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Revisiting Malthusian Trap Theory in Bangladesh: A Time Series Approach to Recognize the Existence of the Trap

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Abstract

The key feature of the Malthusian model is that output per capita is strongly linked to population growth (Olsson, 2012). This paper uses data from 1996 to 2020 to justify the existence of the Malthusian trap in Bangladesh. Data collection includes per capita GNI growth rate (PCGNI GR), industrial growth rate (IND GR), GNI growth rate (GNI GR), and population growth rate (PGR). Here the regression model and cointegration test have been used to justify the relevance of the theory in case of Bangladesh. According to the regression results and the value of normalized cointegrating coefficients it is found that the change in the growth rate of per capita GNI is same directional at a same rate to the change in the growth rate of GNI of Bangladesh. That means, if the growth rate of GNI increases or decreases by 1% then the growth rate of per capita GNI will also increase or decrease to the same percentage. On the other hand, the population growth has a cent percent negative effect on the growth of per capita GNI. This means that, an increase in per capita income due to an increase in total income will be offset by population growth. These results prove that the Malthusian trap theory is quite relevant for Bangladesh. The results also show that the industrial growth has positive influence on the per capita income of Bangladesh, which can break the trap. Therefore, steps must be taken to control population growth and improve industrial sector to break down the trap.

Keywords Malthusian trap, Industrial Growth rate, GNI growth rate, Population Growth rate

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JEL Classification B22, C32, Q56, E01

1 Introduction

In this "Malthusian world", there is a strong link between income per capita and population growth so that anything that increases aggregate income in a society will soon be neutralized by an increase in the size of the population. Hence, even despite periods of rapid technological progress, income per capita will remain at a fairly constant level (Olsson, 2012). Recent empirical work on historical data has shown that standards of living indeed appear to have been roughly similar in Assyria 1500 BC, in Roman Egypt, and in late eighteenth century England (Clark, 2007).

Bangladesh, a country in South Asia, had a population of 167 million people as of 2021. The land area is 130,170 square kilometers. There are approximately 1.26 thousand people per square kilometer, making it one of the most densely populated countries in the world. The population growth rate of Bangladesh in the early 2000s was around 1.71% and had decreased to around 1.05% in 2020 (CliffsNotes, 2022).

Bangladesh has achieved remarkable success in terms of GDP growth and per capita income. Per capita income was US$2,227 in June 2021, while in November 2021 it exceeded US$2,500. Bangladesh is undergoing remarkable

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industrialization. Finished garments make up the bulk of Bangladesh's export earnings. The industrial sector's share is the highest in Bangladesh's GDP (Unanimous, 2023).

2 Literature review

Montano and Lopez (2020) found that the Industrial Revolution and the technological advances broke the Malthusian trap. According to the researchers, the growth of advanced technology must play a leading role in increasing national wealth and thus increasing wealth per capita. While, Kögel and Prskawetz (2000) emphasized that growth in industrialization combined with growth in agricultural total factor productivity can lift countries out of the Malthusian trap.

Niaz (2018) used an econometric approach to analyze the relationship between population growth and economic development and found a negative relationship between population growth and GDP per capita. The researchers linked population growth to environmental degradation to show the overall impact on economic development. Rahman (2018) discussed the Malthusian theory of population in the 20th century in terms of using science and technology for economic growth and strength. The researcher proved that Malthusian population theory had no effect on the development and use of science and technology in today's world.

Steinman et al. (1998) considered physical capital, human capital, and technology as inputs for development for escaping the Malthusian trap. Researchers considered labor, physical capital, education, and technology as exogenous variables. The researchers concluded that traps are ineffective because technological advances can improve human capital and increase economies of scale in manufacturing.

This paper aims to justify the Malthusian trap theory in Bangladesh by examining the effects of GNI growth rate, industrial growth rate, and population growth rate on per capita GNI growth rate using time series data.

3 Methodology

3.1 Unit Root Test

Unit root test need to run in order to check the stationary of the variables. The Augmented- Dickey-Fuller test of unit root has been presented in equation (1) to serve the purpose:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{j=1}^{p} \left(\delta_j \Delta Y_{t-j} \right) + e_t \quad \ldots\ldots\ldots\ldots (1)$$

Where e_t represents stochastic error term. In case of unit root the null hypothesis requires that γ=0.

