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The Long Run Relationship between Population Growth and Economic Growth: a Panel Data Analysis of 30 of the most Populated Countries of the World

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Abstract

The aim of this study is to assess the controversial relationship between population growth and per capita income. The analysis is carried out on a sample of 30 countries. These countries are selected on the sole basis of their populations' sizes. We selected a panel of 30 of the most populated countries of the world regardless of their levels of development. The Augmented Dickey Fuller test of stationarity was employed. The variables of interest turned-out to be I(1). We run the ECM,[1] to test if there is a long run relationship between population growth and per capita income. The ECM result reveal that there is a long run equilibrium relationship between population growth and economic growth, and the granger causality test showed that there also exists a bi-directional causality between economic growth and

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[1] Error Correction Model.

population growth. We concluded by saying that population growth and economic growth are positively related.

Keywords: ECM, Cointegration test, economic growth, population growth.
Jel clasification: O47, O15, J11.

Introduction

According to Solow, Capital by itself cannot explain sustained economic growth, so to explain the sustained economic growth observed in most parts of the world. Mankiw (2010) proposed to expand the Solow model to incorporate the other two sources of economic growth (population growth and technological progress). In this study we focus solely on the impact of population growth on economic growth. One of the most prominent theory of population growth is that of Malthus, which states that population growth contribute negatively to per capita income and deteriorates human development index. Technology development has made almost obsolete Malthus' theory of population growth. Yet many countries are still implementation policies of birth control, through family planning and contraception; and the World Bank and the International Monetary Fund are putting pressure[2] on developing countries to control birth rate growth. Countries like China, are still putting restrictive policies on birth. This situation has pushed us to formulate the following question: does population growth deteriorate economic growth? To be able to answer this question, we selected 30[3] of the most populated countries in the world to estimate the long run relationship that exist between population growth and per-capita income.[4] These countries account for a cumulative population of 5.5 billion inhabitants representing 78% of actual total world population. We hypothesized that population growth contribute positively to economic growth. The methods used to estimate the parameter in this study is the ECM which assesses the long run relationship between the two variables. This method is motivated by the fact that the variables of our model are integrated I (1), meaning that they are stationary at first difference; as we are going to justify in the Data and Methodology section. Before developing Data and Methodology section, we make a panoramic view of the relationship between

[2] Structural adjustment program, HIPC initiative are some of the IMF World Bank pressures on developing countries.

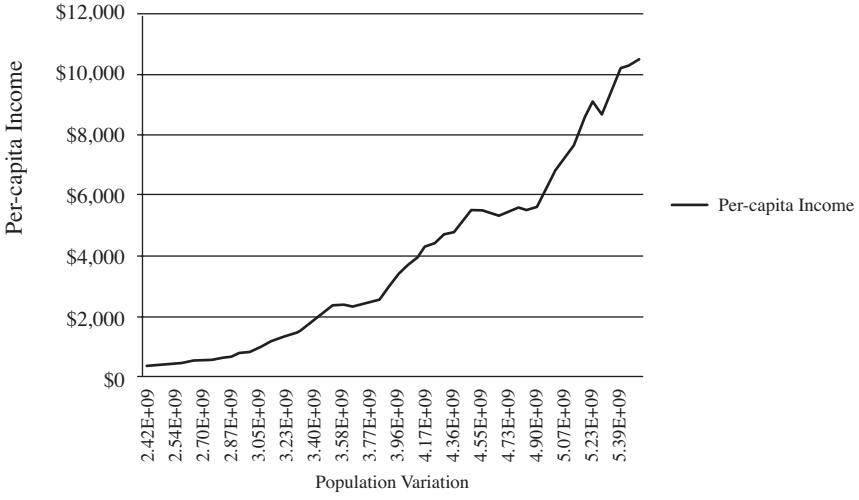
[3] Argentina, Bangladesh, Brazil, China, Colombia, Democratic Republic of Congo, Ethiopia, France, Germany, India, Indonesia, Islamic Republic of Iran, Italy, Japan, Kenya, Korea Republic, Mexico, Nigeria, Pakistan, Philippines, Russian Federation, South Africa, Spain, Tanzania, Thailand, Turkey, Ukraine, United Kingdom, United States of America and Vietnam.

