
“Causality Test Between Savings and Income of Bangladesh(1972-2013) and Conditional Income Convergence of Bangladesh and India”

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ABSTRACT

This thesis examines empirically the long-run relationship between per capita income growth rate (GDPPCGRB) and savings growth rate (GDSGRB) for Bangladesh (1972-2013). The study uses annual time series data. The study also tested to know whether there is income convergence between Bangladesh and India. The concept of conditional incomeconvergence has been used in this thesis. Time series methods have been used for analysis of data. Correlogram and graphical analysis used as an informal procedures and Augmented Dickey Fuller (ADF) test used for formal analysis to carry out the empirical analysis. The Granger causality test supports bidirectional causality between per capita income growth and savings growth in Bangladesh. OLS technique has been used for convergence purpose. The test results contains that conditional income convergence hypothesis do work between Bangladesh and India.

1.0 INTRODUCTION

Economic growth is the common goal for all nations. Various kinds of policies have been implemented by the government to achieve this main target such as increasing saving and investment and productivity of the nation. According to Solow (1956), in the short run higher saving rate leads to a larger amount of capital investment and finally a higher rate of economic growth. A nation's saving and investment are a determinant of its citizen's standard of living (Abel & Bernanke, 2000).

According to Abdul-Malik and Baharumshah (2007), countries having higher savings rates also enjoy the highest economic growth rate and per capita income. Bangladesh is a developing country with weak capital market and highly dependent upon national savings for financing or investment in the country (IMF, 2005). The population of Bangladesh is more than 160 million with per capita income of \$1190 with the 14% increase from the previous year (Bangladesh Bureau of Statistics)

However, theories and empirical works have shown that the direction of causality between gross domestic savings and economic growth may run in various directions: from gross domestic savings to economic growth, from economic growth to gross domestic savings. Modigliani (1970) and Maddison (1992) showed empirical evidence of a positive relationship between savings and income growth. According to them, it is necessary to boost GDP per capita for economic growth. This can be achieved through high level of investment and savings. But investment cannot be increased without increasing the amount of savings (Mehta and Rami, 2014). Classical growth model supports that savings influence GDP per capita (Solow, 1956) but Keynesian hypothesis states that it is GDP per capita or economic growth which contributes to saving (Carroll and Weil, 1994). According to Deaton (1995), causality is important not just for understanding the process, but for the design of a policy. So, one of the objectives of this thesis is to find out the causal direction of GDP per capita and Gross Domestic Saving of Bangladesh. For to identify the direction of causality, ADF test and VAR test have been used to test the Granger Causality Test.

Another purpose of this study is to examine whether conditional income convergence hypothesis holds for per capita income in Bangladesh and India. Bangladesh has been able to achieve GDP growth at more than 6 percent on an average even during the period of global

financial crisis. On the other hand, India has achieved more than 7% GDP growth on an average in the same time frame. In this paper, one of the hypotheses is whether Bangladesh and India's per capita income will converge or not in the long run. We have used the concept of conditional convergence for the study. The OLS regression method has been used to identify the conditional convergence. The test result shows that conditional income convergence holds for Bangladesh and India.

2.0 OBJECTIVES

This study is going to examine whether the direction of causality runs from savings to GDP per capita growth rate or vice versa. Moreover, it also investigates the conditional income convergence hypothesis for the Bangladesh and India.

- ❖ To provide empirical evidence whether there is a causal relationship between gross domestic savings and per capita GDP.
- ❖ To find out the particular direction of causality between them.
- ❖ To investigate whether Bangladesh is in the process of catching up with the India in terms of per capita income.

3.0 HYPOTHESIS

These below hypothesis will be tested for the purpose of the study:

1. H_0 : GDP per capita growth rate of Bangladesh does not granger cause Gross Domestic Saving growth rate of Bangladesh

H_A : GDP per capita growth rate does granger cause Gross Domestic Saving growth rate.

Or H_0 : Gross Domestic Saving growth rate of Bangladesh does not granger cause GDP per capita growth rate of Bangladesh.

H_A : Gross Domestic Saving growth does granger cause GDP per capita growth.

2. H_0 : The conditional income Convergence hypothesis does not hold for Bangladesh and India.

H_A : The conditional income Convergence hypothesis does hold for Bangladesh and India.

4.0 LITERATURE REVIEW

In Solow model, higher saving leads to higher levels of income per capita in steady state and thus to higher growth rates. Solow (1956) suggested that savings affected economic growth because higher savings led to higher capital accumulation which in turn led to economic growth.

Sinha (1996) presented evidence about economic growth and savings in Pakistan. He did causality test using by Granger Causality Test. His evidence is unidirectional causality in growth rates and savings in Pakistan.

Anorvo and Ahmad (2001) analyzed the causal relationship between the growth of domestic savings and economic growth for Congo, Coste D'Ivoire, Ghana, Kenya, Nigeria, South Africa and Zambia. They observed unidirectional causality from GDP growth rate to the domestic savings rate for all countries except they have found causality runs from domestic savings to economic growth rate in Congo

Maurotas and Kelly (2001) used Granger Causality Test to examine the relationship between GDP and Gross Domestic Savings. In his study, he selects India's and Sri Lanka's GDP and Savings for the testing of causal relationship. He used ADF test for the unit root existence, co-integration test for to know the long run relationship between GDP and Savings and finally Granger Causality Test for identifying the relationship. He found no causality between GDP and savings in India. However, he found bidirectional causality in the case of Sri Lanka.

Mohan (2006) studied in the 25 countries about the relationship between their domestic savings and economic growth with different income levels. His paper addressed whether the causality is different from domestic savings to economic growth among low income, low middle income, upper middle income and high income countries. The model he used for stationary or to check unit root in the data he used ADF test. Causality among these countries savings and economic growth has been tested by Granger Causality Test. In his paper, he found unidirectional in high income countries and for upper middle income countries he found bidirectional causality. Moreover, in some lower income countries result is bidirectional for some countries and unidirectional for others.

Sajid and Sarfraz (2008) conducted a test to find out the causal relationship between the growth rate of savings and GDP in Pakistan. They have used quarterly data for the period of 1973-2003. They have used both Co-integration and Vector Error Correction techniques for their study. The results of their study were the existence of bidirectional causality between savings and GDP growth.

Ogoe (2009) tried to find the direction of causality between gross domestic savings and economic growth of Ghana using annual time series data over 1961-2008. In his study, he carried out the time series properties of growth rate of gross domestic savings and the growth rate of real per capita GDP using the ADF unit root test procedure. The estimated results indicated one order of integration or I(1) for the series. The causal relationship between the growth rate of gross domestic savings and the growth rate of real per capita GDP was performed using the Vector Autoregressive (VAR) model and Pairwise Granger Causality Test. The results showed that there was a bi-directional causal relationship between the growth rate of gross domestic savings and growth rate of real per capita GDP in Ghana. Based on the findings of the study, certain monetary and fiscal policies and other measures have been recommended to boost gross domestic savings and increase growth.

Abu Al-foul (2010) examined the relationship between savings and economic growth in Morocco and Tunisia. He uses time-series data of these two countries from the year 1965-2007. He used Augmented Dickey-Fuller Test to check for the existence of stationary in the data. To check for causality, he used the VAR model and then Granger Causality Test. He found bidirectional causality between savings and economic growth in Morocco. However, in the case of Tunisia, the results show causality runs from savings to economic growth, which means unidirectional causality in the case of Tunisia.

Bankole and Fatai (2013) have used Co-integration and Granger Causality test to analyze the relationship between savings and economic growth in Nigeria. They assess model to find out the relation through below two models

$$GDS = \alpha_0 + \sum_{t=1}^n \alpha_1 GDS_{t-1} + \sum_{t=1}^n \alpha_2 RGDP_{t-1} + \varepsilon_{1,t}$$

$$RGDP_t = \beta_0 + \sum_{t=1}^n \beta_1 RGDP_{t-1} + \sum_{t=1}^n \beta_2 GDS_{t-1} + \varepsilon_{2,t}$$

GDS = Gross domestic savings

RGDP = Real GDP per capita

They have conducted the test as follows; GDP per capita will influence the savings if the coefficient(s) of RGDP (α 's) is statistically different from zero and savings will influence GDP if the coefficient(s) of GDS (β 's) is statistically different from zero. They have taken annual data for 1980-2010 for their study. They have also used ADF test to check for the existence of Unit Root. The results of their study were unidirectional causality means causality runs from domestic savings to GDP per capita.

