Original Research Article

Fertility and socio-economic determinants: evidence from co-integration and multivariate Granger casualty tests

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ABSTRACT

Background: The empirical work on fertility determinants widely discusses the role of socio-economic factors like female labour force participation rate, urban population and per capita gross national income in determining fertility rates. The India's high fertility rate began to decline gradually after late 1950s and continued to fall since then. India achieved almost 31 per cent decline in fertility rate from 1990 to 2012. The objective was to examine the relationship between fertility rate, urbanization, female labour force participation rate and per capita gross national income for India.

Methods: This study covers the sample period from 1990-2012. Moreover, the direction of causality between fertility rate, urbanization, female labour force participation rate and per capita gross national income in India using Granger Causality test within the Vector Error-Correction Model (VECM) are examined.

Results: As a summary of the empirical results, we found that fertility rate, urbanization, female labour force participation rate and per capita gross national income in India are co-integrated and there is unidirectional Granger Causality between the four variables in long and short-run.

Conclusions: The growth in urban population, female labour force participation rate and per capita gross national income are responsible for the decrease in fertility rate in India.

Keywords: Fertility, Female labour force participation rate and per capita gross national income, Urbanization

INTRODUCTION

The empirical work on fertility determinants widely discusses the role of socio-economic factors like female labour force participation rate, urban population and per capita gross national income in determining fertility rates. The India's high fertility rate began to decline gradually after late 1950s and continued to fall since then. India achieved almost 31% decline in fertility rate from 1990 to 2012. However historically it has been found that Government of India launched a family planning programme aimed at reducing population growth in 1951.[1]

The relationship between fertility rate and socio-economic factors has undergone extensive investigation by using empirical analysis. The central issue is whether socio-economic factors stimulate the rate of fertility or the fertility rate itself is a stimulus for socio-economic factors. Bearing a child and taking care of infant's needs are considered to consume women's time intensively. Increase in employment opportunity for female enhances the value of women's time in market and so the opportunity cost for having children increases as women's have to forgo their income for bearing and caring of children.[2] Thus increase in availability of employment opportunities for women causes the loss of

women's life time expected income, makes the childbearing costly and thus causes decline in fertility.[3]

In most of the countries urbanization is considered to have negative effect on the fertility rate.[4-6] The forecast indicate that urbanization will become the important factor behind future declines in national fertility. It is almost universally conceded that urban fertility is lower than rural fertility, except in the very poorest urban slums. This may be due to various reasons like urban population enjoy the advantages over rural populations in relation to those factors that affect the fertility level, including education and employment to women, gender equality and better accesses to all other services.

Every successfully developing country runs through two one-time transformations, an industrial revolution, characterized by a secular take-off income per capita, and a demographic transition, characterized by decreasing fertility rates. The most debated question in this respect is probably whether the fertility decline is mainly caused by technological change and the associated secular rise of income per capita income. Moreover, neoclassical growth theory (Solow,; Mankiw et al) argues in favor of an impact of fertility on income per capita through population growth and capital dilution while unified growth theory (Galor) argues that fertility changes are both cause and consequence of economic development.[7-9]

First, the present study uses the data on rate fertility. In country like India, where the rate of fertility is declining gradually this may be due to increase in urbanization and increase in women employment. In this study the causal relationship between rate of fertility and socio-economic indicators are investigated empirically. Second, this study uses a multivariate approach as it is always preferred over bivariate approach because of specification bias due to omission of relevant variables (Chang et al and Stren). This study includes a variable for fertility with urbanization, and women employment.[10-12] Third, the sample period of this study is from 1990-2012. The period for the analysis has been dictated by the availability of women employment data which is available from 1990 to 2012. Fourth, this study employed recently developed autoregressive distributed lag (ARDL) bounds testing approach of co-integration developed by Pesaran and Shin, and Pasaran et al.[13,14] ARDL approach of co-integartion has become popular not only in energy economics (Narayan and Smyth, Halicioglu, Ghosh, Odhiambo) but also in other areas like tourism, education, finance etc.[15-18]

METHODS

Data description :Annual data on rate fertility, labour force participation rate of female, level of urbanization and per capita national income of India have been collected from online database by World Bank (2015) for the time span 1990 to 2012.