[4] In this study we suppose that per-capita income is the proxy for economic growth.

population and per capita income in the selected countries followed by an extended literature review. Then we finish by concluding and proposing recommendations to governments.

1. Relationship between population and economic growth in the selected countries

Figure 1
Relationship between population and economic growt in the selected countries

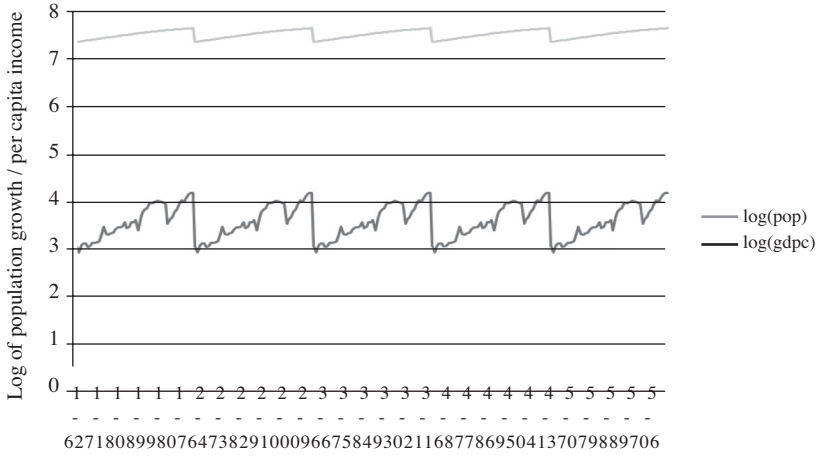


Source: Calculatiion of the authors using online world development indicator data base.

This figure (Figure 1) represents the variations in population with respect to per-capita income. It is evident from this graph that the slope is positive meaning that as population increases in the selected 30 countries, per-capita income follows. This graph is a summary of population growth relationship to per-capita income between 1960 and 2013. In 1960 the cumulative population in these countries was 2.42 billion and the per-capita income was 386 USD. As years go by, population grows as well as per capita income in the selected countries up to the level that in 2013, the cumulative population in the selected countries was 5.50 billion and the cumulated per-capita income was 10,500 USD and both variables are expected to increase as we can forecast when analysing the trend of the graph. This figure

helps us to stand on the hypothesis that: population growth is positively related to economic growth. To be more accurate we computed a second graph showing the long run relationship between per-capita income and population growth. From the trend of the two graphs (per-capita income and population growth), we can easily see the variation of both variables, and compare their trends. It is clear that both variables move in the same direction and slope. For simplicity reason we just use a segment of the whole graph in other to have a better view of the panorama. The second graph (Figure 2) represents the relationship between population growth and per capita income. This figure clearly projects the direction of both variables. The variables move in the same direction, we can therefore conclude at this level that there is an apparent positive association-ship between population growth and per capita income. To cast out any doubt we follow our analysis using advanced econometric tools, which we develop at the data and methodology section.

Figure 2
Long run associationtionship between Population growth and per capita income



Source: Calculation of the authors using online world development indicator data base.

2. Literature Review

There are a number of well-known and well-developed theories that relate population growth and income levels from the original Malthusian hypotheses to the more recent Kremerian model. These theories give a clear-cut way of thinking about the

relationship between these two variables of key economic relevance. However, empirical work has lagged behind, and there is very little systematic evidence on the relationship.

The relationship between population growth and economic growth is trapped in a dilemma of two contradictory Models: The Malthusian model and Kremerian model; while Malthus saw population growth as a threat to rising living standards, economist Michael Kremer has suggested that world population growth is a key driver of advancing economic prosperity. If there are more people, Kremer argues, then there are more scientists, inventors, and engineers to contribute to innovation and technological progress. As evidence for this hypothesis, Kremer begins by noting that over the broad span of human history, world growth rates have increased together with world population. This fact is consistent with the hypothesis that having more people induces more technological progress Mankiw (2010).

Regardless of the contradictory nature in the conclusion on the relationship between population growth and economic growth, scholars are still dangling to prove their points of views.