Seoud (2014) investigated relationships between savings growth and economic growth in Bahrain. He used Unit Root Test and Granger Causality Test as econometric tools for his study. The equations for his test was,

$$LGDP_{g,t} = \alpha + \beta LPS_t + \varepsilon_t$$

$$LPS_t = \alpha + \beta LGDP_{g,t} + \mu_t$$

Here, $LGDP_{g,t}$ = GDP growth rate at time t

LPS_t = personal savings at time t

Coefficients = α and β ; Error term = ε_t and μ_t

His study used annual savings rate and GDP growth rate of Bahrain from 1990 to 2013. He found bilateral causality between savings and economic growth or GDP growth.

According to Barro and Martin (1991), the convergence issue has become more important because people want to know whether the standard of living for those in poor nations has been improved or has increased more rapidly than that of the richer countries, or conversely whether the rich are getting richer, and the poor are becoming poorer.

Bernard and Durlauf (1995) proposed practical definition of convergence as catching up

$$\lim_{T \rightarrow \infty} E(Y_{i,t+T} - Y_{j,t+T} | I_t) < Y_{i,t} - Y_{j,t}$$

Here t = present year, T = future years.

Countries i and j converge at time t+T years with given income level if their income differences at t is expected to decrease over time.

Oxley and Greasley (1995) offered simple regression to test convergence between two countries. Their suggested regression is

$$\Delta y_{iqt} = \alpha + \gamma t + \beta y_{iqt-1} + \sum_{j=1}^m \theta_{ij} \Delta y_{iqt-j} + \varepsilon_t$$

Here, $i = 1, \dots, N$ countries

$j = 1, \dots, m$ lags

$y_{i,qt} = \log Y_{it} - \log Y_{qt}$

$\log Y_{it} = \log$ of per capita GDP of country i

$\log Y_{qt} = \log$ of per capita GDP of country q or leader country

According to them convergence between country i and j will occur when coefficient β is not equal to zero ($\beta < 0$) and coefficient γ is equal to zero ($\gamma = 0$). If β is not equal to zero ($\beta < 0$) and also γ is not equal to zero ($\gamma \neq 0$) then it indicates catching up. However, if β is equal to zero ($\beta = 0$) then it suggests two countries will diverge over time.

Oxley and Greasley (1997) conducted the convergence between Australia and UK using both GDP per capita and real wages. They examine converging using time series Unit Root Test.

Lim and McAleer (2004) examined the convergence for ASEAN countries and also they tested convergence of ASEAN countries with the U.S.A. Their result does not support convergence between ASEAN countries but found convergence in terms of technology with U.S.A.

Ismail (2008) used OLS method for the estimation of cross-section convergence. He found both conditional and absolute convergence in ASEAN5 countries. The model he used for his testing is,

$$\Delta \ln y_{i,t} = \alpha_{0,i} + \Phi \ln y_{i,t-1} + \alpha_{1,i} \ln sK_{i,t} + \alpha_{2,i} \ln n_{i,t} + \alpha_{3,i} t + \beta_{1,i} \Delta \ln sK_{i,t} + \beta_{2,i} \Delta \ln n_{i,t} + \varepsilon_{i,t}$$

Where Φ is the convergence parameter and $y_{i,t-1}$ is the lagged dependent parameter which measures the convergence effect.

Spurk (2013) conducted a study to test convergence with seven other countries. These countries are Croatia, Czech Republic, Estonia, Hungary, Poland, Slovakia and Slovenia. He examined the conditional income convergence of these countries with U.S.A. He had taken annual data of these countries from 1991-2007. He modeled to test the convergence between these countries as,

$$g_{j,t} = \theta + \delta \ln y_{j,t=0} + \lambda \ln [y_{j,t} - y_{usa,t}] + \alpha_j + U_{j,t}$$

Here, j = any of the country among Croatia, Czech Republic, Estonia, Hungary, Poland, Slovakia

and Slovenia

$g_{j,t}$ = Real GDP growth rate at time t of country j

$y_{j,t=0}$ = Baseline real GDP per capita

$y_{j,t} - y_{usa,t}$ = Difference of GDP per capita between U.S.A and country j

λ = Speed of convergence

δ = measure of conditional convergence

5.0 METHODOLOGY

From the literature section, we understand most of the countries have bidirectional causality between savings growth and GDP per capita growth. Most of them have used Granger Causality to understand the saving and the GDP per capita behavior direction. In this paper, both formal and informal analysis techniques have been used for the stationary process of the time series variable. Graphical analysis and correlogram has been used for informal analysis and ADF test used for formal analysis. To test the first hypothesis, Granger Causality Test is the easiest and simplest technique.

Conditional income convergence hypothesis inspect by the OLS regression method. The model used for conditional convergence is the modified version given by the different literature.

All the data were collected from World Bank. So, the data for both the countries are secondary data. These data are annually time series data collected from 1972-2013. Econometric estimation procedures are conducted using statistical and data analysis software STATA.

5.1 ECONOMETRIC MODEL

To test hypothesis 1 or examine the Granger Causality Test we build the econometric model as, gross domestic savings growth rate of Bangladesh will denote as GDSGRB and gross domestic product per capita growth rate of Bangladesh will denote as GDPPCGRB. Equations for Granger Causality test are

$$\text{GDSGRB}_t = \alpha_0 + \sum_{t=1}^k \alpha_1 \text{GDPPCGRB}_{t-1} + \sum_{t=1}^k \alpha_2 \text{GDSGRB}_{t-1} + \varepsilon_{1t} \dots \dots (1)$$

$$\text{GDPPCGRB}_t = \beta_0 + \sum_{t=1}^k \beta_1 \text{GDSGRB}_{t-1} + \sum_{t=1}^k \beta_2 \text{GDPPCGRB}_{t-1} + \varepsilon_{2t} \dots \dots (2)$$

Here, the k = number of lags

α 's and β 's = coefficients

ε_t = white noise error term

GDP per capita growth will granger causes savings growth if the coefficient of GDP per capita in equation (1) is statistically significant. On the other hand, savings growth will

granger cause GDP per capita if the coefficient of savings in equation (2) is statistically significant.

If both equations are true, then there will be bidirectional causality. If one is true, then unidirectional causality will occur. However, if both equations are rejected then there will be no convergence.

The income convergence hypothesis or 2nd hypothesis will be tested through the OLS regression model.

$$\Delta \text{GAP}_{ibt} = \alpha + \beta t + \gamma \text{GAP}_{ibt} + \sum_{k=1}^n \theta_k \Delta \text{GAP}_{ibt-k} + \varepsilon_t \dots\dots\dots (3)$$

Here, $\text{GAP}_{ibt} = \log I_{it} - \log B_{bt}$

$\log I_{it}$ = log of real per capita GDP of India

$\log B_{bt}$ = log of real per capita GDP of Bangladesh

K = number of lags

ε_t = white noise error term

Some conditions for convergence are as follows:

- If GAP_{ibt} contains unit root it means if $\gamma = 0$ then Bangladesh and India's GDP per capita income will diverge over time.
- If there is no unit root in $\text{GAP}_{ibt}[\gamma \neq 0]$ and β is statistically insignificant or no deterministic trend in the model then it suggest convergence.
- Again, if there is no unit root in $\text{GAP}_{ibt}[\gamma \neq 0]$ but this time if β is statistically significant or presence of deterministic trend in the model then it indicates long run catching up.

