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Nexus between Population, Income, Output and Employment: Econometric Evidence from India

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Abstract

Keynesian theory of income, output and employment is a short run theory and assumes constant population size. But in reality income, output and employment are not the short term phenomena; neither the size of population can be constant. The present paper attempts to analyse the relationship of income, output, and employment with population growth in context of India. Multivariate regression analysis is used to establish the relationship between the variables. ARIMA model is applied to forecast the population growth in India. The results suggest that there is significant effect of population growth on income, output and employment and ARIMA (1, 1, 2) is the most suitable model to be used for forecasting population growth. In depth analysis suggests that population growth rates shows downward trend. The paradox of growth in GDP and unemployment rate is also observed.

Keywords: *Income, Output, Employment, Population Growth, Multivariate Regression Analysis, ARIMA JEL: E12, C32, O04*

1. Introduction

Keynes has critiqued the Classical theory of income, output and employment for its superfluous assumption of full employment equilibrium by considering it as atypical situation. Say's Law of market was also repudiated by observing that supply always exceeds demand. The low propensity to consume of rich and low purchasing power of poor creates the lacunae between supply and demand and therefore there will be existence of involuntary unemployment.

Keynes theory of employment has explicated the deficiency of effective demand as a contributing factor of unemployment. Even Malthus in his theory of economic development explained that population growth increases prosperity only if it increases effective demand. Level of employment is directly related to aggregate demand, which can be increased by increasing the expenditure on either consumption or investment or both. Here, Keynes advocated the state involvement which can be seen now with increased role of Government to maintain the equilibrium between the various macroeconomic variables of economy. But the assumption of constant population size and applicability of Keynes theory for the short period question its validity because neither the population remain constant nor the short run effects of macroeconomic variables such as income, output and employment can be functional to analyse the economic conditions. The difference between the prosperity and poverty in a country depends on how rapidly it propagates over long term (Chandra, A., 2011).

In the context of importance of the population growth and its relationship with economic growth, we can have a speedy understanding of Malthusian theory of economic development which recommends that while scrutinizing the essential economic indicators viz., GDP, National Income and employment, growth rate of population can't be ignored.

1.1. The Malthusian theory of economic development

Malthus (1798) in his famous Malthusian theory of population showed more appreciation for the significance of methodical theory of growth. In his principles of political economy Malthus was more genuine in his exploration of population growth in the background of economic development. According to Malthus, population tends to develop faster in geometrical progression (1, 2, 4, 8, 16, 32, 64…….so on) and has inclination to double itself every 25 years. Malthus has reflected the growth in population as always detrimental for economic development. Actually the countries can be divided into two classes on the basis of population as (1) Overpopulated countries and (2) Underpopulated countries and it is observed that increase of population is detrimental for an over populated country, which will hinder economic development. But this is not the case for an under populated country. Rather increase in

population in an under populated country motivates the rate of its economic growth, raises the income per capita of the people and kindles economic development.

His depiction regarding the relation between population growth and economic development is also relevant to the present-day poor economies. It is well established fact that income, output and employment are not only closely related but interrelated too. These variables vary invariably with change in population size. The consequence of population and income growth are matters of considerable concern- particularly in East and Southeast Asia (Deaton and Paxson, 1997). The long run expansion rate of the economy depends on the population size (Romer, 1990), (Grossman and Helpman, 1991) and (Aghion and Howitt, 1992).

This paper is an attempt to understand the relationship among growth rate of population, income, output and employment. Using the time series data from 1990 through 2013 on population growth rate, GDP annual growth rate at current prices, growth rate of National Income at factor cost and unemployment rate, nexus among all of these variables is observed. The empirical methodology adopted for this purpose includes Multivariate regression analysis. The findings strongly express the significant effect of population growth rate on GDP growth rate, National Income growth rate and unemployment rate. Since population growth upset income, output and employment significantly, it becomes indispensable to forecast the population size for coming years so that authorities can plan the fiscal policies keeping the future population size in consideration. For this purpose, ARIMA model is applied to forecast the population growth rate. ARIMA (1, 1, 2) is found as most suitable model to be used for the forecasting. The result of forecasting specifies the downward trend in the population growth rate.

