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Is Population Growth beneficial or detrimental for Economic Growth? : An Indian Experience

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Abstract: The nature, direction and pattern of the causal relationship between population growth and economic growth has been the subject of very old debate among economists, demographers, policy-makers and researchers which is an open issue in development economics. This study seeks to examine the fundamental issue concerning causality between population development and economic development for India. Therefore, the paper tries to assess empirically the dynamic relationship between population growth and economic growth in India using annual data over the period 1952-53 to 2010-11. The unit root properties of the data were examined using the Augmented Dickey Fuller test (ADF) and Phillip-Perron (P-P) after which the cointegration and causality tests were conducted. The result suggests that the series of both variables of our consideration-POP and GDP, namely, population growth and economic growth are found to be integrated of order one using the ADF and Phillips-Perron tests for unit root. The cointegration test confirmed that economic growth and export are cointegrated, indicating an existence of long run equilibrium relationship in Indian context between the two as confirmed by the Johansen cointegration test results. The Granger causality test finally confirmed the presence of uni-directional causality which runs from India's population expansion to its economic growth but not *vice versa* .

Keywords: Population growth, economic growth, causality, India.

1. Introduction

The nature, direction and pattern of the causal relationship between population growth and economic growth has been the subject of very old debate among economists, demographers, policy-makers and researchers which is an open issue in development economics. Even though the nexus between population development and economic development has received extensive attention in the earlier period, it seems a stylized reality that it is hard to obtain a robust effect of population on economic development today.

Economic performance in any country is, to a large extent, influenced by the country's demographic situation. In recent years, the developed countries have been facing declining fertility rates that caused serious shortages of the workforce. Besides, the dipping fertility rates have led to the incident called "ageing population" which has become a socio-economic truth in many developed countries. The magnitude of the relationship between population growth and economic growth has been well recognized by development economists. Despite the fact that there are abundant research studies on the relationship between population and economic development, there is no universal consensus as to whether population expansion is beneficial or detrimental to economic growth.

According to Population 'revisionist' economists, population growth acts as an indispensable constituent for stimulating economic development because a sizeable population provides the required consumer demand to generate favorable economies of scale in production, lower production costs, and provide a sufficient and low-cost labor supply to achieve higher output levels (Todaro 1995, p. 303). Johnson (1999) pointed out two different sources of increasing returns to scale which are associated with the positive beneficial effects of population growth. One results from the agglomeration of related economic activities with the development and expansion of community and city. With the evolution and expansion of the city, there are advantages to be obtained from the agglomeration of bringing related activities together and making possible the specialization of activities. With the advent of capitalism and industrialization in Europe, Adam Smith pointed out that another source of scale economies is related to the size of enterprises. Smith (1976) argued that the division of labor or specialization is a function of the size of the market. Population size is one of the important factors determining the size of the market and the size of enterprises engaged in productive activities. Positive beneficial effects of population growth also stem from the human contribution to scientific and humanitarian discoveries and technological change. Kremer (1993) asserts that technological change has been a function of population size. Simon (1989) contends that the most important positive effects of additional people are the improvement of productivity through contribution of new ideas and learning-by-doing resulting from increased production.

Johnson (1999) pointed out that a high rate of economic growth is associated with high population growth and low economic growth is associated with low population growth. Furthermore, Johnson (2000) talked about why and how human civilization had escaped the Malthusian trap in the nineteenth century: three major factors contributed to the growth of human civilization during the nineteenth century and averted the Malthusian trap. They are (a) the significant advances in agricultural productivity in the eighteenth and nineteenth centuries, (b) the enormous increase in knowledge over the past two centuries, and (c) the response of families to the removal of restraints on their well-being imposed by limited food supplies.

Malthus' theory written and published in the year 1798 on the relationship between population expansion and development, under the title "*An Essay on the Principle of Population"* (Malthus 1798) was based on the "law of diminishing returns" which regarded the quantity of available land as fixed. The author claimed that there existed a tendency for population growth to surpass production growth because the former increases in the geometric progression while the latter increases in the arithmetic progression. Malthus concluded that an unencumbered population growth would plunge a country into the state of acute poverty. According to Kelley and Schmidt (1996), since the publication of Malthus' treatise the pessimist views about the impact of growing population were prevalent among population analysts. This position is reflected in several publications and research studies (Meade 1961, Meadows *et al*. 1972, Samuelson 1975, Tinbergen 1985, Buchholz 1999).