6.0 THEORITICAL FRAMEWORK

6.1 Time or Lag Length

In time series economics relationship between dependent variable and independent is rarely immediate. Most of the time dependent variable (Y) reacts to the independent variable with a lapse of time. Such a gap of time is called lag or time lag (Gujrati, 2004). For example

$$Y_t = \alpha + \beta_0 X_t + \beta_1 X_{t-1} + \beta_2 X_{t-2} + \dots + \beta_k X_{t-k} + U_t \dots \dots \dots (4)$$

The number of lag term to be included in a model or analysis is very important. We can choose from either Akaike or Schwarz information criterion (Gujrati, 2004). For annual time series data, maximum number of lag length 3-4 is good enough (Woodridge, 2012). According to Akaike (1977) and Schwarz (1978), when selecting the optimized model, the goal is to maximize the goodness of fit or R^2 . AIC or SIC works to reduce the residual sum of squares or increase the R^2 value. We need to select the model with the lowest AIC or SIC value. For example, AIC aims to obtain the minimum value of the following statistic:

$$AIC = e^{2k/n} \frac{RSS}{n} \dots \dots \dots (5)$$

k = number of regressors including intercept

n = number of observations

RSS = residual sum of squares

6.2 Granger Causality

It is a technique for determining whether one time series is useful in forecasting in another. For example, in macroeconomics we often want to the causality between GDP and Money Supply (M). To estimate this involvement, let's take following pair of regressions:

$$GDP_t = \sum_{i=1}^n \alpha_i M_{t-i} + \sum_{i=1}^n \beta_i GDP_{t-i} + U_{1t} \dots \dots \dots (6)$$

$$M_t = \sum_{i=1}^n \lambda_i M_{t-i} + \sum_{i=1}^n \delta_i GDP_{t-i} + U_{2t} \dots \dots \dots (7)$$

In Granger Causality Test relationship between two variables can unidirectional, bidirectional and independence means no granger causality in any direction. For instance, in the above equations causality from Money Supply to GDP will be unidirectional if the estimated

coefficients of lagged M in equation (6) are statistically different from zero and estimated coefficients of lagged GDP in equation (7) is statistically not different from zero.

Moreover, bilateral causality will be occurring when the coefficients of both Money Supply and GDP are statistically different from zero in both the equations.

Granger Causality only applied in stationary time series data. If the data or series are non-stationary, then the time series model should be differentiated in order to make it stationary.

6.3 Stationary

In time series econometrics stationary is a common assumption. In practice, most of the time series data are non-stationary. The use of non-stationary time series data can lead us to spurious regressions. According to Granger and Newbold (1974), a spurious regression has a high R^2 , but the results are without any economic meaning. According to Green (2003), spurious regression is a phenomenon which econometricians aim to avoid. Schmidt (2008) said that a time series, say Y_t , is stationary if its mean, variance is constant over time and the value of covariance depends only on the distance of two time periods.

$$\text{Mean: } E(Y_t) = \mu_t; \text{ for all } t$$

$$\text{Variance: } \text{Var}(Y_t) = E(Y_t - \mu)^2 = \sigma^2; \text{ for all } t$$

$$\text{Covariance: } \text{Cov}(Y_t Y_k) = \text{Cov}(Y_{t+s} Y_{k+s}); \text{ for all } t, k, s$$

6.4 Random Walk Model

Most of the time series data we encounter are non-stationary data. For example, the efficient capital market hypothesis say's change in the price of stock from one day to the next day is completely different; that is, they are non-stationary and follow a random walk (Enders, 2010). So, the random walk model (RWM) is,

$$Y_1 = Y_0 + U_1$$

$$Y_2 = Y_1 + U_2 = Y_0 + U_1 + U_2$$

$$Y_3 = Y_2 + U_3 = Y_0 + U_1 + U_2 + U_3$$

In general we can write it as,

$$Y_t = Y_{t-1} + \sum U_t \dots\dots\dots (8) [t= 1,2,3,\dots,n]$$

RWM is two types

1. Random walk without drift
2. Random walk with drift

Equation (8) is an example of RWM without drift. In RWM without drift, there is no constant or intercept term. According to Enders (2010), Mean of a RWM without drift is constant but variance changes over time.

$$\text{Mean: } E(Y_t) = E(Y_{t-1} + \sum U_t) = Y_{t-1}$$

Mean is equal to its initial value which is constant.

$$\text{Variance: } \text{Var}(Y_t) = t\sigma^2$$

Variance is increasing as t increases. Thus, it's violating the condition of stationary.

Now, if we add a constant term in the equation (8) it will become a RWM with drift.

$$Y_t = \alpha_0 + Y_{t-1} + \sum U_t \dots\dots\dots (9) [t= 1,2,3,\dots,n \text{ and } \alpha_0 \text{ is drift parameter}]$$

In RWM with drift the mean as well as the variance increases over time.

$$\text{Mean: } E(Y_t) = Y_{t-1} + t\alpha_0$$

$$\text{Variance: } \text{Var}(Y_t) = t\sigma^2$$

According to Gujrati (2003), RWM with or without drift is non-stationary.

6.5 White Noise

According to Brooks (2008), a white noise is a purely random process. A white noise term has a zero mean, constant variance and it is serially uncorrelated.

For example,

$$Y_t = \alpha_0 + \beta_1 Y_{t-1} + \varepsilon_t$$

Here, ε_t is a random error and it is a white noise term.

Mean: $E(\varepsilon_t) = 0$; for all t

Variance: $\text{Var}(\varepsilon_t) = \sigma^2$; for all t

Covariance: $\text{Cov}(\varepsilon_t, \varepsilon_{t-s}) = 0$; $s \neq 0$

6.6 Unit Root

A RWM is also known as a Unit Root process. A RWM without drift can be written as,

$$Y_t = \rho Y_{t-1} + \varepsilon_t \dots\dots\dots (10)$$

If $\rho=1$, then it is RWM without drift also it means we face a unit root problem. The existence of a unit root in a model shows that the data is non-stationary. Now let subtract Y_{t-1} from the both sides of the equation (10),

$$Y_t - Y_{t-1} = \rho Y_{t-1} - Y_{t-1} + \varepsilon_t$$

$$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t ; [\delta = \rho - 1] \dots\dots\dots (11)$$

If $\delta=0$ then $\rho=1$, that is we have a unit root and the time series under our observation is non-stationary. So, the term non-stationary, random walk and unit root can be considered as synonymous with each other (Gujarti,2004).

6.7 Tests for Stationary

According to Gujrati (2004), whether a data is stationary or not it can be checked in both formal and informal analysis.

6.7.1 Informal Analysis

Informal analysis includes

- Graphical analysis
- Correlogram analysis.

6.7.1.1 Graphical Analysis

If a graph of a variable shows upward or downward trend, then the mean of the variable is changing over time, which suggests the existence of non-stationary in the data.

6.7.1.2 Correlogram

It is an image of autocorrelation statistics. It is commonly used for checking randomness in the dataset. If the data is purely random or white noise, then autocorrelations will be around zero. Thus, the time series will be stationary.

6.7.2 Formal Analysis

6.7.2.1 Unit Root Test

Unit Root Test is most popular test to examine the existence of stationary in a time series data. From equation (11) we can write RWM without drift parameter as

$$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t ; [\delta = \rho - 1]$$

Now if $\delta = 0$ then,

$$\delta = \rho - 1$$

$$0 = \rho - 1$$

$$\text{So, } \rho = 1$$

It means dataset is non-stationary. So, for stationary δ must be less than zero ($\delta < 0$) which δ must be negative (Wooldridge, 2012).

6.7.2.2 Dickey Fuller Test

The simplest and most widely used tests for unit root or to check stationary in the dataset a tool were developed by Dickey and Fuller known as a Dickey Fuller test. Let's consider an AR (1) model as like as equation (11),

$$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t ; \varepsilon_t \text{ is a white noise term}$$

So, our null hypothesis is $\delta = 0$ or presence of unit root or non-stationary dataset and alternative hypothesis is $\delta < 0$ or dataset is stationary. We have seen that a RWM or unit root

process may have drift, no drift or even it may have trend term in the model (Gujrati,2004). So, Dickey-Fuller test is estimated in three different forms,

$$\text{RWM without drift: } \Delta Y_t = \delta Y_{t-1} + \varepsilon_t$$

$$\text{RWM with drift: } \Delta Y_t = \theta_0 + \delta Y_{t-1} + \varepsilon_t$$

$$\text{RWM with drift and trend: } \Delta Y_t = \theta_0 + \theta_1 t + \delta Y_{t-1} + \varepsilon_t$$

In each case null and alternate hypothesis is,

$$H_0: \delta=0; \text{ data are non-stationary}$$

$$H_A: \delta<0; \text{ data is stationary}$$

6.7.2.3 Augmented Dickey-Fuller test

Sometime we may have some time series data which may not be explained by AR(1) process. Such as,

$$\Delta Y_t = \alpha_0 + \rho Y_{t-1} + \sum_{i=1}^p \beta_i \Delta Y_{t-1} + \varepsilon_t \dots\dots\dots (12)$$

According to Gujrati (2004),we cannot estimate ρ unless all autoregressive or past values are properly included. Also the lag of Y_t may be correlated. So we use Augmented Dickey-Fuller (ADF) test to clean up any serial correlation in equation (12).