2. Review of Literature

The different views were observed about the relationship of population growth with economic development. We can experience the difference in the kind of relationship as positive, negative and even neutral found in different studies through the following literature review. Bloom and Freeman (1988) found that at given rates of population growth, income growth is associated to the time track of population growth. Rapid population growth reduces the rate at which surplus work force is absorbed into productive employment and thus delay the removal of economic dichotomy and the rise of living standards that symbolizes modern economic growth. But Kelley and Schmidt (1995) pointed out that rate of population growth does not appear to have a remarkable influence on per capita output growth. With continuous observation and evidences Kelley and Schmidt (1996) found that the population growth has both negative and positive effects and these effects vary over the short and the long term. The results were supported by the study conducted by Kosai, Saito and Yashiro (1998) saying that there is negative consequence of population decline on economic growth. Galor and Weil (1999) in their study experienced that in the Malthusian regime, population growth is definitely related to level of income per capita but in post Malthusian regime, the traditional positive relation between per capita income and population growth is inverted. The results of the study conducted by Gregory and Hansen (1996) and Johansen (1998), showed that there is no long run association between population and economic growth. But Kelley and Schmidt (2001) mentioned that population size has been conventionally noticed as a positive aspect of long-run growth in countries with abundant resources, strong foundations, and relatively low population masses. Kalim (2003), M.Rafiq, et al. (2010) showed that extraordinary level of population growth corrode the economy and has negative impression on macroeconomic variables. Tsen and Furuka (2005) opined that the connection between population and economic growth is not direct. However, following R & D based growth models, including the more common models of Dalgaard and Kreiner (2001), Strulik (2005), and Bucci (2008) by removing the scale effect, produced a long-run economic growth rate autonomous of population size.

Boucekkine, Martinez and Tamarit (2011) showed a negative consequence of population growth on per capita income, which dictates in the initial period, and a positive effect which reinstates a positive correlation between population growth and economic performance in the long term. As employment level of an economy is a very vital economic indicator Kitov (2011) modelled the advancement of employment/population ratio in the biggest developed countries using a transformed Okun's law with the rate of variation of real GDP per capita as the motivating force. This model validates an extraordinary analytical power with the coefficient of determination between 0.84 and 0.95. One can accurately describe the dynamics of employment (and thus, unemployment) since 1970.

Arslan and Zaman (2014) through their empirical findings showed that population growth has noteworthy progressive relationship with unemployment. If population growth rate increases then the unemployment also increases. Here, we can conclude that population growth affects economic growth depending upon the time period and existing size and density of the population. Therefore it becomes imperative to understand the current relation between mounting population and economic growth.

3. Methodology

3.1. Purpose of the study

There is ongoing debate over the relationship between population and economic growth. Some of the studies found positive while others found a negative relationship.

Even there are evidences of neutrality of population growth effect on economic growth. It is important for any country to know the effect of population growth on vital aggregate variables of economy such as Gross Domestic Product, National Income and Employment Rate which in turn will help the authorities to frame their policies. Therefore the purpose of the study is to understand the relationship exists between population and economic growth in context of India and find the best model to forecast the growth in population.

3.2. Data Description

In this section, details of the Multivariable regression analysis test assumptions are discussed after the information about data variables and their respective sources are presented followed by the objectives and set of hypothesis. Heteroscedasticity corrected model is used to determine the best fit model showing relationship between population growth and growth in income, output and employment. Further, ARIMA model of forecasting is used as it was suggested as most popular method by Box-Jenkins (Jenkins, 1970). It is applied in its three step technique of modelling i.e., model identification, parameter estimation and diagnostic checking. After completion of three steps, we can obtain the most suitable and adequate model of forecasting.

The empirical analysis has been supported out in the case on Indian economy with a dataset of the period 1990 to 2013. The present study uses the secondary data collected from the National Sample Survey, Central Statistical Organisation, Ministry of Statistics and Plan Implementation, Government of India. The study has used the time series data of annual growth rate of GDP at current prices, growth rate of National Income at factor cost and unemployment rate of India from 1990 to 2013. The reliability of the data for empirical research can be qualified to the fact that all the data sources used in this study are government sources and thus, data is very much reliable and perfect for policy research.