There are a few numbers of empirical studies on the relationship between population and economic growth. A majority of them uses cross- section regression to analyse the relationship between the two variables (Easterlin 1967; Thirlwall 1972; Simon 1992; Kelley and Schmidt 1996; Ahlburg 1996). Some of them found no statistically significant relationship between population and economic growth while other studies were not able to come to conclusive results. Dawson and Tiffin (1998) used annual time series data over the period 1950-93 to analyse the long-run relationship between population and economic growth in India. The study employed cointegration and Granger causality methods and reported that there is no long-run relationship between the two variables. Moreover, population growth neither Granger causes economic growth nor is caused by it. Thornton (2001) conducted a similar research on the long-run relationship between population and economic growth in seven Latin American countries, namely, Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela. The study used annual time series data generally over the period 1900-94 and employed the same methods of analysis as Dawson and Tiffin (1998). The study concluded that there is no long-run relationship between the two variables in any of the seven countries. Furthermore, population growth neither Granger causes economic growth nor is caused by it. In other study, Jung and Quddus (1986) employed standard Granger-Causality tests to examine the linkage between population growth and economic development with annual data from several developing countries. They found no clear evidence for any causal relationship between the two variables. Kapuria-Foreman (1995) also employed the standard Granger-Causality

tests, they reported that population growth and economic development displayed a distinct pattern of causal characterisation (Darrat et al.; 1999). However, Furuoka (2005) conducted a study on population growth and economic development (GDP) in Malaysia using Engle-Granger method and Johansen cointegration test. He found that there exists a long-run cointegration relationship between population growth and GDP as well as a bidirectional causal relation in the short-run. Simon (1989) argued that population and economic development are essentially related over the long-run horizon and should possess minimal tendency for a short-run relationship. Another study done by Tse and Furuoka (2005) on population and economic growth in Asian economies, including Malaysia, indicated that there is cointegration relationship between economic growth and population in Malaysia. They also found that economic growth Granger causes population growth. They used Johansen and Gregory-Hansen approaches for cointegration test and standard Granger causality test to test the existence of causal relation between the variables.

Undoubtedly, the relationship between population and economic growth is complex and the historical evidence is ambiguous, particularly concerning the causes and impacts (Thirlwall 1994). For instance, Becker et al. (1999) demonstrated in a theoretical model that a high population growth could have both negative and positive impacts on productivity. Not only may a large population reduce productivity because of diminishing returns to more intensive use of land, but to other natural resources. Conversely, a large population could encourage greater specialization, and a large market increases returns to human capital and knowledge. As a result, the net relationship between greater population and economic growth depends on whether the inducements to human capital and expansion of knowledge are stronger than diminishing returns to natural resources (Dullah et al. 2011).

3. Data and Methodology

In this section we justify the use of the Error Correction Model method employed to estimate the long run relationship between population growths on economic growth. This is done after running the unit root and the cointegration tests. Thereafter, we test the econometric validity and accuracy of the results using the Wald test and Variance Inflation Factors. We finish by looking at the causality between the variables of interest.

The data we use in this study are collected from the World Bank online data base 2014. The period of analysis goes from 1960 to 2013 (53 years) and is done on a panel of 30 countries. These countries are chosen on the sole basis of their population size; which represent 78% of the world total population.

4. Results and Interpretation

4.1 Panel Unit-root test

Table 1
Summary Panel Unit Root test

Residual Summary Panel Unit Root test (Level)						
Test	Null: Unit root (assumes common unit root process)	Levin, Lin & Chu t*	Null: Unit root (assumes individual unit root process)	Im, Pesaran and Shin W stat	ADF - Fisher Chi-square	PP - Fisher Chi-square
Statistic		-4.2022		-10.1195	210.186	218.099
Prob.**		0.0000*		0.0000*	0.0000*	0.0000*
Residual Summary Panel Unit Root test (Level)						
Statistic	Null: Unit root (assumes common unit root process)	-4.88241	Null: Unit root (assumes individual unit root process)	3.55093	10.9182	2.89513
Prob.**		0.0000*		0.0000*	0.0000*	0.0000*
Population Summary Panel Unit Root test (First Difference)						
Statistic	Null: Unit root (assumes common unit root process)	-4.88241	Null: Unit root (assummes individual unit root process)	-7.7352	154.518	39.0839
Prob.**		0.0000*		0.0000*	0.0000*	0.0000*
Per Capita Income Summary Panel Unit Root test (Level)						
Statistic	Null: Unit root (assumes common unit root process)	10.1739	Null: unit root (assumes individual unit root process)	11.0241	1.71606	2.89566
Prob.**		1.0000		1.0000	1.0000	1.0000
Per Capita income Summary Panel Unit Root tests (First Difference)						
Statistic	Null: Unit root (assumes common unit root process)	-36.4402	Null: Unit root (assumes individual unit root process)	-30.2567	799.677	801.175
Prob.**		0.0000*		0.0000*	0.0000*	0.0000*