However, many economists and researchers disagree with such gloomy views. Robert Repetto (1985) has pointed out that many of the empirical studies that claimed that a rapid population growth impeded economic development could not be considered reliable. This is because the statistical correlation between population expansion and economic growth has not addressed the causal relationship between the two (Repetto, 1985).

The relationship between population growth and per capita income growth may also depend on the stage of economic development and demographic transition of a country. Galor and Weil (1999) developed a unified growth model that characterizes the historical evolution of population, technology and output. Galor and Weil (1999) argued that the endogenous transition of population evolves over three distinct regimes, namely, Malthusian regime, post-Malthusian regime and Modern Growth regime. Each regime corresponds to a particular stage of economic growth on a one-to-one basis. In a Malthusian regime, technological progress is slow and population growth prevents any sustained rise in income per capita. In a Post-Malthusian regime, technological progress rises and population growth absorbs only part of output growth. In a modern growth regime, reduced population growth and sustained income growth characterizes the demographic transition and evolutionary path of the economy.

In view of the above debate, this paper empirically examines whether there is a long-run and short-run relationship between economic growth via GDP growth and population growth `in India. The paper also examines the nature and direction of any causal relationship between population growth and economic growth by applying standard econometric techniques. The pertinent issue centered around short-run and long-run relationships between these two variables is whether population growth stimulates and/or dampens economic growth in India.

The paper continues with a detailed presentation of our methodology in section 2, followed by the results and their interpretations in section 3. Section 4 presents summary and conclusions.

2. Methodology

2.1. Data and Variables:

The objective of this paper is to investigate the dynamics of the relationship between population growth and economic growth in India using the annual data for the period 1952-53 to 2010-11 which includes the 59 annual observations. The two main variables of this study are economic growth and population growth of India. The growth in real Gross Domestic Product (GDP) is used as the proxy for economic growth in India and we represent the economic growth rate by using the constant value of Gross Domestic Product (GDP) measured in Indian rupee. All necessary data for the sample period are obtained from the Handbook of Statistics on Indian Economy, 2010-11 published by Reserve Bank of India. Population growth figure is taken from *' Census, 2011'*,Govt. of India. All the variables are taken in their natural logarithms to reduce problems of heteroscedasticity to the maximum extent.

Using the time period, 1952-53 to 2010-11 for India, this study aims to examine the long-term and causal dynamic relationships between the level of education expenditure and economic growth. The estimation methodology employed in this study is the cointegration and error correction modeling technique.

As Phillips (1986) has observed, a regression analysis that contains non-stationary variables may produce misleading results. Therefore, the empirical analysis in the present study was done in three stages. In the first stage, unit root tests were used to determine whether the time series data were stationary. In the second stage, cointegration tests were carried out in order to analyse whether the pairs of variables were cointegrated or moved jointly in the long-run.In the third stage, we examined whether there had been a causal relationship between the two variables.

2.2. Econometric specification

2.2.1.Hypothesis

The paper is based on the following hypotheses for testing the causality and co-integration between via GDP growth and population growth (POP) in India (i) whether there is bi-directional causality between GDP growth and POP growth, (ii) whether *there* is unidirectional causality between the two variables, (iii) whether there is no causality between GDP growth and POP growth in India (iv) whether there exists a long run relationship between GDP growth and POP growth in India.

Step –I: Ordinary least square method

Here we will assume the *hypothesis* that there is no relationship between population growth (POP) and economic Growth in terms of GDP. To confirm about our hypothesis, primarily, we have studied the effect of foreign trade on economic growth and vice versa by two simple regression equations:

$LnPOP_i=a+b*LnGDP_i$ ....(1)

$LnGDP_i=a_1+b_1*LnPOP_i$....................(2)

GDP = Gross domestic product.
POP = Population growth in India.
t= time subscript.