3.3. Objectives

1) To analyse the interrelationship between growth rate of population and GDP, national income and unemployment rate.
2) To find the best model for forecasting the population growth rate.

3.4. Generation of hypothesis

Our basic objective for the paper is to analyse whether there is any significant relationship between population growth rate and rate of economic growth. Economic growth of an economy is determined by the growth in country's GDP, National Income and Employment level. Hence, we propose the following hypothesis:

H_1: There is significant impact of population growth, national income growth and unemployment rate on GDP growth rate.
H_2: There is significant impact of population growth, GDP growth and unemployment rate on national income growth rate.
H_3: There is significant impact of population growth, GDP growth and national income growth on unemployment rate.

3.5. Empirical Methodology

To understand the relationship Multivariate regression analysis is conducted. The essence of regression analysis is to fit a model to our data and use it to predict values of the dependent variable (DV) from one or more independent variables (IVs). To use multivariate regression, it is important to check for the statistical assumption violation. The assumptions required to be checked are:

i) Linearity

Linearity denotes that the mean values of the outcome variable for each addition of the predictor(s) should lie along a straight line. To assess the linearity, scatter plot is used. Scatter plots of each variable i.e., GDP growth rate, National income growth rate, unemployment rate and population growth rate showed linearity.

ii) Normality

Normality refers to the shape of the data dispersal for an individual metric variable. Jarque-Bera test is applied to test the normal distribution of variables.

Table 1 Jarque-Bera test for normal distribution of data

Variables	*p-value*
GDP growth rate	0.750415
National income growth rate	0.215771
Population growth rate	0.423575
Unemployment rate	0.436224

Since p-value for all the variables for Normality test is more than 0.05, variables are normally distributed.

iii) Homoscedasticity

At each level of the predictor variable(s), the variance of the residual terms should be constant. Homoscedasticity means that the residuals at each level of the predictor(s) should have the same variance; when the variances are very unequal there is said to be Heteroscedasticity. The present study uses *Heteroscedasticity corrected model* to control the assumption of Homoscedasticity.

iv) Autocorrelation

For any two observations the residual terms should be uncorrelated (or independent). This assumption can be

tested with the Durbin–Watson test, which tests for serial correlations between errors. Test Statistic closer to value 2 shows no autocorrelation.

v) Multicollinearity

Multicollinearity exists when there is a robust correlation between two or more predictors in a regression model. There should be no Multicollinearity in the model, which means there should be no impeccable linear relationship between two or more of the predictors. VIF Values > 10.0 may indicate a collinearity problem.

4. Empirical results and Analysis

Here, we have discussed the interrelationship of GDP, National Income and unemployment keeping Population growth rate as a common variable in each case and attempted to trace out the relationship of each economic indicator with population growth in presence of others.

Case 1:

H_1: There is significant impact of population growth, national income growth and unemployment rate on GDP growth rate.

In this case, GDP growth rate is Dependent variable and National income growth rate, Population growth rate and unemployment rate are independent variables. By using the Heteroscedasticity-corrected model, we found the following model with significant values to be able to establish the relationship of GDP growth rate with population growth rate, national income growth rate and unemployment rate.

Table 2: Heteroscedasticity-corrected 1991-2013 (T = 23)
Dependent variable: GDP Growth Rate

	Coefficient	Std. Error	t-ratio	p-value	
constant	−5.09433	2.34011	−2.1770	0.0423	**
Population growth rate	−4.53839	0.541335	−8.3837	<0.0001	***
National income growth rate	0.265726	0.0978916	2.7145	0.0138	**
Unemployment Rate_1	3.80393	0.636819	5.9733	<0.0001	***
R-squared	0.831655				
Durbin - Watson	1.679560				

R-squared = 0.83 interprets that independent variables i.e., population growth rate, national income growth rate and unemployment rate account for almost 83% variation in dependent variable i.e., GDP growth rate.

Durbin-Watson test statistic = 1.679560 shows absence of autocorrelation.

Table 3: Test Results for Multicollinearity of data

Variables	VIF
National income growth rate	1.033
Population growth rate	1.255
Unemployment rate	1.292

The VIF values for independent variables i.e. growth rates of National income, population and unemployment are less than 10. The obtained values confirm the absence of multicollinearity among the growth rates of National income, population and unemployment.