Cointegration: The ARDL bound testing approach recommended by Pesaran et al., 2001 has been employed to study log-run equilibrium relationship among variables female fertility rate (LFRTR), labour force participation of female (LEP) and degree of urbanization (LURB). The other advantages of this approach include its ability to check for short run dynamics without loss of long run information as this approach is based on the following Unrestricted Error Correction Mechanism (UECM).

$$\Delta \ln FRTR_t = a_{0FRTR} + \sum_{i=1}^{n} b_{iFRTR}\Delta \ln FRTR_{t-i} + \sum_{i=1}^{n} c_{iFRTR}\Delta \ln EP_{t-i}$$
$$+ \sum_{i=1}^{n} d_{iFRTR}\Delta \ln URB_{t-i} + \sum_{i=1}^{n} e_{iFRTR}\Delta \ln GNI + \sigma_{1FRTR} \ln FRTR_{t-1}$$
$$+ \sigma_{2FRTR} \ln EP_{t-1} + \sigma_{3FRTR} \ln URB_{t-1} + \sigma_{4FRTR} \ln GNI + \varepsilon_{1t} \quad (1)$$

$$\Delta \ln EP_t = a_{0EP} + \sum_{i=1}^{n} b_{iEP}\Delta \ln EP_{t-i} + \sum_{i=1}^{n} c_{iEP}\Delta \ln FRTR_{t-i}$$
$$+ \sum_{i=1}^{n} d_{iEP}\Delta \ln URB_{t-i} + \sum_{i=1}^{n} e_{iFRTR}\Delta \ln GNI + \sigma_{1EP} \ln EP_{t-1}$$
$$+ \sigma_{2EP} \ln FRTR_{t-1} + \sigma_{3EP} \ln URB_{t-1} + \sigma_{4FRTR} \ln GNI + \varepsilon_{2t} \quad (2)$$

$$\Delta \ln URB_t = a_{0URB} + \sum_{i=1}^{n} b_{iURB}\Delta \ln URB_{t-i} + \sum_{i=1}^{n} c_{iURB}\Delta \ln EP_{t-i}$$
$$+ \sum_{i=1}^{n} d_{iURB}\Delta \ln FRTR_{t-i} + \sum_{i=1}^{n} e_{iFRTR}\Delta \ln GNI + \sigma_{1URB} \ln URB_{t-1}$$
$$+ \sigma_{2URB} \ln EP_{t-1} + \sigma_{3URB} \ln FRTR_{t-1} + \sigma_{4FRTR} \ln GNI + \varepsilon_{3t} \quad (3)$$

$$\Delta \ln GNI_t = a_{0GNI} + \sum_{i=1}^{n} b_{iGNI}\Delta \ln GNI + \sum_{i=1}^{n} c_{iGNI}\Delta \ln URB_{t-i}$$
$$+ \sum_{i=1}^{n} d_{iGNI}\Delta \ln EP_{t-i} + \sum_{i=1}^{n} e_{iGNI}\Delta \ln FRTR_{t-i} + \sigma_{1GNI} \ln GNI$$
$$+ \sigma_{2GNI} \ln URB_{t-1} + \sigma_{3GNI} \ln EP_{t-1} + \sigma_{4GNI} \ln FRTR_{t-1} + \varepsilon_{4t} \quad (4)$$

Where Δ is the first difference operator. $LnFRTR_t$ is the natural logarithm of fertility rate, $lnEP_t$ is the natural logarithm of women employment, $lnURB_t$ is the natural logarithm of degree of urbanization and $lnGNI$ is the natural logarithm of per capita gross national income.

The residuals ($\varepsilon_{1t}, \varepsilon_{2t}, \varepsilon_{3t}, \varepsilon_{4t}$) are assumed to be normally distributed and white noise.

The ARDL procedure of co-integration is usually applied when there is mixed order of integration as some of them are I(0) and others are I(1). Wald based F-test is used to examine whether a co-integration relationship exists among the variables.

The null hypothesis of no co-integration among variables in equations (1-4) is $H_0: \sigma_1 = \sigma_2 = \sigma_3 = \sigma_4 = 0$ against the alternative hypothesis $H_1:$ $\sigma_1 \neq \sigma_2 \neq \sigma_3 \neq \sigma_4 \neq 0$ stating the co-integration exists among the variables. The computed F-statistics for co-integration are denoted as F_{FRTR}(FRTR/EP,URB,GNI), F_{EP}(EP/FRTR,URB,GNI), F_{URB}(URB/EP,FRTR,GNI) and F_{GNI}(GNI/URB,EP,FRTR) for each equation respectively.

The F-test has a non-standard distribution which depends upon (a) whether the variables included in the ARDL model are I(0) or I(1) or mixed order; (b) how many number of regressors; (c) whether this model contains an concept and trend; (d) the sample size. Pesaran et al., (2001) developed two sets of critical F values to check the presence of co-integration. If calculated value F-statistics fall outside the critical band, a conclusive decision can be taken without needing to know whether the variables are I(0) or I(1) or mixed order. If the value of F-statistics falls within the critical band then inference remains inconclusive. Under such situations, it is necessary to check the order of integration of the related variables followed by Johnsen and Juselius (1990) procedure to detect co-integration[19].