Step II: The Stationarity Test (Unit Root Test)

When dealing with time series data, a number of econometric issues can influence the estimation of parameters using OLS. Regressing a time series variable on another time series variable using the Ordinary Least Squares (OLS) estimation can obtain a very high R^2, although there is no meaningful relationship between the variables. This situation reflects the problem of spurious regression between totally unrelated variables generated by a non-stationary process. Therefore, prior to testing Cointegration and implementing the Granger Causality test, econometric methodology needs to examine the stationarity; for each individual time series, most macro economic data are non stationary, i.e. they tend to exhibit a deterministic and/or stochastic trend. Therefore, it is recommended that a stationarity (unit root) test be carried out to test for the order of integration. A series is said to be stationary if the mean and variance are time- invariant. A nonstationary time series will have a time dependent mean or make sure that the variables are stationary, because if they are not, the standard assumptions for asymptotic analysis in the Granger test will not be valid. Therefore, a stochastic process that is said to be stationary simply implies that the mean $[(E(Y_t)]$ and the variance $[Var(Y_t)]$ of Y remain constant over time for all t, and the covariance $[covar(Y_t, Y_s)]$ and hence the correlation between any two values of Y taken from different time periods depends on the difference apart in time between the two values for all $t \neq s$. Since standard regression analysis requires that data series be stationary, it is obviously important that we first test for this requirement to determine whether the series used in the regression process is a difference stationary or a trend stationary.

a) Augmented Dickey Fuller (ADF)

The Augmented Dickey Fuller (ADF) test is the modification of the DF test, allowing higher order of autoregressive process. The tests for unit root identify whether an individual series (Y_t) is stationary by running an ordinal least square (OLS) regression equation. The ADF test makes a parametric correction for higher-order correlation by assuming that the y series follow an AR (ρ) process and adjusting the test methodology where ρ is the number of lagged changes in Y_t necessary to make μ_t serially uncorrelated. Two types of Augmented Dickey Fuller regressions covered the non-linear trend and linear trend element respectively as shown in equation (3) and (4)

$$\Delta Y_t = \beta_0 + \beta_1 Y_{t-1} + \gamma_1 \sum_{i=2}^{k} \Delta y_{t-i+1} + \varepsilon_t \text{ .... (3)}$$

$$\Delta Y_t = \beta_0 + \beta_{it} + \gamma Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-1} + \varepsilon_t \text{ ....(4)}$$

where t is the time or trend variable, Δ is the first-difference operator, Y_t is the logarithm of the variable in period t, $\Delta Y_t = Y_t - Y_{t-1}$, α and β are the constant parameters, μ is intercept, ε_t is the disturbance term which was assumed to be white noise and p is the number of the lagged terms. The optimal lag length of ρ may be selected by using Akaike Information Criteria (AIC) suggested by Akaike (1977). In each case, the hypothesis involved in identifying the unit root problem or non-stationarity which can be represented as below

H0: $\alpha = 0$ (non-stationary for equation 3)
HA: $\alpha < 0$ (non-stationary for equation 4)
H0: $\beta = 0$ (non-stationary for equation 3)
HA: $\beta < 0$ (non-stationary for equation 4)

The null hypothesis that α and β = 0, the conventionally computed t-statistic is known as the τ (tau) statistic, whereby the critical values of this statistic have been tabulated by Dickey and Fuller on the basis of Monte Carlo simulation. If the computed absolute values of τ-statistic exceed the ADF critical τ values, then the above null hypothesis can be rejected, meaning that the Y_t is stationary. A large negative τ value is generally an indication of stationarity.

b) Phillips-Perron (PP)

More weight was given to the Phillips-Perron unit root as this test has been shown to be more reliable than Dickey-Fuller test in presence of large amounts of heteroscedasticity. The PP unit root test proposed by Phillips and Perron (1988) has an advantage as it propose a nonparametric method of controlling for higher-order serial correlation in a series.

The PP unit root test is performed by conducting the following regressions:

$Y_t=\alpha_0+\beta Y_{t-1}+\eta t$ ………..………… (5)
$Y_t=\alpha_0+\alpha_{1t}+\beta Y_{t-1}+\eta t$ ……………….(6)

where α_0 is the intercept, β and α_1 is the estimator of the equilibrium parameters, and t is the trend term and ηt is white noise error term.