The most significant relationship between Dependent variable and independent variables is found as:

^GDP = -5.09 - 4.54*Pop. + 0.266*N. I. + 3.80*Unempl_1
(2.34) (0.541) (0.0979) (0.637)

T = 23, R-squared = 0.832. (Standard errors in parentheses)

There is a significant relationship found between dependent variable and independent variables.

Hence we can reject the Null hypothesis H_0 of no relationship between Dependent and independent variables. By accepting Alternate Hypothesis H_1, we infer that there is significant relationship between GDP growth rate and population growth rate along with National growth rate and unemployment rate.

The calculated negative co-efficient (-4.54) proves that there is significant inverse relationship between population growth rate and GDP growth rate. There is positive relationship of GDP growth found with growth in National Income (0.266). In this case, the surprising element is significant positive relationship of GDP growth with unemployment rate with co-efficient 3.80.

Case 2:

H_2: There is significant impact of population growth, GDP growth and unemployment rate on national income growth rate.

In this case, National income growth rate is Dependent variable and National income growth rate, Population growth rate and unemployment rate are independent variables. By using Heteroscedasticity-corrected model, the p-values of GDP growth rate, Population growth rate and unemployment rate are found highly significant and thus confirm their significant impact on national income growth rate.

Table 4: Heteroscedasticity-corrected, 1990-2013 (T = 24)
Dependent variable: National income at factor cost growth rate

	Coefficient	Std. Error	t-ratio	p-value	
constant	24.3974	4.48588	5.4387	<0.0001	***
Population growth rate	4.5177	1.21365	3.7224	0.0013	***
Unemployment Rate	−5.8303	1.35491	−4.3031	0.0003	***
GDP Growth Rate	0.771649	0.144331	5.3464	<0.0001	***
R-squared	.729587				
Durbin - Watson	1.192520				

R-squared = 0.729 interprets that independent variables i.e., population growth rate, GDP growth rate and unemployment rate account for almost 73% variation in dependent variable i.e., National Income growth rate.

Durbin-Watson test statistic = 1.192520 shows absence of autocorrelation.

Table 5: Test Results for Multicollinearity of data

Variables	VIF
Population growth rate	1.412
Unemployment rate	1.335
GDP growth rate	1.215

The VIF values for independent variables i.e. growth rates of GDP, population and unemployment are less than 10. The obtained values confirm the absence of multicollinearity among the growth rates of GDP, population and unemployment.

The most significant relationship between Dependent variable and independent variables is found as:

^N. I. = 24.4 + 4.52*Pop. - 5.83*Unempl. + 0.772*GDP
(4.49) (1.21) (1.35) (0.144)

T = 24, R-squared = 0.730. (Standard errors in parentheses)

There is a significant relationship found between dependent variable and independent variables. Hence we can reject the Null hypothesis H_0 of no relationship between Dependent and independent variables. By accepting Alternate Hypothesis H_1, we infer that there is significant relationship between national income growth rate and population growth rate along with GDP growth rate and unemployment rate.

The result shows the positive relationship of population growth (4.52) and GDP growth (0.77) with National Income growth, but the unemployment rate (-5.83) has negative relationship with National Income growth.

Case 3:

H_3: There is significant impact of population growth, GDP growth and national income growth on unemployment rate.

In this case, Unemployment rate is Dependent variable and National income growth rate, Population growth rate and GDP growth rate are independent variables. The use of Heteroscedasticity-corrected model has given the following model which shows the significant values of growth rates of GDP, National income and population. With the help of which we are able to confirm the relationship of unemployment rate with growth rates of GDP, National income and population.

Table 6: Heteroscedasticity-corrected, 1991-2013 (T =23)
Dependent variable: Unemployment Rate

	Coefficient	Std. Error	t-ratio	p-value	
constant	2.81798	0.329252	8.5587	<0.0001	***
GDP Growth Rate_1	0.044368	0.0235548	1.8836	0.0750	*
Population Growth Rate_1	0.669585	0.163376	4.0984	0.0006	***
N.I. Growth Rate_1	−0.0151003	0.0140356	−1.0759	0.0295	**
R-squared	0.478975				
Durbin - Watson	1.555352				

R-squared = 0.48 interprets that independent variables i.e., population growth rate, GDP growth rate and National Income growth rate account for almost 48% variation in dependent variable i.e., unemployment rate.
Durbin-Watson test statistic = 1.555352 shows absence of autocorrelation.