3.2 Time series Regression model

The least squares principle provides a way of choosing the coefficients effectively by minimizing the sum of the squared errors. That is, we choose the values of $\beta_0, \beta_1, \ldots, \beta_k$ that minimizes the residual sum of squares offered in equation (2);

$$\sum \varepsilon^2 t = \sum (yt - \beta_0 - \beta_1 x_{1t} - \beta_2 x_{2t} - \cdots - \beta_k x_{kt})^2 \ldots\ldots\ldots\ldots (2)$$

This is called least squares estimation because it gives the least value for the sum of squared errors. Here in this paper the linear regression model for Malthusian trap theory is represented by equation (3):

$$y_t = \beta_0 + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \varepsilon_t \ldots\ldots\ldots\ldots (3)$$

Based on the equation (3), y is the per capita GNI growth (PCGNI GR), x_1 is the industrial growth rate (IND GR), x_2 is the GNI growth rate (GNI GR), x_3 is the population growth rate (PGR) and ε_t is the error term. Subscript $_t$ represents the time series indication of the model. A regression coefficient is said to be statistically significant if its calculated t value falls in the rejection area or if *p*-value is less than 5%.

3.3 Cointegration Test

A two-stage Engle-Granger method (Engle-Granger, 1987) was used to check for cointegration between the variables. Two types of test-statistics are used to justify the cointegration vector: the trace test-statistic and the maximum Eigen value test-statistic. These are listed below through equations (4) and (5):

$$\lambda trace = T \sum_{i=r-1}^{n} \ln(1 - \lambda i) \ldots\ldots\ldots\ldots (4)$$

$$\lambda max = -T \ln (1-\lambda r+1) \ldots\ldots\ldots\ldots (5)$$

Here, *r + 1* will be tested to verify if it is rejected in favor of *r* root. Johansen argued that under the null hypothesis these two tests have non-standard distributions that provide approximate critical values for the statistics represented by the Monte Carlo method. The alternative of the trace test requires that the cointegration vector be less than or equal to *r+1*, whereas the maximum Eigen value test holds *r+1*.

3.4 Granger

The Granger causality test is carried out for checking whether there is unidirectional or bi-directional causal relationship between any two variables. The following equations (6) and (7) will serve the issue:

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$$Y_t = \delta + \sum_{i=1}^{m} \alpha i\ Yt - 1 + \sum_{i=1}^{n} \gamma i\ \ Xt\text{-}1 + vi\ ..$$

$$X_t = \kappa + \sum_{i=1}^{m} \mu i\ \ Xt\text{-}1 \quad + \sum_{i=1}^{n} \varphi i\ \ Y\ t\text{-}1 + \eta i \quad \ldots\ldots\ldots\ldots (7)$$

In equations (6) and (7) both v_i and η_i are the white noise disturbance terms which are assumed stationary. Both equations represent the present values of any one of the variables are related to the past values of itself and another variable. X will Granger Cause Y if the calculated F-statistics is significant at conventional level and similar will occur in case of Y to X.

4.1 Data

This study covers data from 1996 to 2020 for all above-mentioned variables. The main source of data is the World Development Indicators published by the World Bank. The results have been obtained by using econometrics software Eviews version 10.

4.2 Result of unit root tests

Table-1: Unit Root Test (ADF)

Unit Root test without trend and intercept				**Unit Root test with trend and intercept**		
Variable	Level	First Dif	Second Dif	Level	First Dif	Second Dif
PCGNIGR	-1.543831	-4.424266	-5.207258	-2.307423	-4.318757	-5.051258
IND GR	-2.901693	-3.902785	-3.980769	- 3.376605	-3.722887	-3.881076
GNI GR	-1.877796	-4.489609	-5.240288	-2.402467	-4.395597	-5.086151
PGR	-1.961064	-1.331528	-3.534626	-2.019754	-4.017247	-3.393349

Note. *, ** and *** represents the level of significance in critical value for 10%, 5% and 1% respectively.

According to the **Table-1** the results of the ADF unit root test show that in the level and in first difference of data the variables are not stationary. However, all the variables are stationary in the second differences. That means all the variables are integrated in the order 2.

4.3 Result of Regression

Table-2: Time series regression where Dependent Variable: PCGNI GR

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.136721	0.245755	0.556330	0.5845
IND GR	0.001135	0.000739	1.536518	0.1409
GNI GR	0.986644	0.000979	1007.513	0.0000
PGR	-1.035321	0.007450	-138.9624	0.0000
R^2	**0.999996**	**F-statistic**		**1189848**
Adjusted R^2	**0.999995**	**Prob(F-statistic)**		**0.000000**

