Economics Bulletin

Volume 29, Issue 1

Population Growth and Economic Development: New Empirical Evidence from Thailand

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Abstract

Population growth has a substantial impact on economic development. There are two schools of thought regarding this issue. Some researchers maintain that population has a negative impact on economic development while others are convinced that the effect is positive. This paper aims to provide additional evidence by employing the bounds test (Pesaran et al., 2001) to analyse a long-run relationship between population growth and economic development in Thailand. The findings of this study indicate the existence of a long-run equilibrium relationship between population growth and economic development in Thailand. Also, the findings show that there exists a unidirectional causality from population growth to economic development in Thailand. This means that population growth in Thailand has a positive impact on the country's economic performance. These findings support the population-driven economic growth hypothesis which states that population growth promotes economic development.

Citation: Fumitaka Furuoka, (2009) "Population Growth and Economic Development: New Empirical Evidence from Thailand", *Economics Bulletin*, Vol. 29 no.1 pp. 1-14.
Submitted: Dec 23 2008. **Published:** February 03, 2009.

1. Introduction

Population growth has a substantial impact on any country's economy. For example, due to the declining population growth many developed countries face a serious problem of "ageing society" and experience labour shortage which puts a strain on their pension systems. On the other hand, many developing nations experience a rapid population growth which also affects their economic performance. The importance of the relationship between population growth and economic development has been recognized by the development economists. As Dawson and Tiffin (1998, 149) put it: "The relationship between population growth and economic development has long been thought to be fundamental to our understanding of less developed countries (LDCs). Indeed, most textbooks on economic development include a section on 'population and development'". However, there is no consensus whether population growth is beneficial or detrimental to the economic growth in the developing countries. As Thirlwall (1994, 143) commented, "The relationship between population growth and economic development is a complex one, and the historical evidence is ambiguous, particularly concerning what is cause and what is effect".

In those developing countries where the relationship between population growth and economic performance could be described as *positive*, the demographic trends stimulate economic development and promote a rise in living standards. This is because the population growth encourages competition in business activities and, as the country's population grows, the size of its potential market expands as well. The expansion of the market, in its turn, encourages entrepreneurs to set up new businesses. A prominent population economist, Julian Simon, stressed the positive side of population growth and distinguished human beings as the vital and most essential element for economic development. As Simon (1996, 589) put it, "The ultimate resource is people – skilled, spirited, and hopeful people who will exert their wills and imaginations for their own benefit, and inevitably they will benefit not only themselves but the rest of us as well".

By contrast, if the relationship between population growth and economic performance of a country can be described as *negative*, the increase of population is likely to become an impediment to the country's economic development. This is because the rapid expansion of population increases dependency burden (i.e., the number of people who are considered to be economically unproductive, such as children and elder people). The negative views on the population growth have been prevailing over the positive opinions since Thomas Malthus warned about the danger of "over-population". As Kelley and Schmidt (1996, 13) commented, "Pessimism about the economic impacts of population has dominated the thinking of population analysts since the original alarmist treatise by the Reverend Thomas Malthus was published over two centuries ago".

With the two schools of economic thought expounding diametrically different opinions regarding the impact of population growth on economic development, the present paper chooses Thailand as a case study to empirically examine a long-run relationship between population growth and economic growth. Several empirical research studies have been done on this topic. The majority of these academic inquiries have used cross-section regression to analyse the relations between the two variables (Ahlburg 1996; Easterlin 1967; Kelley and Schmidt 1996; Kuznets 1967; Simon 1992; Thirlwall 1972). Some of these studies did detect a statistically significant relationship between population growth and economic development. However, the cross-section regression analyses employed in these papers do not allow reaching a conclusive opinion as the results were contradictory. Among serious methodological problems is that there exist vast discrepancies between different countries. As a result, the research studies on the relationship between per capita income and population growth that employed cross-section regression analyses tended to suffer from the problem of heteroskedasticity.