** Probabilities for Fisher tests are computed using an asymptotic Chi-square
All other tests assume asymptotic normality.
* stationary (reject the null hypothesis i.e. no unit root)
Source: Calculation of the authors using eviews 8.1.

On table 1, we have the summary results of the unit root test for the variables and the results reveal that the residual is stationary at level, while the variable for population and GDP per-capita are not. We then run a unit root test at first difference for those variables and they turn out to be stationary at first difference. From these results, we supposed that our variables are cointegrated at same level; reason why we proceed with the pedroni and Kao cointegration test, for confirmation.

4.2 Cointegration Test

Table 2
Pedroni Residual Cointegration Test

Series: GDPC POP				
Alternative hypothesis: common AR coefs. (within-dimension)				
	Statistic	*Prob.*	*Weighted-Statistic*	*Prob.*
Panel v-Statistic	10.67205	0.0000	10.67205	0.0000
Panel rho-Statistic	-4.845603	0.0000	-4.845603	0.0000
Panel PP-Statistic	-2.457457	0.0070	-2.457457	0.0070
Panel ADF-Statistic	-1.963316	0.0248	-1.963316	0.0248
Alternative hypothesis: individual AR coefs. (between-dim ension)				
	Statistic	*Prob.*		
Group rho-Statistic	-1.750556	0.0400		
Group PP-Statistic	-0.894528	0.1855		
Group ADF-Statistic	-0.307957	0.3791		
Phillips-Per on results (non-parametric)				
Kao Residual Cointegration Test				
		Series: GDPC POP		
	t-Statistic	*Prob.*		
ADF	-6.535289	0.0000		
Residual variance	1274997.			
HAC variance	1655136.			

Source: Calculation of the authors using eviews 8.1

From the results of the Pedroni and Kao Residual Cointegration Test, we can rely on the Panel v-Statistic, Panel rho-Statistic, Panel PP-Statistic, Panel ADF-Statistic and their Weighted-Statistic probability values of within and between dimensions.

Their probabilities are equal to zero meaning that they are independently and individually less than 5%. We conclude that the variables of interest are cointegrated. This validates the rejection of the null hypothesis of no cointegration of the variables. Therefore, we can run the ECM method to evaluate the long run relationship between population growth and economic growth in a panel of 30 of the most populated countries in the world. The result is analysed and explained in the next paragraph.

4.3 Error Correction Model and Causality test.

After testing for causality using the Pairwise Granger Causality Tests and the Pairwise Dumitrescu Hurlin Panel Causality Tests, both tests lead us to the same conclusion of bi-directional causality between economic growth and population in the panel of the 30 most populated countries in the world as can be seen on table 3 and 4. Therefore, we decided to run the ECM test in other to assess long-run relationship between population and per capita income. Wooldridge (2012) explained that cointegration between two series implies a particular kind of model, called an error correction mechanisms or error correction model, for the long and short-term dynamics the error correction mechanism (ECM) was first used by Sargan and later popularized by Engle and Granger to correct for disequilibrium. An error correction model evaluates the short-run and long-run dynamics in the relationship between the dependent variable (economic growth) and the independent variable (Population growth). An important theorem, known as the Granger representation theorem, states that if two variables (the dependent variable and the independent variable) are cointegrated, the relationship between the two can be expressed as ECM.