In the **Table-2** the value of R^2, adjusted R^2 and the probability of F-statistics affirm that the model is perfectly fit. Here it is observed that the industrial growth (IND GR) has positive effect on per capita GNI growth (PCGNI GR). Though the *p*-value is above 10% (indicating an insignificant result), but the value of the coefficient states that a 1% increase in industrial growth rate leads to increase per capita GNI by 0.001%. GNI growth has a significant positive impact on per capita GNI growth as the value of the coefficient suggests that for a 1% increase in GNI growth (GNIGR), the per capita GNI increased by 0.98% (≈1, *p*-value 0.00). The coefficient of population growth rate is highly significant with *p*-value 0.00. The value of coefficient expresses that a 1% increase in population growth (PGR) leads to 1% fall in per capita GNI (PCGNI GR). That means the increase in per capita income is fully neutralized by the growth of population, a clean indication of existence of Malthusian trap in Bangladesh. More specifically this study reveals that GNI growth rate has almost cent percent positive effect on per capita GNI growth (PCGNI GR) but this is completely neutralized by the increase in population growth (which is the main inside of Malthusian trap theory).

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4.4 Cointegration Test

Table-3: Johansen Cointegration Test (Series: PCGNIGR GNIGR INDGR PGR)

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.783727	63.98652	47.85613	0.0008
At most 1 *	0.592201	30.29980	29.79707	0.0437
At most 2	0.336519	10.56621	15.49471	0.2396
At most 3	0.067631	1.540581	3.841466	0.2145

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level. * denotes rejection of the hypothesis at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigen value)

Hypothesized No. of CE(s)	Eigen value	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.783727	33.68672	27.58434	0.0072
At most 1	0.592201	19.73359	21.13162	0.0775
At most 2	0.336519	9.025628	14.26460	0.2840
At most 3	0.067631	1.540581	3.841466	0.2145

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level* denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values

Based on **Table-3** the Johansen and Juselius (1990) test has been done by taking one lag length. Trace statistics shows the variables are cointegrated at none and in At most one. However, the max statistics shows that the model is stationary at none and all other hypotheses are insignificance. Therefore, it can be said that there is a cointegrating relationship among the variables. The following **Table-4** exhibits the value of the cointegrating coefficients.

Table-4: Normalized cointegrating coefficients (standard error in parentheses)

PCGNIGR	GNIGR	INDGR	PGR
1.000000	-0.983118	-0.003069	1.028248
	(0.00095)	(0.00054)	(0.00233)

The normalized cointegrating coefficients are always estimated opposite as sign indicated in the rows of Table-4. Based on this idea it can be observed that GNI growth (GNIGR) has almost cent percent positive effect on per capita GNI (PCGNIGR). Again, industrial growth rate (INDGR) is positively influencing per capita GNI (0.003). The coefficient of population growth (PGR) is negative (-1.028) indicating a 1% increase in population growth leads to 1% fall in per capita GNI. That means the Malthusian trap is relevant for Bangladesh even in the long run. But industrial development can break the trap as industrial growth (INDGR) has positive effect on per capita GNI growth.

4.5 Granger Test

Table-5: Pair wise Granger Causality Tests

Null Hypothesis:	Obs	F-Statistic	Prob.
INDGR does not Granger Cause PCGNIGR	22	0.94471	0.4083
PCGNIGR does not Granger Cause INDGR		3.70836	0.0461
GNIGR does not Granger Cause PCGNIGR	22	5.17002	0.0176
PCGNIGR does not Granger Cause GNIGR		4.08429	0.0356
PGR does not Granger Cause PCGNIGR	22	5.20460	0.0172
PCGNIGR does not Granger Cause PGR		5.09366	0.0185

GNIGR does not Granger Cause INDGR	22	5.69447	0.0128
INDGR does not Granger Cause GNIGR		1.28070	0.3033
PGR does not Granger Cause INDGR	23	1.44291	0.2623
INDGR does not Granger Cause PGR		1.34050	0.2866
PGR does not Granger Cause GNIGR	22	4.11470	0.0349
GNIGR does not Granger Cause PGR		5.08521	0.0186

According to the results of **Table-5**, it can be realized that per capita GNI Granger cause to industrial growth, GNI and per capita GNI has bidirectional causality. Population growth has bidirectional causal relationship with both per capita GNI and GNI growth. However, population growth does not have any causal relationship with industrial growth.

5 Conclusion

The empirical findings of both regression and cointegration tests showed the evidence of existing the Malthusian trap condition in Bangladesh. That means anything that increases per capita income will soon be neutralized by the increase in the population growth of Bangladesh. On the other hand, industrialization has a positive effect on per capita income. Rapid industrialization could help to break this trap. Turning surplus labor into human capital can also help to grow industries and economies. Controlling population could also be an important tool for breaking the trap. There may be other tools which could be helpful to break this trap, are not considered here. Further research can be carried out to show the effect of those variables.

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