A lack of adequate data sets posed a serious obstruction for conducting time-series regression analyses of the relationship between population growth and economic development. However, since the end of the 1990s, reliable time-series data sets extensive enough to allow conducting time-series regression analysis to examine the long-run relationship between population and income level have been available. The availability of good quality data sets has stimulated further research on the topic that employed standard econometric tools for time-series data, such as unit roots test, Johansen cointegration test (1988, 1991), Granger causality test (Granger 1969).

For example, Dawson and Tiffin (1998) used time-series data to analyse a long-run relationship between population growth and economic development in India. The study employed the augmented Dickey-Fuller (ADF) unit root test and Johansen cointegration test to analyse the relationships between the two variables. However, according to the researchers, no long-run *equilibrium relationship* between the population growth and economic development in India could be established. This means that these pairs of variables did not seem to move jointly. As Dawson and Tiffin (1998, 154) concluded, "… [P]opulation growth neither causes per capita income growth nor is caused by it." Thornton (2001) conducted a similar research on the long-run relationship between population growth and economic development in seven Latin American countries, such as Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela. The study employed Johansen cointegration test. Its findings supported the conclusion reached by Dawson and Tiffin. According to Thornton (2001, 466), "A long-run relation between population and real per capita GDP does not appear to exist; hence, population growth neither causes growth of per capita GDP nor is caused by it".

In some studies, however, the relationship between population growth and economic performance has been detected. Thus, Furuoka (2005) chose Malaysia as a case study to examine the relationship between population growth and income. The paper used Johansen cointegration test and the error correction model (ECM) and concluded that there existed a long-run equilibrium relationship between the population growth and per capita Gross Domestic Product (GDP) growth in Malaysia. Klasen and Lawson (2007) examined the relationship between population growth and economic development in Uganda. They argued that the empirical findings indicated a negative impact of population growth on economic development. The researchers concluded that high population growth put a considerable break on per capita growth prospects in Uganda.

There is a lack of systematic research on the relationship between population growth and economic development in Thailand. A notable exception is a study by Wong and Furuoka

(2005) that covers the period from 1950 to 2000. Although the paper can be placed among pioneer studies on the relationship between population growth and income growth in Thailand, apparently, the authors had faced a methodological difficulty that prevented the study from yielding a consistent empirical result. Thus, Wong an Furuoka (2005) found that population was integrated of order one, I(1) while economic growth was integrated of order zero, I(0). This present paper aims to overcome this methodological problem by employing bounds testing approach (Pesaran *et al*. 2001) to analyse a long-run relationship between population growth and economic development in Thailand.

Besides the above-mentioned empirical analyses, some researchers used theoretical models to examine the relationship between population growth and economic development. For example, Bucci and La Torre (2007) used a two-sector endogenous growth model. They pointed out that population growth may have a negative or ambiguous effect on a country's economic development. In other words, when physical capital and human capital are substitute, the population growth has a negative impact on the economic development. On the other hand, when physical capital and human capital are complementary, the effect of population growth becomes ambiguous. Furthermore, Turnemaine (2007) in order to analyse the relationship between population growth and per capita growth developed a model in which technical progress, human capital and population growth interact endogenously. The researcher concluded that population growth can have either a positive or a negative impact on the economic development. The outcome depends on the relative contribution of population and human capital to the economic development.

As empirical findings of the available research studies on the topic have revealed, the use of the time-series analysis to examine a long-run relationship between population growth and economic development does not guarantee that all methodological difficulties can be solved. In other words, many researchers have employed the standard cointegration test -- Johansen cointegration test -- to examine the co-movements of population growth and income levels. The problem is that Johansen cointegration test requires that all the underlying variables are integrated of order one, however, some variables may not be integrated of order one. In order to deal with this methodological difficulty, this study employs bounds testing approach for cointegation analysis proposed by Pesaran *et al*. (1999, 2001). The application of the bounds testing approach to examine the intricate relationship between population growth and economic development can be considered an important methodological innovation. The present paper aims to provide additional empirical evidence to the on-going debate between the two schools of economic thought on the impact of the growing population on economic development and selects Thailand as a case study.

Thailand is a developing country in Asia with a relatively large population of approximately 65 million as of 2004. The size of Thailand's population could be detrimental to the country's economic development. On the other hand, more populous nations in Asia, such as China or India, have shown a very impressive economic performance. This may lend some support to the proposition that a vast population may have a positive influence on a country's economic development due to the availability of a sizeable workforce.