That is $\Delta \text{ Log } GDPC_{it} = \beta_0 + \beta_1 \Delta LogPOP_{it} + \alpha_2 U_{t\text{-}1} + \varepsilon_{it}$ (2)

$$\Delta (LOG(\widehat{GDPC}_{it})) = 0\text{-}022 + 2.146 * (LOG(\widehat{POP}_{it})) - 0.356 * \hat{U}_{t-1}$$

Where ε_{it} is the white noise error term, $U_{t\text{-}1}$ = ECT the lagged value of the error term (error correction term or the speed of adjustment). When the error correction term is statistically significant and negative it works to push the dependent variable (GDPC) back toward the equilibrium Gujarati (2008). From table 5 we can see that statistically, the ECT term is highly significant and negative; suggesting that economic growth (GDPC) adjusts to population growth with a one year lag at the rate of 35.6%. Therefore, this model shows that there exist a long-run equilibrium relationship between population growth and economic growth in the sample of 30

countries selected. This also means that population growth causes economic growth in the panel of the selected 30 countries.

Table 3
Pairwise Dumitrescu Hurlin Panel Causality Tests

Sample: 1960 2013			
Lags: 2 Null Hypothesis:	W-Stat.	Sbar-Stat.	Prob.
POP does not homogeneously cause GDPC	4.51386	6.04697	1.00·E-09
GDPC does not homogeneously cause POP	6.19391	10.2435	0

Source: Calculations of autors using Eviews 8.1

Table 4
Wald Test

Test Statistic	*Value*	*df*	*Probability*
t-statistic	32.28567	1440	0.0000
F-statistic	1042.365	(1,1440)	0.0000
Chi-square	1042.365	1	0.0000
Null Hypothesis: C(1)=0			
Null Hypothesis Summary:			
Normalized Restriction (=0)		Value	Std. Err.
C(1)		3.881700	0.120230

Restrictions are linear in coefficients.

Source: Calculation of the authors using eviews 8.1.

Table 5
Dependent Variable: D(LOG(GDPC))

Method: Panel Least Squares
Sample (adjustede): 1963 2013
Periods included: 51
Cross-sections included: 30
Total panel (balanced) observations: 1530

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.*
C	0.02	0.03	0.83	0.41
D(LOG(POP))	2.15	1.99	1.08	0.28
U(-1)	-0.36	0.02	-17.15	0.00
R-squared	0.16			0.05
Adjusted R-squared	0.16			0.23
S.E. of regression	0.22			-0.23
Sum squared resid	70.64			-0.22
Log likelihood	181.73			-0.23
F-statistic	147.64			1.86
Prob (F-statistic))	0			

Source: Calculation of the authors using eviews 8.1.

Conclusion and Recommendations

The International Monetary Fund, the World Bank as well as many Non-Governmental Organisations and countries have being putting in place policies that restrict citizenries to give birth up to a certain level. In Africa, for example, population density and growth have been highly limited due to contraceptive policies and illegal immigration of African youths to Europe. This study assesses the long run relationship between population growth and per capita income growth in a panel of 30 of the most populated countries in the world within a period of 53 years. These countries are known to account for 78% of the world total population. The Error Correction Mechanism is used, and the results are consistent with the fact that; population growth plays as catalyst to economic growth in the long run. The speed of adjustment of economic growth to population growth is 35.6% within one year as shown by the ECM results. Therefore, our findings support the existence of a

long-run relationship between population and economic growth and provide strong support for the hypothesis that population growth is positively related to economic growth. The results of causality tests suggest that there is a bi-directional causality when causality is assumed to run from population to real per capita or vice versa in the long run in the panel of the selected countries. This result drives us to share the same conclusion with Kremer; who stated that population growth is a development driving force. We rely on this result due to the fact that there is no selectivity bias in the selection of the countries used in this study. These countries were selected solely on the basis of the size of their population.

We therefore suggest to less populated countries (most especially those of Africa, South America and Asia) to review their family planning policies, and social security programs in other to enable youths to have access to job market through job creation forum and credit availability, rather than to foster birth control and social unrest which forces the youths to engage in illegal immigration to Europe, so that economic growth could be boosted. Therefore, we advise governments in these countries to put in place policies to encourage highly trained youths to stay in their countries of origins to contribute to development through research and development. We hope that this will be more effective if the governments are fair in the redistribution of wealth and embezzlement is combated with full energy.

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