6.8 Convergence

The catch-up effect, also called the theory of convergence, which states that the poorer countries or economies will tend to grow faster than the richer economies. Thus, all economies will eventually converge in terms of per capita income. In the neoclassical theory, particularly in the Solow model (1956), poorer economies may converge to rich ones because there are diminishing returns to capital.

The term convergence carries two meanings in the growth theory. First one is absolute convergence and the second one is conditional convergence.

Barro and Martin (1991) said unconditional or absolute convergence may be too demanding between countries. Absolute convergence requires a lower income gap between two countries

or the income gap is declining between two countries over time, irrespective of the types of technology they are possessed, investment rate, savings pattern, overall GDP, per capita GDP, policies and institutions of these countries.

They have given the idea of conditional convergence of any two countries can be possible when countries differ in those determinants of an economy. This conditional convergence is much easier to conduct or to test between two countries.

Absolute convergence is more applicable across regions within countries. Differences in technology, preferences and institutions are likely to be smaller in firms and households of different regions within a single economy (Barro & Martin, 1991).

According to Barro and Martin (1991), convergence can also be defined as β -convergence and σ -convergence. β -convergence is the situations where poor economies tend to grow faster than rich ones. The term σ -convergence means real per capita GDP levels of two countries tend to decrease over time.

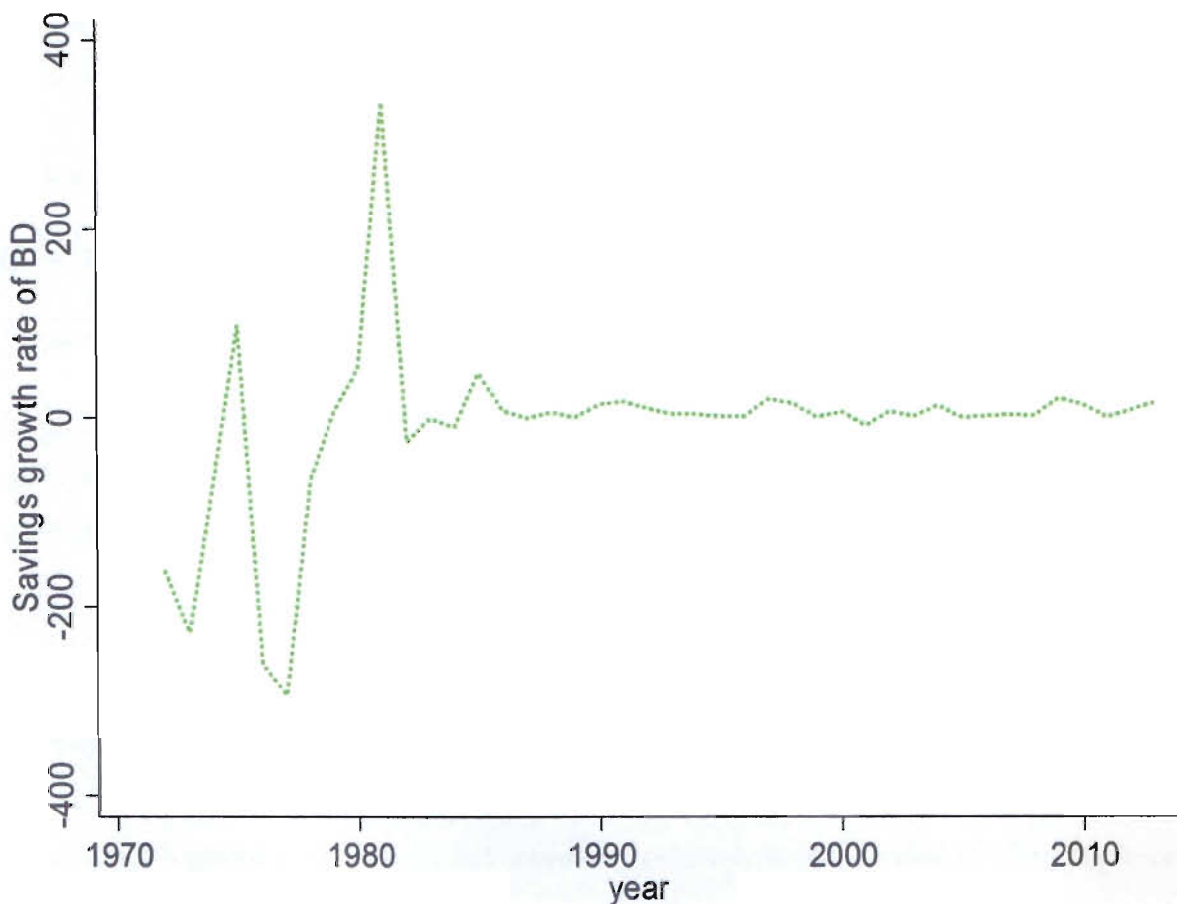
7.0 RESULTS

In this section the results obtained from various tests and model are presented and analyzed. To test our first hypothesis about the causality between gross domestic savings growth rate of Bangladesh (GDSGRB) and gross domestic product per capita growth rate of Bangladesh (GDPPCGRB), we do need to check whether the data is stationary or not.

7.1 Stationary Test of GDSGRB

First, we take an informal test to look for the stationary in the data. We draw the graph of GDSGRB to check whether there is any trend in the graph.

Figure 1: Gross Domestic Savings growth rate of Bangladesh



From figure 01 we can say the mean value of savings is not changing over time. Then we check the data with another informal test which is Correlogremanalysis. From Correlogram test we can see there is no correlation between current value and its lag value. Finally, we

have done the White Noise Test and it gives us that the error term is linearly independently distributed. Informal analysis shows the data is stationary or does not have Unit Root.

Now, for formal procedure, we have used ADF test. From our informal analysis we can say as the data is stationary so, we take the model RWM without drift for our test.

$$\Delta GDSGRB_t = \rho GDSGRB_{t-1} + \sum_{k=1}^n \rho_k \Delta GDSGRB_{t-k} + \varepsilon_t$$

Here, k= number of lags in the model.

Our hypothesis for ADF test is, H_0 : there is unit root, $\rho=0$

H_A : there is no unit root, $\rho<0$

To determine the optimum number of lag length we have used AIC method of minimizing it. Maximum number of lags is selected at four because it is an annual time series data. Minimum lag is at zero.