The population growth rate in Thailand has been relatively constant although there has been a gradual downturn in the country's demographic trend. Thus, from 1960 to 1975, population growth in Thailand was approximately 3 percent per year. In the second half of the 1970s, the expansion of population decreased to approximately 2 percent, and further diminished to approximately 1 percent in the end of the 1990s. On the other hand, Thailand's income growth which is measured by per capita real Gross Domestic Product (GDP) fluctuated more drastically than its population growth. Between the years 1960 and 2003, income growth in Thailand was relatively high, except for the years 1997 and 1998, when the Asian financial crisis hit the country. The average income growth rate in Thailand in the 1970s was approximately 10 percent per year, and even was recorded at 15.9 percent per year in 1973. In the 1980s, the average growth rate was somewhat lower at approximately 8.7 percent per year. From 1995 to 2004, the average economic growth was approximately 5.0 percent per year.

The main research question this paper addresses is: Has the population growth promoted economic development in Thailand? Or, on the contrary, has the expanding population become an obstruction for the country's economic growth? To answer these questions, standard econometric analyses, such as unit root test and Granger causality test, as well as a newly developed econometric method, which is the bounds tests for cointegration (Pesaran *et al*. 2001), are used in this study to examine a long-run relationship between population growth and economic performance in Thailand.

2. Research Method

Empirical analysis employed in this study consists of the following three steps: (1) the augmented Dickey-Fuller (ADF) unit root test, (2) the bounds test for cointegration, and (3) Granger causality test. First of all, an important prerequisite for the existence of a co-integrating relationship between variables (*GDP* and *POP* in the present study) is that the variables have the same order of integration. This means that if *GDP* is integrated of order *d,* the other variable -- *POP* -- should also be integrated of order *d*. First of all, a standard test, i.e. the augmented Dickey-Fuller (ADF) unit root test in which calculation is based on equation (A2, see Appendices), is used to examine the stationarity of the time series data. The lag length, *n*, for the ADF test was chosen by minimizing the Akaike's information criterion (AIC) in which calculation is based on the equation (A3, see Appendices).

As the second step, the bounds testing approach is used to examine the long-run movement of the variables. The test is based on the following Unrestricted Error Correction Model (UECM) of order *n:*

$$\Delta GDP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 POP_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta GDP_{t-i} + \sum_{j=0}^{n} \delta_j \Delta POP_{t-i} + \varepsilon_t \qquad (1)$$

where β_0 is the drift component, $\beta_1, \beta_2, \gamma, \delta$ are slope coefficient, n is the number of lag length, and ε_t is an error term. According to Pesaran *et al*. (1999, 2001), the standard F-statistic and t-statistic can be used to test for significance of the lagged levels of the variables in equation (1) by testing two null hypotheses. Firstly, the F-statistic is used to test for the joint significance of the coefficients of lagged levels. The first null hypothesis is:

$$H_0^1 : \beta_1 = \beta_2 = 0 \qquad (2)$$

Secondly, the t-statistic is used to test for significance of the coefficient of the lagged dependent variable. The second null hypothesis is:

$$H_0^2 : \beta_1 = 0 \qquad (3)$$

The joint null hypothesis which is a combination of these two hypotheses is given by the intersect of the first and second null hypotheses (Pesaran *et al*. 1999, 8):

$$H_0 = H_0^1 \cap H_0^2 \qquad (4)$$

Pesaran *et al*. (1999, 2001) provided two sets of asymptotic critical values to test the joint null hypothesis that there exists no level relationship between the dependent variable and the independent variables, irrespective of whether these variables are integrated of order zero, *I*(0), or integrated of order one, *I*(1). One set of asymptotic critical values assumes that all the variables are *I*(0) while the other set assumes that all the variables are *I*(1). Pesaran *et al*. (1999, p.1) argued that these two sets of asymptotic critical values can provide *critical value bounds* for all possible classifications of the variables into *I*(0) and/or *I*(1). If F-statistic and/or t-statistic fall outside the 95% upper bound of the critical values, a conclusive inference would be drawn and the joint hypothesis would be rejected. Otherwise, the interference would be inconclusive or the joint hypothesis would not be rejected.