The first step in this procedure is to assume that the number of lag terms in the regression functions is equal to zero. The PP unit root test is similar to ADF unit root test from the regression equation in (5) and (6) with lag p = 0. Next, the statistic will be transformed to remove any effects of series correlation on the asymptotic distribution of the test statistics. Thus, the test transformed the t-statistic into the Phillips-Perron Z-statistic as a simple modification of t-statistic which allows the lagged level term to be incorporated in the ADF test. The PP test accounts for non-independent and identically distributed (n.i.i.d) process using non-parametric adjustment to the standard ADF test. The critical values of PP test are the same as those used for ADF test since both tests have the same asymptotic distribution. The null and alternative hypothesis applied in the unit root is:

Ho : Y_t is non-stationary, Y_t does exhibit a unit root
Ho : Y_t is stationary, Y_t does not exhibit a unit root

If all series are integrated as of order one, denotes I (1), consists of unit root at first difference. Further diagnosis of common trend within the prices, as the long-run relationship will be conducted. The cointegration test requires at least two variables to exhibit the same order of non-stationary or integrated in the same order.

Step III: Johansen Juselius Cointegration Analysis:

Cointegration, an econometric property of time series variable, is a precondition for the existence of a long run or equilibrium economic relationship between two or more variables having unit roots (i.e. Integrated of order one). The Johansen approach can determine the number of co-integrated vectors for any given number of non-stationary variables of the same order. Two or more random variables are said to be cointegrated if each of the series are themselves non- stationary. This test may be regarded as a long run equilibrium relationship among the variables. The purpose of the Cointegration tests is to determine whether a group of non – stationary series is cointegrated or not.

Having concluded from the ADF results that each time series is non-stationary, i.e it is integrated of order one I(1), we proceed to the second step, which requires that the two time series be co-integrated. In other words, we have to examine whether or not there exists a long run relationship between variables (stable and non-spurious co-integrated relationship) . In our case, the mission is to determine whether or not EXR-(Nominal Exchange Rate) and CPI(Relative Prices) variables have a long-run relationship in a bivariate framework. Engle and Granger (1987) introduced the concept of cointegration, where economic variables might reach a long-run equilibrium that reflects a stable relationship among them. For the variables to be co-integrated, they must be integrated of order one (non-stationary) and the linear combination of them is stationary I(0).

The crucial approach which is used in this study to test r cointegration is called the Johansen cointegration approach. The Johanson approach can determine the number of cointegrated vectors for any given number of non-stationary variables of the same order.

Formally, if two or more non-stationary time series share a common trend, then they are said to be cointegrated. Engle and Granger (1987) expressed the component of the vector $Y_t = (y_{1t}, y_{2t}, \ldots, y_{nt})'$ are considered to be cointegrated of order d, b, denoted $Y_t \sim CI(d, b)$ if :

(i) all the component Y_t are stationary after n difference, or integrated of order d and noted as $Y_t \sim I(d)$.
(ii) presence of vector $\beta = (\beta_1, \beta_2, \ldots, \beta_n)$ in such that linear combination

$\beta Y_t = \beta_1 Y_{1t} + \beta_2 Y_{2t} + \ldots \beta_n Y_{n\,t}$ whereby the vector β is named the Cointegrating vector.

A few major characteristics of this model are that the cointegration relationship obtained indicates a linear combination of non-stationary variables, in which all variables must be integrated of the same order and lastly if there are n series of variables must be integrated of the same order. Besides, if there are n series of variables, there may be as many as n-1 linearly independent cointegrating vectors.