Table 7: Test Results for Multicollinearity of data

Variables	VIF
Population growth rate	1.238
National income growth rate	1.237
GDP growth rate	1.476

The VIF values for independent variables i.e. growth rates of GDP, population and National income are less than 10. The obtained values confirm the absence of multicollinearity among the growth rates of GDP, population and National income.

The most significant relationship between Dependent variable and independent variables is found as:

^Unempl. = 2.82+ 0.670*Pop_1 + 0.0444*GDP_1 - 0.0151*N. I._1
(0.329) (0.163) (0.0236) (0.0140)

T = 23, R-squared = 0.479. (Standard errors in parentheses)

There is a significant relationship found between dependent variable and independent variables. Hence we can reject the Null hypothesis H_0 of no relationship between Dependent and independent variables. By accepting Alternate Hypothesis H_1, we infer that there is significant relationship between unemployment rate and population growth rate along with GDP growth rate and national income growth rate.

In this case too, we can see the positive relationship of unemployment rate and GDP growth with coefficient 0.044. The positive relationship of unemployment rate with population growth is justified with coefficient 0.670. The inverse relationship between National Income is not surprising and well justified with coefficient -0.015.

The findings of the present study have provided with substantial empirical evidence to show that population growth affects aggregate macroeconomic variables significantly. For a country like India where mounting population is serious problem and there is significant relationship obtained between population growth rate and macroeconomic variables such as GDP, National income and unemployment rate, it becomes reasonably crucial to know the existing trend of population growth rate in order to be able to forecast for near future growth in population. In the next section, we attempted to forecast the population growth rate by using ARIMA modelling,

ARIMA Model for Population Growth Rate Forecasting

Forecasting helps in judgment making for an unidentified future situation. Autoregressive integrated moving average (ARIMA) model for forecasting is the most widespread method for estimation of time series or longitudinal type data. Kumar et al (2009) stated that the ARIMA offers a good system for predicting the degree of any variable. The method assumes that the future value of a time series have a clear and definite functional relationship with current, past values and white noise. ARIMA models are generally denoted as ARIMA *(p,d,q)* where parameters *p*, *d*, and *q* are non-negative integers, *p* is the order of the Autoregressive model, *d* is the degree of differencing, and *q* is the order of the Moving-average model. Development of ARIMA model for any variable involves primarily three steps: model identification, parameter estimation and diagnostic checking.

Model Identification

First step in the identification of model is to observe the stationarity. In case of non-stationarity, time series has to be transformed to a stationary series by taking the first differences of the non-stationary time series value. Augmented Dickey-Fuller test is applied to determine the stationarity in the time series data. While calculated by using level of variable, p-value=0.8702 claimed that time series data is non-stationary. By using first difference of variable, the p-value is 6.989e-009 which confirms the stationarity of the time series data. Thus the value of *d* is 1.

Parameter Estimation

In order to obtain the value of *p* and *q*, the Correlogram is used and obtained values shows that possible model can be (1, 1, 1), (1, 1, 2) and (2, 1, 1). Based on these statistical results, models (1, 1, 1) and (2, 1, 1) are rejected as these are failed to fulfil the necessary conditions. The model (1, 1, 2) is the one which shows all significant values and thus fulfil the conditions of stationarity.

Diagnostic Checking

In a well fitted model, the residual attained are anticipated to have the property of white noise (Abdullah, 2012). In other words, errors should be random or independent. Thus for model validation, diagnostic checking is done by using Ljung-Box Q statistic. The p-value = 0.9140 shows that the residuals have the property of white noise or errors are random and independent. Hence, the conclusion is that the ARIMA (1, 1, 2) model is well specified and adequate and best for forecasting population growth rate.