As the third step, this paper uses Granger causality test (Granger 1969) to analyse the causality between population growth and economic growth in Thailand. The null hypothesis for equation (A4, see Appendices) is that *POP* does not Granger-cause *GDP*. On the other hand, the null hypothesis for equation (A5) is that *GDP* does not Granger-cause *POP*. Rejection of the null hypothesis could indicate the causal relationship between the two variables. The lag length, *n*, was chosen by minimizing the Akaike's information criterion.

Four types of causal relationship between population growth and economic development are possible:

(a) *Independence*: There is no causality between population growth and economic development, which could be interpreted as an independent relationship between population growth and economic development, if the set of estimated coefficients on the lagged POP_t in equation (A4) is not statistically significant and if the set of estimated coefficients on the lagged GDP_t in equation (A5) is not statistically significant.

(b) *Population-driven economic growth*: There is a unidirectional causality from population growth to economic growth, *but not vice versa*, which could be interpreted as support for the existence of the "population-led" output expansion, if the set of estimated coefficients on the lagged POP_t in equation (A4) is statistically significant and, at the same time, if the set of estimated coefficients on the lagged GDP_t in equation (A5) is not statistically significant.

(c) *Growth-driven population growth*: There is a unidirectional causality from economic growth to population growth, *but not vice versa*, which could be interpreted as support for the existence of the "growth-led" population expansion, if the set of estimated coefficients on the lagged GDP_t in equation (A5) is statistically significant and, at the same time, if the set of estimated coefficients on the lagged POP_t in equation (A4) is not statistically significant.

(d) *Two-way causality*: There is a unidirectional causality from population growth to economic growth, *and vice versa*, which could be interpreted as a mutually reinforcing bilateral causality between population expansion and economic growth, if the set of estimated coefficients on the lagged POP_t in equation (A4) is statistically significant and, similarly, if the set of estimated coefficients on the lagged GDP_t in equation (A5) is statistically significant.

3. Empirical Results

This section examines the relationship between population growth and economic development in Thailand for the period 1961-2003. The data on population and the per capita real Gross Domestic Product (GDP) in the country are from the Penn World Table 6.2 (CIC 2006). In the Penn World Table, the data on population is taken from the World Bank's database, *World Development Indicators,* while the data on the per capita real GDP is obtained by aggregating domestic expenditures for consumption, investment and government.[1]

All the data are transformed into log form for the purpose of this analysis. The Akaike Information Criterion (AIC) was used to determine the optimal lag length selection for unit root tests while the maximum lag length was set at five (5). As Table 1 shows, in the case of both *GDP* and *POP*, the optimal lag length for the ADF test for unit root in level is one (1). Also, in the case of both *GDP* and *POP*, the optimal lag length for the ADF test for unit root in first difference is zero (0).

Further, the augmented Dickey-Fuller (ADF) unit root test was employed to test the existence of unit roots in the individual time series. The results obtained from the ADF test are shown in Table 2. In the case of *GDP*, the ADF test can not reject the null hypothesis of unit root in level while the test can reject the null hypothesis of unit root in first difference. On the other hand, in the case of *POP*, the ADF test can reject the null hypothesis of unit root in level. These findings indicate that *GDP* is integrated of order one, $I(1)$, while *POP* is integrated of order zero, $I(0)$. This means that Johansen cointegration test can not be used to examine a long-run relationship between these two

[1] An alternative source of data on Thailand's population and income is Thailand's National Statistics Office (NSO). Although the accuracy of statistical data on Thailand can be affected by the discrepancies in the data collection methods, the gap between the different data sets is negligible.

variables. This is because the Johansen cointegration test requires that the two variables should be integrated of order one, $I(1)$. Therefore, this paper proceeds to use the bounds test for a long-run co-movement of these two variables.

