CAUSALITY BETWEEN EXCHANGE RATE AND ECONOMIC GROWTH IN BANGLADESH

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Abstract

This paper attempts to examine the relationship between Exchange Rate (ER) and Economic Growth (EG) proxied by Real Gross Domestic Product (RGDP) in Bangladesh for a period of 41 years ranges from 1973 to 2013 by using time series econometric technique. The empirical results show that there is a significant positive correlation between ER and EG. The results also advocate the presence of long-run equilibrium relationship between ER and EG. This is evidenced from Granger's Causality Test that there is a bi-directional causality runs through ER to EG and EG to ER.

Keywords: Exchange Rate, Economic Growth, Real Gross Domestic Product, Bangladesh, Unit Root, Co-integration, Causality

Introduction

Bangladesh is said to be a country with great potentials. Though many consider it over burdened with huge population, many other consider this population as asset. Talking the positive aspects, this population can easily contributes economic growth (Rahman et al., 2006).Talking about the negative aspects, this population requires a huge amount of daily necessities that may not be possible for Bangladesh to produce and thus they fare bound to go for foreign trade. Over the past few decades, the nexus between Exchange rate and economic growth have drawn extensive attention of macroeconomists, policy makers and the central bankers of both developed and developing countries. Specifically, the issue that whether exchange rate is necessary for economic growth or it is harmful generates a significant debate both theoretically and empirically.

The exchange rate is defined as the domestic price of a unit of foreign currency. Exchange rate can be called the conversion factor that determines the rate of change of currencies. Real and nominal exchange rates are different from each other. If we leave out the inflation influence then it is real exchange rate and if we incorporate the inflation influence then it is nominal exchange rate. The nominal exchange rate can be expressed in bilateral and multilateral term. Real exchange rate volatility means the short term oscillation of the real exchange rate. A different pattern of exchange rate behavior into catagories is known as exchange rate regime. In which exchange rate remains fixed is called fix exchange rate regime and in which exchange rate fluctuates is known as floating exchange rate regime. The middle of fix and floating exchange rate is called managed float regime. The gross domestic product (GDP) is one the primary indicators used to determine the health of a country's economy. It represents the total dollar value of all goods and services produced over a specific time period - you can think of it as the size of the economy. Usually, GDP is expressed as a comparison to the previous quarter or year. For example, if the year-to-year GDP is up 3%, this is thought to mean that the economy has grown by 3% over the last year. Economists have long known that poorly managed exchange rates can be disastrous for economic growth. Avoiding significant overvaluation of the currency is one of the most robust imperatives that can be gleaned from the diverse experience with economic growth around the world, and one that appears to be strongly supported by cross-country statistical evidence (Razin and Collins, 1997). Cheung and Lai (1998) considered the influence of relative factors such as the per capita GDP to the foreign exchange reserves. Johansen (1988) thought that the foreign exchange reserve of some countries with a rapid increase is the by-product of the undervalued real exchange rate policy carried out by them aiming at promoting the export, not that these national monetary and financial authorities are intended.

Review of Recent Literature

A large number of research studies relating to various aspects of exchange rate have been published home and abroad. However, critical reviews of some of the important research studies/articles have been made in this study. Glasure and Lee (1999) examined the export-led growth hypothesis for Korea in five-variable vector autoregressive and vector error correction models from 1973:1 to 1994:4. Results of the vector autoregressive models indicate economic growth Granger-causing export growth, regardless of the sample period. However, results of the vector error correction models show bidirectional causality between export growth and economic growth when the multivariate generalizations of the Granger causality tests are used. In the variance decompositions, the real exchange rate contains most information regarding future fluctuations in economic growth and export growth followed by money supply and government expenditure in the subsample and the full sample, with economic growth as a dependent variable. However, when the dependent variable is export growth, then the order of the magnitude in the full sample becomes the exchange rate, followed by economic growth, government spending, and money supply. The findings in this paper suggest that the omitted variables have masked or overstated the effect of exports on income or income on exports in prior studies. Mundaca and Strand (2005) derive the optimal exchange rate policy for a small open economy subject to terms-of-trade shocks. Firm owners and workers are risk averse but workers more so. Wages are given or partially indexed in the short run, and capital markets are imperfect. The government sets the exchange rate to allocate risk between workers and owners. With less risk-averse firms, and greater difference in risk aversion between workers and firms, the optimal exchange rate should vary little with pure terms-of-trade shocks but more with general shocks to prices. Optimal exchange rate variation is greater with indexed wages, but is smaller when firms behave monopolistically and when wage taxes (profit taxes) change procyclically (countercyclically) with export prices (import prices). The model gives policy rules for determining optimal variations of the exchange rate, and indicates when it is, and is not, optimal to join a currency union with trading partners, implying zero exchange rate variation.