Table 1: ADF Test Result for GDSGRB

Variable	Coefficient	Std. Error	Test Statistic	P-Value
GDSGRB _{t-1}	-.8201884	.1696373	-4.83***	0.00

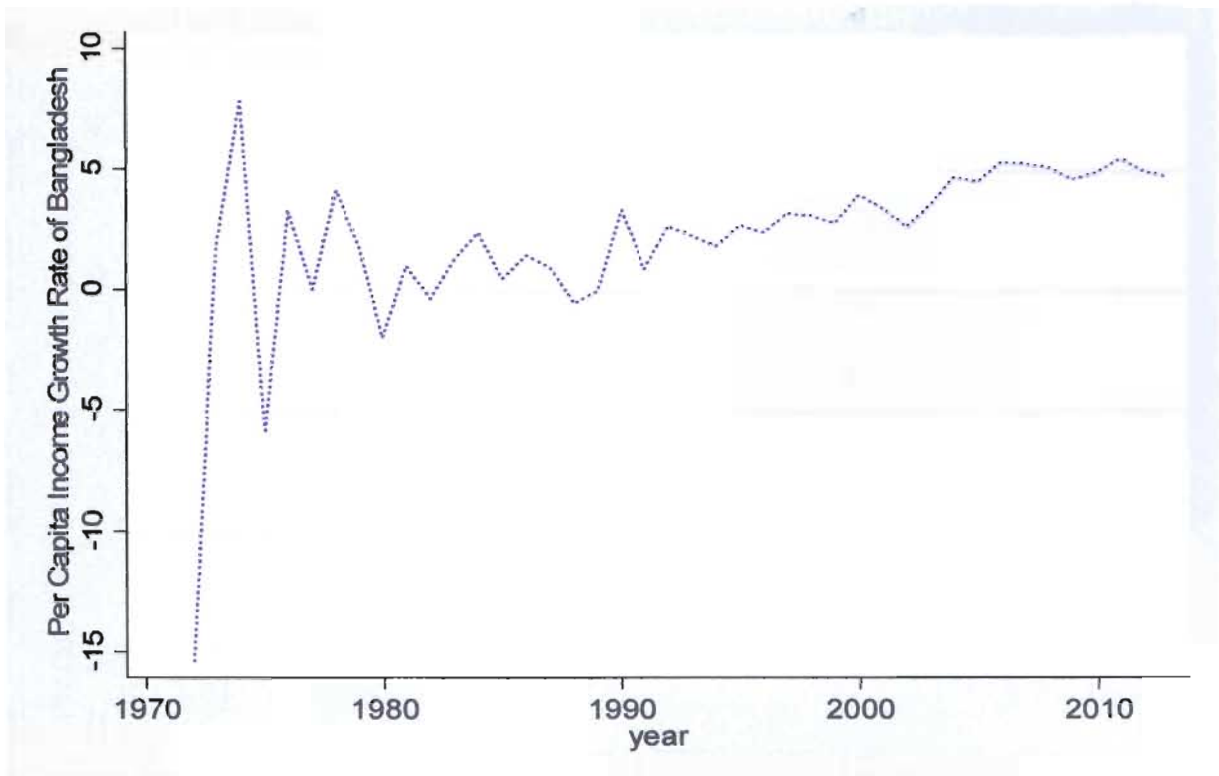
*** Statistically Significant at 5% significance level

The critical value provided at the 5% level of significant is -1.950 and the computed test statistic is -4.83. So, we reject the null hypothesis of a unit root. This means that the data of GDSGRB are stationary.

7.2 Stationary Test of GDPPCGRB

Again first we go for informal analysis. We draw the graph of GDSGRB to check whether there is any trend in the graph. From figure-02 we can say that per capita income data has an upward trend. Upward trend data is not stationary because its mean value is changing over time.

Figure 2: Per Capita Income Growth Rate of Bangladesh



Our Correlogram analysis also shows high correlation with its lagged values. So, we can say per capita income growth rate is non-stationary. If we take the ADF test for the per capita income data then results is

$$\Delta \text{GDPPCGRB}_t = \rho \text{GDPPCGRB}_{t-1} + \sum_{k=1}^n \rho_k \Delta \text{GDPPCGRB}_{t-k} + \varepsilon_t$$

Here, k= number of lags in the model.

Our hypothesis for ADF test is, H_0 : there is unit root, $\rho=0$

$$H_A: \text{there is no unit root, } \rho < 0$$

Optimum number of lag using AIC method is at two.

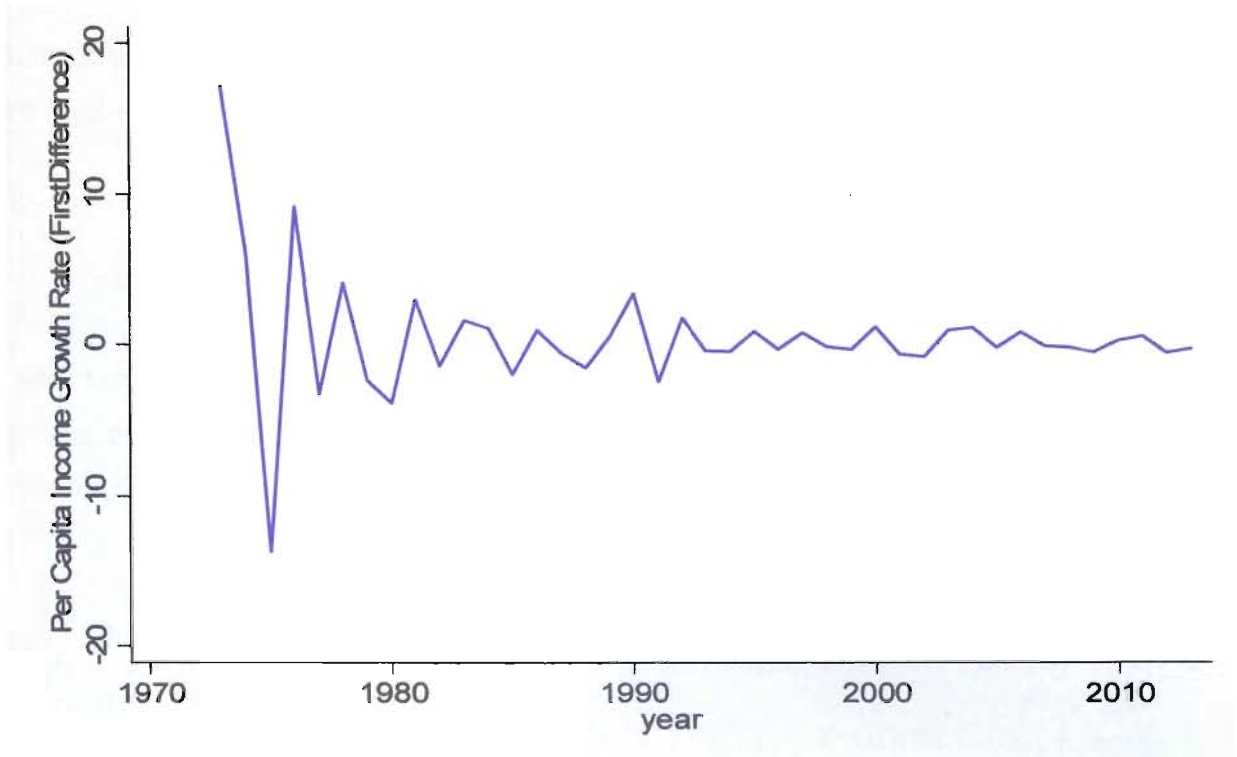
Table 2: ADF Test Result for GDPPCGRB

Variable	Coefficient	Std. Error	Test Statistic	P-Value
GDPPCGRB _{t-1}	0.0232589	0.0804588	0.289	0.774

The critical value provided at the 5% level of significant is -1.950 and the computed tau (τ) value is 0.0232. So, we cannot reject the null hypothesis of a unit root. This means that the data of GDPPCGRB are non-stationary.

To make the data stationary we take the first difference of per capita income growth rate.

Figure 3: Per Capita Income Growth Rate of Bangladesh (First Difference)



Now the mean value of the data is not changing over time. The Formal ADF test model becomes RWM without drift,

$$\Delta D1.GDPPCGRB_t = \rho D1.GDPPCGRB_{t-1} + \sum_{k=1}^n \rho_k \Delta D1.GDPPCGRB_{t-k} + \varepsilon_t$$

Here, k= number of lags in the model.

Our hypothesis for ADF test is, H_0 : there is unit root, $\rho=0$

$$H_A: \text{there is no unit root, } \rho < 0$$

Optimum number of lag using AIC method is at four.

Table 3: ADF Test Result for GDPPCGRB (First Difference)

Variable	Coefficient	Std. Error	Test Statistic	P-Value
D1.GDPPCGRB _{t-1}	-2.221	.590	-3.76***	.001

*** Statistically Significant at 5% significance level

The critical value provided at the 5% level of significant is -1.950 and the computed tau (τ) value is -3.76. So, we reject the null hypothesis of a unit root. This means that the data of GDPPCGRB are stationary.