Forecasting

In this paper, ARIMA models are developed to forecast the growth rate of population. ARIMA (1, 1, 2) is found as most suitable and adequate model and can be applied to forecast the future population growth. The following graph shows that actual population growth rate is fluctuating. Therefore, selection of ARIMA model is quite useful as it offers a good technique for predicting any fluctuated variable (Abdulla, 2012).

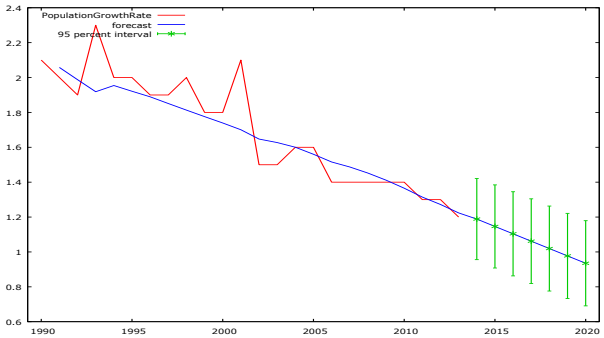

Figure1. Forecast of Population Growth Rate

The actual population growth rate curve shows wide fluctuations from 1990 to 2013. It is very clear from the above graph that growth rate has already shown a declining trend and continues to decline in future. This is the positive finding for the country like India which is already overpopulated and according to the world

statistics, going to be the most populated country in the world. The declining trend in the population growth rate support the achievement of population control programmes to a certain extent. Still a more intense implementation of such programmes is required at a vast level.

5. Discussion

The findings of the present study indicate that population growth affect GDP growth negatively but National Income growth and unemployment growth positively. It is well known fact that increased population impose extra burden on consumption expenditure and tend to reduce the investment expenditure which thereby leads to the fall in the level of production in the economy and this fact is well justified with the help of inverse relationship found between GDP growth and population growth. Similarly, positive relationship of national income growth and population growth is well understood on the ground that increased work force from increased population contributes in aggregate national income and thereby leads to increase in the national income. But here we can't conclude that it is a positive indication about improving economic performance. Rather increased population brings down the per capita income which is not the good sign for an economy. In case of unemployment rate, positive relationship with population growth is quite natural. Rapid population growth reduces the rate at which surplus work force is absorbed into productive employment (Bloom and Freeman, 1988). When economy is not well equipped to absorb the extra work force, population growth leads to increase in unemployment rate.

The above discussion is already observed realities and the present study provided the empirical evidences in context of India. But the positive relationship found between unemployment rate and GDP growth rate is the concern which needs to be addressed. The growth in unemployment rate with the growth in GDP shows lop-sided growth in the different sectors of the economy. Growth in specialized sectors is one of the reasons for simultaneous growth in GDP and unemployment rate.

After exploring the significant relationship between population growth and economic indicators, the paper attempted to forecast the future growth rate of population. By using ARIMA modelling , ARIMA (1, 1, 2) is found as most suitable and adequate model to forecast the population growth and result of forecasting showed the downward trend in the growth rate of population. Trend shows that the rate of growth of population is moving downward which is a good sign for the country like India where it becomes very important to check the population growth.

Conclusion and Recommendation

The present study attempts to explore the relationships between macroeconomic variables such as income, output, employment and population as these are the most important economic indicators. Since growth of population is major concern of most of the developing countries like India, it is imperative to understand the existing relationship among these variables in respect of India. For this purpose, time series data of GDP annual growth rate, National income growth rate, unemployment rate and population growth rate are collected and used in Multivariate regression analysis.

Multivariate regression analysis is used with a specific objective of exploring the impact of population growth on one economic indicator in presence of another instead of analysing the impact of population growth individually on each indicator. Empirical results clearly showed the significant impact of population growth on economic indicators.

One of the findings claimed the lop-sided growth in economy causing the growth in the unemployment rate with the growth in GDP. This can be addressed by analysing the impact of population growth on different sectors of the economy i.e. agriculture, industry and service sector separately. It is proved that population growth affects the developing economy like India negatively because India is already overpopulated. Any extra effort to develop the economy will be absorbed by excess burden of increasing population. Though the forecasting result shows the downward trend, there is still a lot to be done to check the population growth if the India wants a rapid economic growth.

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