Johansen's (1991) cointegration test is adopted to determine whether the linear combination of the series possesses a long-run equilibrium relationship. The numbers of significant cointegrating vectors in non-stationary time series are tested by using the maximum likelihood based on λ trace and λmax statistic introduced by Johansen (1991) Johansen and Juselius (1990). The advantage of this test is it utilizes test statistic that can be used to evaluate cointegration relationship among a group of two or more variables. Therefore, it is a superior test as it can deal with two or more variables that may be more than one cointegrating vector in the system. Prior to testing for the number of significant cointegrating vectors, the likelihood ratio (LR) tests are performed to determine the lag length of the vector autoregressive system. In the Johansen procedure, following a vector autoregressive (VAR) model, it involves the identification of rank of the *n* X *n* matrix Π in the specification given by:

$\Delta Y_t=\delta+\Sigma\Gamma_i\Delta Y_{t-i}+\Pi Y_{t-k}+\varepsilon_t$ …………………. (7)

Where Y_t is a column vector of the n variables, Δ is the difference operator, Γ and Π are the coefficient matrices, k denotes the lag length and δ is constant. In the absence of cointegrating vector, Π is a singular matrix, which means that the cointegrating vector rank is equal to zero. On the other hand, in a cointegrated scenario, the rank of Π could be anywhere between zero. In other words, the Johansen Cointegration test can determine the number of cointegrating equation and this number is named the cointegrating rank.

The Johansen Maximum likelihood test provides a test for the rank of Π, namely the trace test (λtrace) and the maximum eigenvalue test (λmax). Firstly, the λtrace statistic tests whether the number of cointegrating vector is zero or one. Then, the λmax statistic test whether a single cointegrating equation is sufficient or if two is required. Both test statistics are given as follows

$\lambda trace(r)=-T\Sigma In(1-\lambda)$………………(8)

$\lambda max(r,r+1)=-TIn(1-\lambda r+1)$ ……….(9)

where P is the number of separate series to be analyzed, T is the number of usable observations and **λ** is the estimated eigen value obtained from the (i + 1) × (i + 1) cointegrating matrix.In this article, we have used LR test for testing whether there exists long run cointegration or not.

Step-IV: The Granger Causality test

Causality is a kind of statistical feedback concept which is widely used in the building of forecasting models. Historically, Granger (1969) and Sim (1972) were the ones who formalized the application of causality in economics. Granger causality test is a technique for determining whether one time series is significant in forecasting another (Granger. 1969). The standard Granger causality test (Granger, 1988) seeks to determine whether past values of a variable helps to predict changes in another variable. The definition states that in the conditional distribution, lagged values of Y_t add no information to explanation of movements of X_t beyond that provided by lagged values of X_t itself (Green, 2003). We should take note of the fact that the Granger causality technique measures the information given by one variable in explaining the latest value of another variable. In addition, it also says that variable Y is Granger caused by variable X if variable X assists in predicting the value of variable Y. If this is the case, it means that the lagged values of variable X are statistically significant in explaining variable Y. The null hypothesis (H_0) that we test in this case is that the X variable does not Granger cause variable Y and variable Y does not Granger cause variable X.In summary, one variable (X_t) is said to granger cause another variable (Y_t) if the lagged values of X_t can predict Y_t and vice-versa.

The spirit of Engle and Granger (1987) lies in the idea that if the two variables are integrated as order one, I(1), and both residuals are I(0), this indicates that the two variables are cointegrated.

Therefore, a time series X is said to Granger-cause Y if it can be shown through a series of F-tests on lagged values of X (and with lagged values of Y also known) that those X values predict statistically significant information about future values of Y. In the context of this analysis, the Granger method involves the estimation of the following equations:

If causality (or causation) runs from POP to GDP, we have:

$dLnGDP_{it}=\eta_i+\Sigma\alpha_{11}dLnGDP_{i,\ t-1}+\ \ \Sigma\beta_{11}dLnPOP_{i,\ t-1}+\varepsilon_{1t}$ ………………………………(10)

If causality (or causation) runs from GDP to POP, it takes the form:

$dLnPOP_{it}=\eta_i+\Sigma\alpha_{12}dLnPOP_{i,t-1}\ \ +\Sigma\beta_{12}dLnGDP_{i,t-1}+\lambda ECM_{it}+\varepsilon_{2t}$ ………(11)

where, GDP_t and POP_t represent gross domestic product and population growth respectively, ε_{it} is uncorrelated stationary random process, and subscript *t* denotes the time period. In equation 10,failing to reject: H_0: $\alpha_{11} = \beta_{11} =0$ implies that population growth does not Granger cause economic growth. On the other hand, in equation 11,failing to reject H_0: $\alpha_{12}= \beta_{12} =0$ implies that economic growth via GDP growth does not Granger cause population growth.