Both data on gross domestic saving growth rate of Bangladesh and gross domestic product of per capita income growth rate of Bangladesh is stationary.

7.3 Granger Causality Test Output

This test result will show us the direction of causality between savings growth rate and per capita income growth rate of Bangladesh. Our previous test results show us that our data on savings and per capita income is stationary. Our equations for testing the causality was equation (1) and (2), we need to rewrite these equations as,

$$GDSGRB_t = \alpha_0 + \sum_{t=1}^k \alpha_1 D1.GDPPCGRB_{t-1} + \sum_{t=1}^k \alpha_2 GDSGRB_{t-1} + \varepsilon_{1t}$$

$$D1.GDPPCGRB_t = \beta_0 + \sum_{t=1}^k \beta_1 GDSGRB_{t-1} + \sum_{t=1}^k \beta_2 D1.GDPPCGRB_{t-1} + \varepsilon_{2t}$$

For the Granger Causality, we run the VAR model fist to select lowest AIC value. VAR results show the lowest AIC value at lag four. After obtaining the VAR results, we put the VAR results into Granger Causality test.

Table 4: Test result for Granger Causality Tests

Null Hypothesis	F-Value	Probability	Decision
GDSGRB does not Granger Cause GDPPCGRB	5.129	0.000***	Reject Null
GDPPCGRB does not Granger Cause GDSGRB	9.9669	0.0031***	Reject Null

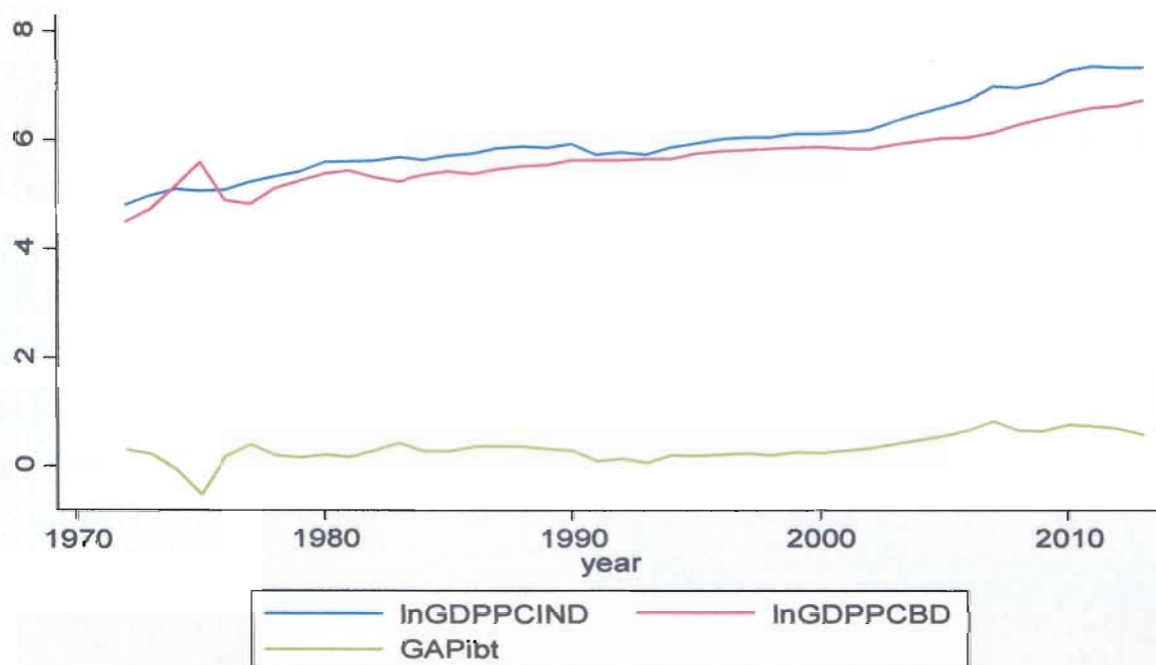
*** Statistically Significant at 5% significance level

Both the cases null hypothesis is rejected at the 5% significance level. It means we have bi-directional causality between savings growth rate in Bangladesh and per capita income growth rate of Bangladesh.

7.4 Testing For Convergence

The first step to test income convergence of Bangladesh and India we transform the per capita income of both countries into logarithm form. Then we take their income gap ($\ln\text{GDPIND} - \ln\text{GDPBD}$).

Figure 4: Log of per capita income of Bangladesh and India and the income difference



Now, as usual, we need to verify whether the income gap of these two countries is stationary or not. Graphical analysis suggests that gap of income is not stationary, but after taking the first differences the income gap becomes stationary. Also, after first differencing ADF test results show there is no unit root in the income gap.

Table 5: ADF test results for income gap (GAPibt)

Variable	Coefficient	Std. Error	Test Statistic	P-Value
D1.GAP _{ibt}	-1.950	0.266	-7.327***	0.00

*** Statistically Significant at 5% significance level

The critical value provided at the 5% level of significant is -1.950 and the computed tau (τ) value is -7.327. So, our data are now stationary.

Now, as we said about our model for the convergence test in the econometric model section that if the income gap contains unit root, then GDP per capita of Bangladesh and India

diverge over time. So, Bangladesh and India's per capita income will not diverge because there is no unit root in the data or income gap between Bangladesh and India's is stationary.

7.5 OLS regression for Convergence

We wrote our model for convergence hypothesis in econometric model section in equation (3),

$$\Delta \text{GAP}_{ibt} = \alpha + \beta t + \gamma \text{GAP}_{ibt} + \sum_{k=1}^n \theta_k \Delta \text{GAP}_{ibt-k} + \varepsilon_t$$

We need to rewrite this equation for our analytical convenience as

$$\Delta \text{D1.GAP}_{ibt} = \alpha + \beta t + \gamma \text{D1.GAP}_{ibt} + \sum_{k=1}^n \theta_k \Delta \text{D1.GAP}_{ibt-k} + \varepsilon_t$$

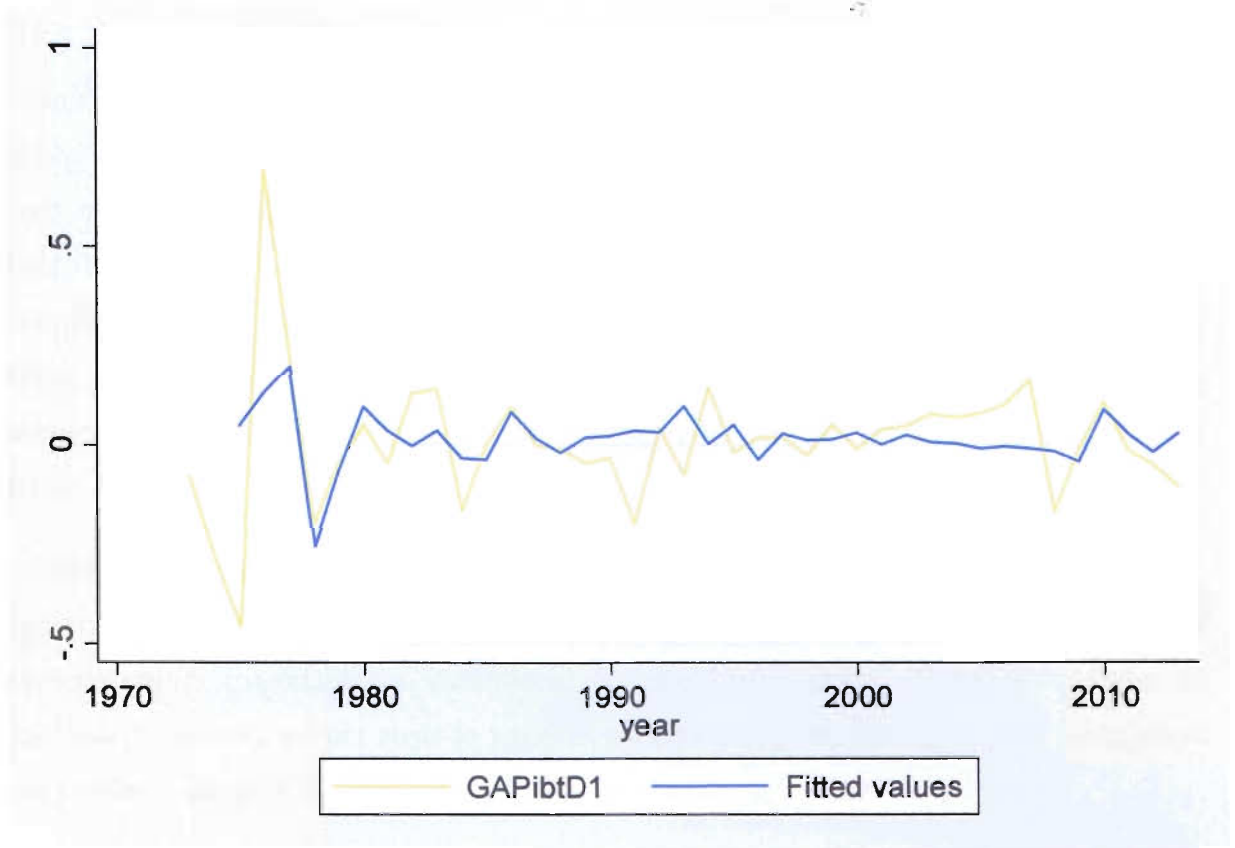
As our data are stationary, we need to look for the deterministic or the trend term in the model. Absence of deterministic term will give us conditional convergence. OLS results with lagged two for the trend term is