Granger causality test: Apart from testing the presence of co-integration, the next stage of this paper is to ascertain the direction of causality via the Granger causality test. The Granger representation theorem suggests that there will be Granger causality in at least one direction if there is a co-integration relationship among the variables. However, the direction of causality can be detected through the vector error-correction model (VECM) of long-run co-integration vectors. Granger-Causality test is used for detecting causal relationship between two or more variables.

In our case, test for Granger causality is conducted within the frame-work of a vector error correction model (VECM) as follows:

$$(1-L)\begin{bmatrix} \ln FRTR_t \\ \ln EP_t \\ \ln URB_t \\ \ln GNI_t \end{bmatrix} = \begin{bmatrix} \beta_1 \\ \beta_2 \\ \beta_3 \\ \beta_4 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} \phi_{11i} \phi_{12i} \phi_{13i} \phi_{14i} \\ \phi_{21i} \phi_{22i} \phi_{23i} \phi_{24i} \\ \phi_{31i} \phi_{32i} \phi_{33i} \phi_{34i} \\ \phi_{41i} \phi_{42i} \phi_{43i} \phi_{44i} \end{bmatrix} \times \begin{bmatrix} \ln FRTR_{t-1} \\ \ln EP_{t-1} \\ \ln URB_{t-1} \\ \ln GNI_{t-1} \end{bmatrix}$$

$$+ \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \end{bmatrix} \times [ECT_{t-1}] + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \end{bmatrix}$$

(5)

where $(1-L)$ is the differenceoperator, ECT_{t-1} is the lagged error correction term. ε_{it} (i=1, 2, 3, 4) are theserially uncorrelated random disturbance terms with zero mean. The F-statistics on the lagged explanatory variables of the error-correction model indicates the significance of the short-run causal effects. The t-statistics on the coefficient of error-correction term indicates the significance of the long-run causal effect. The optimum lag length p is selected for each variable by using either Schwarz-Bayesian (SBC) or Akike information criteria (AIC).

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RESULTS

The results of the bounds testing for co-integration are reported in table 1. The bounds test indicates that the co-integration is present at 5% level of significance when, fertility rate (FRTR), labour force participation rate (EP) and Urbanization (URB)are the dependent variables and at 10% level of significance when, Per Capita Gross National Income (GNI) is dependent variable. This is true with time trend. Also in case of without time trend the co-integration is present in all the four equations at 5% level of significance. This is because F-statistics for all the equations is higher than the upper bound critical value at 5% level of significance. This implies that the co-integration relationship exists when all the variables has been considered as a dependent variables. This implies that cointegration exists among fertility rate, urbanization, labour force participation rate and per capita gross national income over the period 1990-2012 in India.

Once a long-term relationship has been established, further two-step procedure is carried out. In step one the optimal order of lags in the model are selected based on Schwarz–Bayessian information criteria as suggested by Pesaranet al.(2001) and in the next step, the selected model is estimated through ordinary least-square technique.

The existence of a long-run relationship among fertility rate, urbanization, labour force participation rate and per capita gross national income suggests that there must be Granger causality at least in one direction. Table 2 presents the results of short and long-run Ganger Causality within vector error-correction model (VECM) framework. In the short-run effect, the results indicate that, all the three labour force participation rate, Urbanization, per capita gross national income are found to be statistically significant at 5% level of significance in fertility equation, implying that labour force participation rate, urbanization and per capita gross national income granger causes fertility rate in the short-run.

For the long-run causality, we found that the coefficient of the lagged error-correction term ECT_{t-1}has a negative sign and statistically significant at 5% level of significance only in the per capita gross national income equation. The significant negative sign of error-correction term implies that the variable is non-explosive and long-run equilibrium relationship is attainable. This is because the coefficient of ECT_{t-1} shows speed of adjustment from

short run to long run equilibrium. The estimated coefficient of ECT_{t-1} is -0.2962. This suggests that any short-run deviation from equilibrium path or shocks to variables included in the per capita gross nation income

model may take more than three years to achieve the same long-run equilibrium again as the rate of convergence to long-run equilibrium path of this model is 29.62 percent per year.

Table 1: Bounds testing approach for co-integration.

F-statistics	With time trend	Without time trend
F_{FRTR}(FRTR/EP,URB, GNI)	131.8799**	148.4161**
F_{EP}(EP/FRTR,URB, GNI)	18.2187**	20.5132**
F_{URB}(URB/EP,FRTR, GNI)	8.7749**	5.8499**
F_{GNI}(GNI/URB, LOB, FRTR)	5.3060***	8.1556**

- Significant at 5% level of significance, *- Significant at 10% level of significance.