Empirical results of the bounds test for cointegration and its critical values (Pesaran *et al*. 2001) are reported in Table 4. According to the results, the F-statistic falls outside the 99% upper bound. This means that the first null hypothesis can be rejected at the 1 percent level of significance. Besides, the t-statistic falls outside the 99% upper bound. This means that the second null hypothesis also can be rejected at the 1% level of significance. These findings indicate that there existed a cointegrating relationship between *POP* and *GDP* in Thailand over the period 1960-2003. This means that there was a long-run co-movement between these two variables. The Akaike Information Criterion (AIC) was used to determine optimal lag length selection for the Granger causality test while the maximum lag length is set at five (5). Table 4 shows that optimal lag length for the Granger causality test is two (2), which minimises the AIC.

Next, the causal relationship between the population expansion and economic growth in Thailand is examined by using the Granger causality test. According to the results presented in Table 5, the null hypothesis that *POP* does not Granger-cause *GDP* could be rejected at the 5% level of significance. This means that the results indicate that population expansion Granger-caused per capita real GDP growth in Thailand. On the other hand, the null hypothesis that *GDP* does not Granger-cause *POP* could not be rejected. This means that the results do not support a proposition that GDP Granger-caused population expansion in Thailand.

In short, there existed a long-run cointegrating relationship between *POP* and *GDP* in Thailand. Also, there was a unidirectional long-run causality from *POP* to *GDP*. In other words, the expansion of population in Thailand Granger-caused the country's economic development. These findings indicate that Thailand represent a textbook example of the population-driven development where the population growth promotes economic development.

4. Concluding Remarks

Population growth could be described as "destiny" that determines the course of economic development. This study attempted to provide additional empirical evidence to the on-going debate about the intricate relationship between population growth and economic development and chose Thailand as a case study. Previously, the standard cointegration test -- Johansen cointegration test – was employed in research studies to examine the co-movement of population growth and income level. The problem is that Johansen cointegration test requires that all the underlying variables should be integrated of order one, however, this condition may not always be fulfilled. In order to deal with this methodological problem, this paper employed bounds testing approach to the cointegation analysis (Pesaran *et al*. 2001). Application of the bounds testing approach in an empirical analysis of the relationship between population growth and economic development can be viewed as an important methodological contribution. The empirical findings of this study indicate that there existed a co-integrating relationship between population growth and economic development in Thailand over the period 1960-2003. Also, Granger causality test indicated the existence of a unidirectional causality from *POP* to *GDP* in the country.

The findings of this study's econometric analysis imply that the expansion of population in Thailand had a positive impact on the country's economic development. These findings give support to the population-driven economic growth hypothesis that states that the population growth in a country's promotes its economic development. This is the most important outcome of the present research. Future studies may want to focus on identifying the factors that lead to the expansion of population and to examine the determinants of economic growth in various countries. This could give an additional insight into the relationship between a country's economic performance and its demographic situation. Considering a fact that the relationship between population growth and economic development is a complex one, different from the present study's econometric methods could be employed for the analysis. It is also possible that if the quality of population or the human capital aspect is incorporated in a study, the empirical results could differ from those reported here. The present study did not aim to explore the quality of population but rather concentrated on the quantity part. Incorporating the quality of population aspect into empirical analysis of the relationship between population expansion and economic growth could be a promising direction for future studies on this topic.

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Appendices

Table 1: Optimal lag length selection for unit root tests (Maximum Lag Length=5)

a) *GDP*

	Akaike Information Criterion (AIC)			
	Level		First Difference	
Lag Length	Constant without trend	Constant with trend	Constant without trend	Constant with trend
0	-3.143	-3.112	-3.483*	-3.479*
1	-3.488*	-3.464*	-3.410	-3.404
2	-3.413	-3.395	-3.354	-3.354
3	-3.368	-3.396	-3.294	-3.310
4	-3.320	-3.317	-3.230	-3.262
5	-3.267	-3.205	-3.213	-3.205

*indicates optimal lag length selected by the AIC

b) *POP*

	Akaike information criterion (AIC)			
	Level		First Difference	
Lag Length	Constant without trend	Constant with trend	Constant without trend	Constant with trend
0	-10.362	-10.510	-11.728*	-11.709*
1	-11.934*	-11.903*	-11.680	-11.672
2	-11.893	-11.855	-11.618	-11.599
3	-11.838	-11.557	-11.561	-11.551
4	-11.795	-11.463	-11.495	-11.474
5	-11.732	-11.710	-11.421	-11.391