Table 06: Convergence Test result for trend term

Variable	Coefficient	Std. Error	T-value	P-value
Trend (t)	0.0001	0.002	0.07	0.943
$R^2 = 17\%$, F-value = 0.038				

Our test result indicates that trend term statistically insignificant at 5% significant level. So, per capita income of Bangladesh and India will converge. That means our 2nd hypothesis is rejected and we accept the alternative hypothesis of conditional convergence between Bangladesh and India.

Figure 5: Predicted or Fitted value and income gap of Bangladesh and India



8.0 CONCLUSION

Saving is one of the main factors of economic growth or we can say higher economic growth or higher per capita income influence more saving. Many growth theories suggested that more savings is necessary to accumulate more physical capital through more investment. Thus, it will result in more economic growth. In this paper, we have found bidirectional causality among saving rate and per capita income growth. National savings can be increased through both private and public savings. The private savings rate can be encouraged by proper tax policy and public or government savings rate can increase by lowering the budget deficit.

Conditional convergence allows countries to have their specific steady income level. Conditional convergence has a number of policy implications. Savings and investment environment is important for conditional income convergence. If the government of Bangladesh can take proper steps to national savings and invest in capita, then Bangladesh will converge towards the India's steady state level of income faster.

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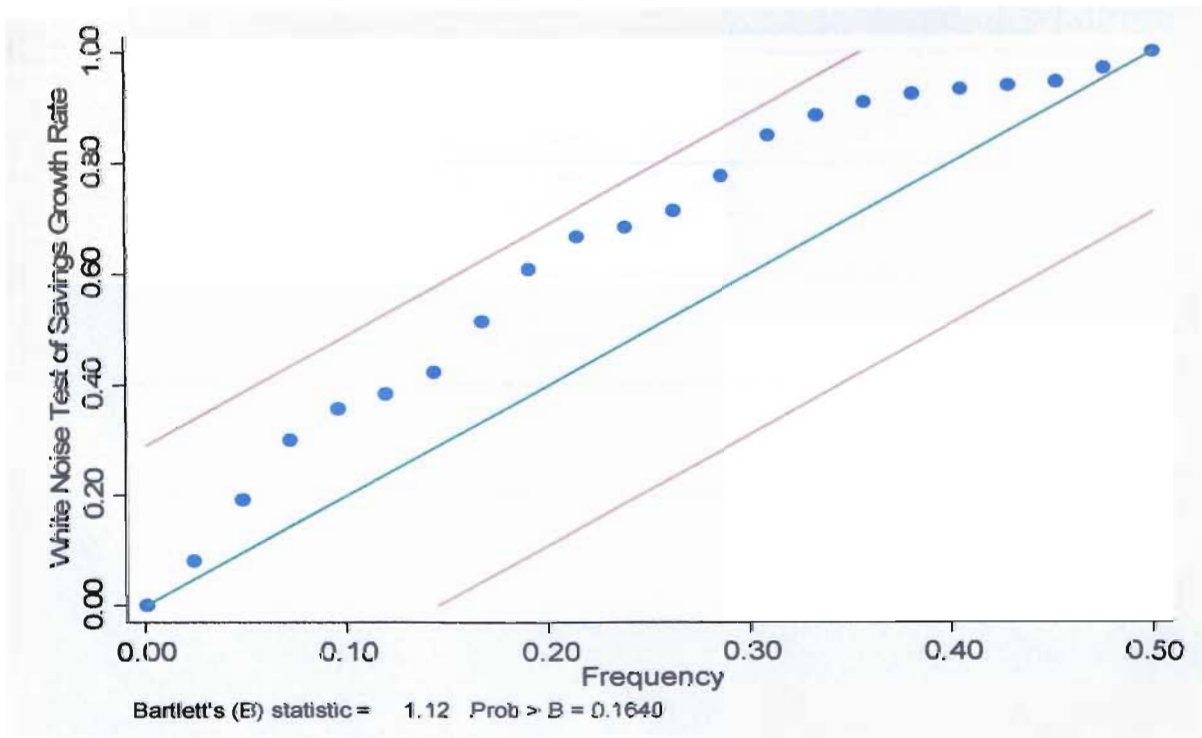
APPENDIX

Appendix A- Stationary test for GDSGRB

*** Correlogram analysis of GDSGRB

LAG	AC	PAC	Q	Prob>Q	-1	0	1	-1	0	1
					[Autocorrelation]			[Partial Autocor]		
1	0.3392	0.3401	5.1854	0.0228						
2	-0.0227	-0.1259	5.2092	0.0739						
3	0.0429	0.1112	5.2963	0.1513						
4	0.0542	-0.0084	5.439	0.2451						
5	-0.0110	0.0128	5.4451	0.3640						
6	0.1410	0.2100	6.4651	0.3732						
7	-0.0827	-0.1145	6.8265	0.4472						
8	-0.2442	-0.2528	10.069	0.2602						
9	-0.1508	-0.1767	11.342	0.2530						
10	0.0382	0.0290	11.426	0.3253						
11	0.0090	-0.0013	11.431	0.4079						
12	-0.0227	0.0070	11.463	0.4897						
13	-0.0302	-0.0028	11.521	0.5673						
14	-0.0269	-0.0156	11.569	0.6409						
15	-0.0190	-0.0225	11.593	0.7095						
16	0.0044	0.0148	11.595	0.7714						
17	0.0002	0.0165	11.595	0.8240						
18	-0.0202	-0.0113	11.626	0.8659						
19	-0.0130	0.0078	11.64	0.9004						

*** White Noise test for GDSGRB



*** Lag length for GDSGEB

lag	LL	LR	df	p	FPE	AIC
0	-223.034				7734.25	11.7913
1	-221.419	3.2312	1	0.072	7488.31*	11.7589*
2	-221.332	.17308	1	0.677	7858.94	11.807
3	-220.886	.8914	1	0.345	8095.26	11.8361
4	-220.885	.00337	1	0.954	8538.4	11.8887

Appendix B- Stationary test for GDPPCGRB

*** Correlogram analysis of GDPPCGRB

LAG	AC	PAC	Q	Prob>Q	-1	0	1	-1	0	1
					[Autocorrelation]			[Partial Autocor]		
1	0.0760	0.0789	.26027	0.6099						
2	0.0300	0.0271	.30182	0.8599						
3	0.3754	0.3745	6.9797	0.0725						
4	0.1044	0.0176	7.5099	0.1113						
5	0.2561	0.2323	10.785	0.0558						
6	0.0325	-0.1014	10.839	0.0935						
7	0.1294	0.1991	11.723	0.1100						
8	0.2088	0.0815	14.092	0.0794						
9	0.0851	0.0215	14.497	0.1057						
10	0.1265	-0.0133	15.421	0.1175						
11	0.0545	-0.1530	15.598	0.1567						
12	0.0210	-0.0691	15.625	0.2090						
13	0.0750	0.0862	15.983	0.2500						
14	0.0402	0.0908	16.09	0.3079						
15	-0.0252	-0.1453	16.133	0.3732						
16	0.0900	0.1508	16.709	0.4046						
17	0.0082	-0.2074	16.714	0.4739						
18	-0.0898	-0.0012	17.336	0.5002						
19	-0.0091	-0.1356	17.342	0.5667						