Table 2: Results of Granger causality.

Dependent variable	ΔlnFRTR	ΔlnEP	ΔlnURB	ΔlnGNI	ECT_{t-1} (t-statistics)
ΔlnFRTR	-	8.5666*	4.1185**	4.7421**	-
ΔlnEP	2.9015	-	0.1813	1.1633	-
ΔlnURB	1.0410	0.9494	-	0.7401	-
ΔlnGNI	1.7238	2.1554	1.0096	-	-0.2962**

*- Significant at 1% level of significance, **- Significant at 5% level of significance.
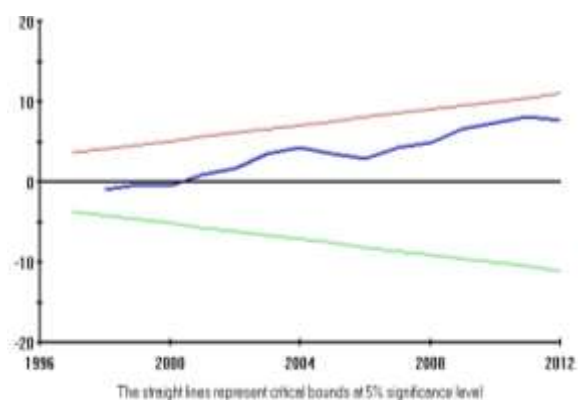

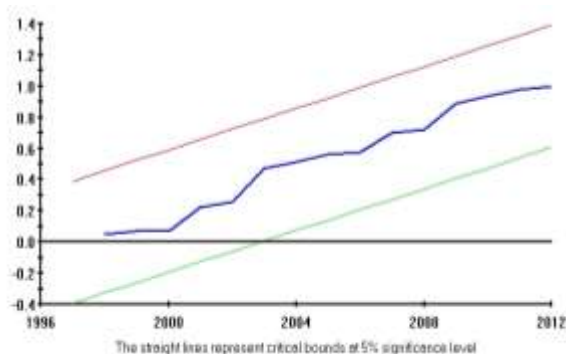**Figure 1A: Plots of CUSUM for the estimated ECM model.**

Figure 1 B: Plots of CUSUMSQ for the estimated ECM model.

Finally, the stability in the coefficients of the estimated model are checked by using cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests to the recursive residuals. The plots of CUSUM and CUSUMSQ statistics in Figure 1A and 1B reveals that the test statistics are always stay within the 95% critical bounds, indicating that all coefficients in the estimated ECM model stable over the sample period 1990-2012.

DISCUSSION

The results of the bounds testing for cointegration reveals that cointegration exists among fertility rate, urbanization, labour force participation rate and per capita gross national income over the period 1990-2012 in India. In short-run the results of Granger Casualty suggested that labour force participation rate, urbanization and per capita gross national income granger causes fertility rate in the short-run. For the long-run causality, we find that the coefficient of the lagged error-correction term ECT_{t-1} has a negative sign and statistically significant at 5% level of significant this implies that the variable is non-explosive and long-run equilibrium relationship is attainable. The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests indicates that all coefficients in the estimated ECM model stable over the sample period 1990-2012. Finally the study suggested that the increase in urbanization, labour force participation rate and per capita income responsible for the decrease in the level of rate of fertility. The same was observed by Jain A, enhancement in female education and improvement in famly planning progrmmas are responsible for decline the fertility in

India.[20] Murthi et al also found that the direct promotion of child health female litracy and female laboure force participation is likely to be more conductive to lowering fertility than are indirect intervention based on promoting economic growth.[21] Masih A and Masih R revealed thatcritical importance of the combined role offemale education and 'planned' family planning programs in reducing fertility rate (bothin the short and long term), despite relatively a very low level of socio-economicstructural development is consistent with the growing theoretical and empirical works.[22-24]

CONCLUSION

This study investigates causality between rate of fertility, urbanization, labour force participation rate and per capita gross national income in India over the period 1990-2012. This study also utilizes the bounds testing approach for co-integartion to examine the presence of long-run equilibrium between rate of fertility, urbanization, labour force participation rate and per capita gross national income.

The current study further establishes long and short-run relationship between rate of fertility, urbanization, labour force participation rate and per capita gross national income in India. The results of the study also indicate that the urbanization, labour force participation rate and per capita gross national income are negatively related to the rate of fertility. This implies that the increase in urbanization, labour force participation rate and per capita income responsible for the decrease in the level of rate of fertility.

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