*indicates optimal lag length selected by the AIC

Table 2: ADF unit root test

	Level		**First Difference**	
Variables	Constant without trend	Constant with trend	Constant without trend	Constant with trend
GDP	-1.457(1)	-1116(1)	-3.343(0)**	-3.617(0)**
POP	-3.370(1)**	-3.217(1)*	-0.678(0)	-1.212(0)

Notes: Figures in parentheses indicate number of lag length
** indicates significance at the 5% level
*indicates significance at the 10% level

Table 3: Bounds test for cointegration

Thailand (*GDP* and *POP*)				
Lag length = 1				
F-statistic	95% lower bound	95% upper bound	99% lower bound	99% upper bound
7.10*	4.94	5.73	6.84	7.84
t-statistic	95% lower bound	95% upper bound	99% lower bound	99% upper bound
-3.90*	-2.86	-3.22	-3.42	-3.82

Notes: critical values are obtained from Pesaran *et al*. (1999)
*indicates significance at the 1% level

Table 4: Optimal lag length selection for the Granger causality test (Maximum Lag Length=5)

Lag Length	AIC
1	-14.225
2	-15.496*
3	-15.341
4	-15.289
5	-15.063

AIC denotes the Akaike Information Criterion
*indicates optimal lag length selected by the AIC

Table 5: Granger causality test

Thailand (*GDP* and *POP*)		
Lags Interval: 1 to 2		
POP→GDP	Chi-square statistic	Probability
	8.699	0.012
	F-statistic	Probability
	4.349	0.020
GDP→POP	Chi-square statistics	Probability
	0.541	0.762
	F-statistic	Probability
	0.270	0.764

a) Augmented Dickey-Fuller (ADF) Test

Dickey and Fuller (1979) suggested a unit root test based on the following regression:

$$\Delta y_t = \mu + \beta t_{t-1} + \delta y_{t-1} + \varepsilon_t \qquad \text{(A1)}$$

where μ is constant, t is linear time trend, β and δ are coefficients, and ε_t is an error term. In the cases where error terms are serially correlated, the method has to be modified. The simplest way to do so is to add many lags of dependent variable Δy_t in the equation (1) in order to ensure that ε_t appears as white noise. This test for stationarity is known as the ADF test. The ADF test is based on the following regression:

$$\Delta y_t = \mu + \beta t_{t-1} + \delta y_{t-1} + \sum_{i=1}^{n} \gamma_i \Delta y_{t-i} + \varepsilon_t \qquad \text{(A2)}$$

where β, δ and γ are coefficients, n is the number of lag length, and ε_t is an error term.

b) Akaike Information Criterion

The Akaike Information Criterion (AIC) criterion is defined as:

$$AIC(q) = T \ln\left(\frac{RRS}{n-p}\right) + 2p \qquad \text{(A3)}$$

where T is the sample size, RRS is the residual sum of squares, n is lag length, p is the total number of parameters estimated.

c) Granger causality test

Granger causality test with the lag length of n could be based on the following equations:

$$GDP_t = c_1 + \alpha_1 GDP_{t-1} + .. + \alpha_n GDP_{t-n} + \beta_1 POP_{t-1} + .. + \beta_n POP_{t-n} + \varepsilon_1 \qquad \text{(A4)}$$

$$POP_t = c_2 + \alpha_1 POP_{t-1} + .. + \alpha_n POP_{t-n} + \beta_1 GDP_{t-1} + .. + \beta_n GDP_{t-n} + \varepsilon_2 \qquad \text{(A5)}$$

where c_1 and c_2 are constants, $\alpha_1 ....\alpha_n$ and $\beta_1 \ldots\ldots \beta_n$ are slope coefficients.

Granger causality could be examined by using the Wald test for the joint hypothesis:

$$\beta_1 = \beta_2 = \ldots\ldots \beta_n = 0 \qquad \text{(A6)}$$