The decision rule: From equation (4), $dLnPOP_{i\ t-1}$Granger causes $dLnGDP_{i\ t}$ if the coefficient of the lagged values of POP as a group (β_{11}) is significantly different from zero based on F-test (i.e., statistically significant). Similarly, from equation (5), $dLnGDP_{i,t-1}$ Granger causes $dLnPOP_{it}$ if $\beta_{12}$is statistically significant.

3. Analysis of the Result

In Ordinary least Square Method, we reject the hypothesis that there is no relationship between the variable and the results of the Ordinary Least Squares Regression are summarized in the Table 1. The empirical analysis on basis of ordinary Least Square Method suggests that there is positive relationship between population growth and economic growth and vice versa.

Table: 1:Result of OLS Technique

Variable	Dependent variable is LnGDP			
	Coefficient	SE	t ratio	R^2
LnPOP	1.862012	0.027101	68.70623	0.54
	Dependent variable is LnPOP			

Ln GDP	0.530646	0.007723	68.70623	0.32

Ho: There is no relationship between the variables; H_1: There is relationship between the variables

Table (2) presents the results of the unit root test for the two variables for their levels. The results indicate that the null hypothesis of a unit root can not be rejected for the given variable and, hence, one can conclude that the variables are not stationary at their levels.

To determine the stationarity property of the variable, the same test above was applied to the first differences. Results from table (2) revealed that the ADF value is smaller than the critical t-value at 1%, 5% and 10%level of significance for all variables. Based on these results, the null hypothesis that the series have unit roots in their differences can be rejected, therefore, the series are trend stationary.

Table:2: Augmented Dickey-Fuller (ADF) Test

Population Growth												
Variables	Level						First Differences					
	Intercept			Intercept&Trend			Intercept			Intercept&Trend		
	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2
LnPOP	-0.73	-0.81	-0.96	-6.22	-4.0	-3.04	-12.6	-8.58	-6.9	-12.6	-8.6	-6.9
Economic Growth												
Ln GDP	Levels						First Differences					
	Intercept			Intercept&Trend			Intercept			Intercept&Trend		
	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2
	3.43	2.62	2.37	-3.11	-3.45	-2.31	-5.50	-5.14	-3.86	-6.58	-5.95	-4.33
Critical Values												
1%	-3.55			-4.13			-3.55			-4.13		
5%	-2.91			-3.49			-2.91			-3.49		
10%	-2.59			-3.17			-2.59			-3.17		

Ho: series has unit root; H1: series is trend stationary

Source: Own estimates

An inspection of the figures reveals in table-3 that each series also is first difference stationary at 1%,5% and 10% level using the PP test. We therefore also rely on the PP test result as a basis for a cointegration test among all stationary series of the same order meaning that the two series are stationary at their first differences [they are integrated of the order one i.e I(1)].

Table:3: Phillips-Perron Test

Population Growth												
Variables	Levels						First Differences					
	Intercept			Intercept&Trend			Intercept			Intercept&Trend		
	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2
LnPOP	-0.73	-0.75	-0.80	-6.22	-6.21	-6.25	-12.6	-13.2	-14.8	-12.6	-13.2	-14.8
Economic Growth												
Ln GDP	Levels						First Differences					
	Intercept			Intercept&Trend			Intercept			Intercept&Trend		
	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2	Lag0	Lag1	Lag2
	3.43	3.22	3.26	-3.11	-3.1	-3.17	-5.5	-5.41	-5.42	-6.58	-6.59	-6.56
Critical Values												

1%	-3.55	-4.13	-3.55	-4.13
5%	-2.91	-3.49	-2.91	-3.49
10%	-2.59	-3.17	-2.59	-3.17

Ho: series has unit root; H_1: series is trend stationary.

