, Journal of Eastern Europe Research in Business & Economics 1.
Jemna, D.V., Cigu, E., 2012. Fertility and its determinants in Romania after 1995, Anale. Seria Științe Economice. Timișoara. XVIII, 142, 49.
Jemna, D.V., 2011. Demographic transition and economic growth in Romania, The Yearbook of the „Gh. Zane” Institute Of Economic Researches. 20 (2): 103, 12
Jemna D.V., Pintilescu C., Turturean C., 2010. Population In Romania Within The United Europe, Analele Stiintifice ale Universitatii “Alexandru Ioan Cuza” din Iasi - Stiinte Economice, 329, 40.
Jóźwiak, J., and Kotowska, I. E., 2008. Decreasing birth rates in Europe: reasons and remedies, Published online: November 20 2008, Centre for European Studies 2008, European View 7:225–236, DOI 10.1007/s12290-008-0062-6
Mureșan, C., 2007. Advancement of Romania in the Second Demographic Transition, Romanian Journal of Population Studies, 1, ½, 39, 47.
Mureșan, C., Hărăguș, P. T., Hărăguș, M., and Schröder C., 2008. Romania: Childbearing metamorphosis within a changing context, Demographic Research 19 (23), 855, 906
Philipov, D., Kohler, H. P., 2001. Tempo Effects in the Fertility Decline in Eastern Europe: Evidence from Bulgaria, the Czech Republic, Hungary, Poland, and Russia, European Journal of Population 17, 37, 60.
Ranjan, P., 1999. Fertility behaviour under income uncertainty, European Journal of Population 15, 25, 43.
Rodin, J., 2011. Fertility Intentions and Risk Management: Exploring the Fertility Decline in Eastern Europe During Transition, Royal Swedish Academy of Sciences 40:221–230, www.kva.se/en, DOI 10.1007/s13280-010-0133-1.
Rotariu, T., 2006. Romania and the Second Demographic Transition, International Journal of Sociology, 36 (1), 10, 27.
Savaș, B., 2008. The Relationship Between Population And Economic Growth: Empirical Evidence From The Central Asian Economies, OAKA, 161, 83.
Sobotka, T., 2003. Re-emerging Diversity: Rapid Fertility Changes in Central and Eastern Europe after The Collapse of the Communist Regimes, Population, 58(4), 451, 86.
Sobotka, T., Zeman, K., and Kantorová, V., 2003. Demographic Shifts in the Czech Republic after 1989: A Second Demographic Transition View, European Journal of Population 19, 249, 77.
Solsona i Pairó, M., 1997. The Second Demographic Transition from a Gender Perspective: The Case of Catalonia, Women and Families: Evolution of the Status of Women as Factor and Consequence of Changes in Family Dynamics, Maria Eugenia COSIO-ZAVALA (ed), CICRED, 171, 90.
Zakharov, S., 1997. Fertility trends in Russia and the European New Independent States: crisis or turning point?”, United Nations, Population Division, Expert Group Meeting on Below- Replacement Fertility. New York, November 4–6 1997. ESA/P/WP.140, 271–290.
Zakharov, S., and Ivanova, E. 1996. Fertility decline and recent changes in Russia: on the threshold of the second demographic transition, In DaVanzo (ed., with the assistance of G. Farnsworth), Russia’s Demographic “Crisis”. RAND Conference Proceedings.