*** Lag length for GDPPCGRB

lag	LL	LR	df	p	FPE	AIC
0	-77.7345				3.69159	4.14392
1	-72.8348	9.7994	1	0.002	3.00686	3.93867
2	-63.0442	19.581*	1	0.000	1.89357*	3.47601*
3	-62.4231	1.2422	1	0.265	1.93258	3.49595
4	-62.3972	.05175	1	0.820	2.03578	3.54722

Appendix C- Stationary test for GDPPCGRB after first difference

*** Correlogram analysis of GDPPCGRB (after first difference)

LAG	AC	PAC	Q	Prob>Q	-1	0	1	-1	0	1
					[Autocorrelation]			[Partial Autocor]		
1	-0.2658	-0.2655	3.1132	0.0777						
2	-0.1591	-0.3923	4.2578	0.1190						
3	0.1341	-0.0402	5.0924	0.1652						
4	-0.1044	-0.2383	5.6113	0.2301						
5	0.2100	0.0997	7.7703	0.1694						
6	-0.1544	-0.1889	8.9712	0.1752						
7	-0.0488	-0.0711	9.0946	0.2459						
8	0.0601	-0.0193	9.2878	0.3186						
9	-0.0624	0.0099	9.5024	0.3922						
10	0.0538	0.1142	9.667	0.4702						
11	0.0090	0.0209	9.6718	0.5601						
12	-0.0486	-0.1121	9.8153	0.6322						
13	0.0128	-0.0990	9.8256	0.7081						
14	0.0477	0.1211	9.974	0.7641						
15	-0.1638	-0.1513	11.793	0.6946						
16	0.1101	0.1849	12.647	0.6983						
17	0.0213	-0.0557	12.681	0.7573						
18	-0.0640	0.0473	12.995	0.7919						

*** Lag length for GDPPCGRB (after first difference)

lag	LL	LR	df	p	FPE	AIC
0	-70.2591				2.75655	3.85184
1	-62.5267	15.465	1	0.000	1.91584	3.48793
2	-61.937	1.1795	1	0.277	1.9593	3.51011
3	-61.0494	1.7751	1	0.183	1.97221	3.51618
4	-55.4451	11.209*	1	0.001	1.53894*	3.26731*

Appendix D- Granger Causality test lag values

***Lowest AIC value for Granger Causality Testusing VAR model

. var gdspcgrb gdppcgrbD1, lags(1/4) small dfk

Vector autoregression

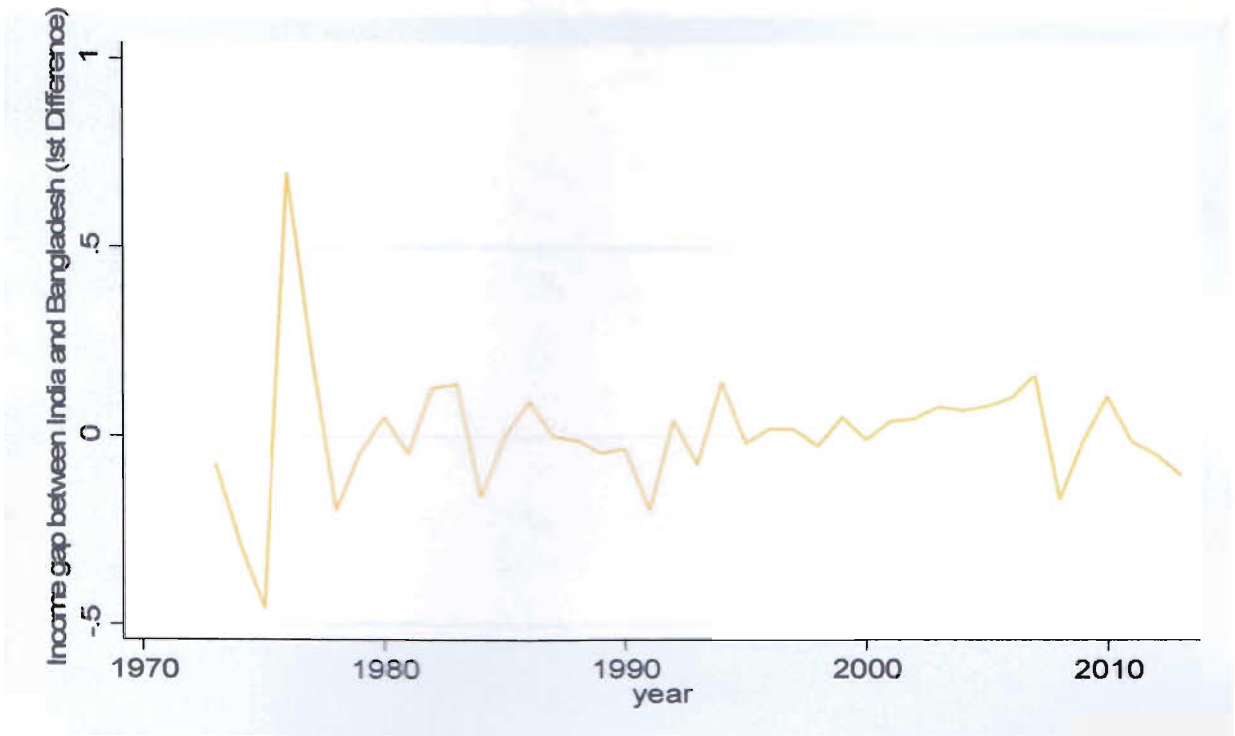
Sample:	1977 - 2013	No. of obs	=	37
Log likelihood	= -235.7389	AIC	=	13.71562
FPE	= 3164.538	HQIC	=	13.9919
Det(Sigma_ml)	= 1172.494	SBIC	=	14.49931

Equation	Parms	RMSE	R-sq	F	P > F
gdspcgrb	9	47.9529	0.6919	7.859137	0.0000
gdppcgrbD1	9	.945625	0.7409	10.00701	0.0000

	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
gdspcgrb						
gdspcgrb						
L1.	.2302357	.1063691	2.16	0.039	.0123486	.4481229
L2.	-.043655	.1091217	-0.40	0.692	-.2671807	.1798706
L3.	-.0995413	.1084533	-0.92	0.367	-.3216979	.1226153
L4.	-.089639	.1160801	-0.77	0.446	-.3274182	.1481403
gdppcgrbD1						
L1.	-24.08704	7.855507	-3.07	0.005	-40.17832	-7.995767
L2.	-5.081755	8.707201	-0.58	0.564	-22.91765	12.75414
L3.	.5308196	6.362089	0.08	0.934	-12.50133	13.56297
L4.	-5.752481	3.398613	-1.69	0.102	-12.71423	1.209262
_cons	16.75617	8.489969	1.97	0.058	-.6347459	34.14708
gdppcgrbD1						
gdspcgrb						
L1.	-.0060206	.0020976	-2.87	0.008	-.0103173	-.0017239
L2.	-.0008871	.0021519	-0.41	0.683	-.005295	.0035208
L3.	.0059689	.0021387	2.79	0.009	.001588	.0103498
L4.	.0001822	.0022891	0.08	0.937	-.0045067	.0048712
gdppcgrbD1						
L1.	-.7575518	.1549097	-4.89	0.000	-1.07487	-.4402337
L2.	-.6221666	.171705	-3.62	0.001	-.9738883	-.2704449
L3.	-.3883258	.1254596	-3.10	0.004	-.6453182	-.1313334
L4.	-.2259427	.0670203	-3.37	0.002	-.3632275	-.0886579
_cons	.3786425	.1674212	2.26	0.032	.0356958	.7215892

Appendix E- Stationary test for income gap

*** GAP_{ibt} after first difference



*** White Noise test of income gap