Source: Own estimates

Having established the time series properties of the data, the test for presence of long-run relationship between the variables using the Johansen and Juselius(1992) LR statistic for cointegration was conducted. The crucial approach which is used in this study to test cointegration is called the Johansen cointegration approach. The Johanson approach can determine the number of cointegrated vectors for any given number of non-stationary variables of the same order. The results reported in table (4) suggest that the null hypothesis of no cointegrating vectors can be rejected at the 1% level of significance. It can be seen from the Likelihood Ratio (L.R.) that we have a single co-integration equations. In other words, there exists one linear combination of the variables.

Table 4: Johansen Cointegration Tests

Hypothesized N0. Of CE (s)	Eigen value	Likelihood Ratio	5% critical value	1% critical value
None **	0.427491	34.04736	12.53	16.31
At most 1	0.049020	2.814675	3.84	6.51

H_o: has no co-integration; H_1: has co-integration

*(**) denotes rejection of the hypothesis at 5%(1%) significance level.

L.R. test indicates one cointegrating equation(s) at 5% significance level.

We have found that for the Ho of "LnPOP does not Granger Cause LnGDP" , we reject the Ho since the F-statistics are rather larger and most of the probability values are lesser than 0.1 at the lag length of 2. Therefore, we conclude that LnPOP does Granger Cause LnGDP but in case of Ho 'LnGDP does not Granger Cause LnPOP', we accept null hypothesis which indicates that LnGDP does not Granger Cause LnPOP. The above results generally show that causality is unidirectional which runs from population expansion to economic growth but not vice versa.

Finally, the Granger causality test was conducted to examine the causality relationship between population expansion and economic growth in India. This was done because a cointegration relationship between *POP* and *GDP* had been detected by the previous tests. According to the results, the null hypothesis that *POP* did not Granger-cause *GDP* could be rejected at the 1 percent level of significance. Therefore, the results indicated that population growth in India Granger-caused the country's real GDP growth. Further, the null hypothesis that *GDP* did not Granger-cause *POP* could not be rejected at the 5 percent level of significance. Thus, the obtained results provided evidence that *GDP* growth in India does not Granger-cause the population expansion.

Table: 5: Granger Causality test

Null Hypothesis	Lag	Observations.	F-statistics	Probability	Decision
LnPOP does not Granger Cause LnGDP	2	57*	6.42365	0.00325**	Reject
LnGDP does not Granger Cause LnPOP	2	57	1.21113	0.30628	Accept

*Observations. after lag.

** Indicates significant causal relationship at 5% significance level .

Source: Own estimates

In short, the present study detected a long-run cointegration relationship between population (POP) and real GDP in India. The results suggest that there was a unidirectional causality from the population expansion to the economic growth in India. But, the country's economic growth does not Granger-cause the population expansion. This lends evidence to the existence of unidirectional causality between population expansion and economic growth in India. In other words, India's population growth contributes to the nation's economic development, which in return does not stimulated population expansion in the country.

4. Conclusion

This study seeks to examine the fundamental issue concerning causality between population development and economic development for India. Therefore, the paper tries to assess empirically the dynamic relationship between population growth and economic growth in India using annual data over the period 1952-53 to 2010-11. The unit root properties of the data were examined using the Augmented Dickey Fuller test (ADF) and Phillip-Perron (P-P) after which the cointegration and causality tests were conducted.

The unit root test clarified that both economic growth and population expansion are non-stationary at the level data but found stationary at the first differences.Therefore,the series of both variables of our consideration-POP and GDP, namely, population growth and economic growth are found to be integrated of order one using the ADF and Phillips-Perron tests for unit root.

The cointegration test confirmed that economic growth and export are cointegrated, indicating an existence of long run equilibrium relationship in Indian context between the two as confirmed by the Johansen cointegration test results.

The Granger causality test finally confirmed the presence of uni-directional causality which runs from India's population expansion to its economic growth but not *vice versa* .

Social, political and cultural institutions most likely play a major additional role in determining whether a country can successfully accommodate population growth and turn it into income growth. The degree of impact and the nature of these institutions is definitely an interesting field of future research. The present study focuses on quantity rather than quality of population. It may so happen that if the quality of population is incorporated into the econometric interpretation of our study anyhow, the empirical results could be different from those reported here. Inclusion of the aspect regarding quality of population into empirical analyses may provide prospective direction for future research.

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