Itō (2005) provided of past work covering use of the yen on PPP, covered and uncovered interest rate parity, the unbiasedness of expected future exchange rates, volatility spillover across borders and the effectiveness of intervention. He tried to discuss the role of the yen in the international financial structure and its future role in global and regional financial markets.

Gala (2008) intended to contribute to the debate by bringing more theoretical elements and providing new econometric evidence to the connections between real exchange rate levels and development.

Aghion et al. (2009) offered empirical evidence that real exchange rate volatility can have a significant impact on productivity growth. However, the effect depends critically on a country's level of financial development. The results appear robust to time window, alternative measures of financial development and exchange rate volatility, and outliers. They also offer a simple monetary growth model in which real exchange rate uncertainty exacerbates the negative investment effects of domestic credit market constraints.

Alba et al (2010) examined the impact of exchange rates on foreign direct investment (FDI) inflows into the United States in the context of a model that allows for the interdependence of FDI over time. Interdependence is modeled as a two-state Markov process where the two states can be interpreted as either a favorable or an unfavorable environment for FDI in an industry. They use unbalanced industry level panel data from the US wholesale trade sector and their analysis yields two main results. First, they find evidence that FDI is interdependent over time. Second, under a favorable FDI environment, the exchange rate has a positive and significant effect on the average rate of FDI inflows.

Ok et al. (2010) studied sources of fluctuations in real and nominal US dollar exchange rates in Cambodia and Lao PDR by decomposing them into the components induced by real and nominal factors. These shocks affecting real and nominal exchange rates are identified by using a structural vector auto-regression (SVAR) model with the long-run neutrality restriction. The empirical analysis demonstrated that real shocks in direction of depreciation lead to real and nominal depreciation, while nominal shocks induce long-run nominal depreciation but real appreciation in the short-run.

Ba and Shen (2010) choose six industries to divide them into three groups based on per capita possession of capital, and then employ the monthly data from 2001 to 2008 to carry out EG two-step co-integration test, and finally analyze the impacts of the US economic growth and the exchange rate variability on different export industries. Empirical results show that the labor-intensive industries are most susceptible to fluctuations brought by economic growth and real exchange rate, while those industries with higher per capita possession of capital are less susceptible to external factors. In the short run, the export of labor-intensive products gives an advantage to China’s foreign trade development, but in the long-run, these industries will be affected greatly by various uncertain factors and the advantages of China’s labor-intensive export industries will disappear with the shift of the international division. Therefore, the only way to guarantee the dominant position of China’s foreign trade is to develop capital and technology intensive export industries and upgrade export structure.

Aman et al. (2013) attempted to explore the relationship between exchange rate and economic growth in Pakistan for period 1976–2010. They employ two, three stage least square (2SLS and 3SLS) techniques and found that exchange rate has a positive association with economic growth through the channel of export promotion incentives, enlarging the volume of investment, enhancing FDI inflow and promoting import substitute industry.

He´ricourt and Poncet(2013) studied how firm-level export performance is affected by Real Exchange Rate (RER) volatility and investigate whether this effect depends on existing financial constraints.

Their empirical analysis relies on export data for more than 100,000 Chinese exporters over the 2000–06 periods. They confirmed a trade-deterring effect of RER volatility. They also found that firms' decision to begin exporting and the exported value decrease for destinations with higher exchange rate volatility and that this effect is magnified for financially vulnerable firms. As expected, financial development seems to dampen this negative impact, especially on the intensive margin of export. These results provide micro-founded evidence suggesting that the existence of well-developed financial markets allows firms to hedge exchange rate risk. The results also support a key role of financial constraints in determining the macro impact of RER volatility on real outcomes.

Thus it appears from the preceding discussions that relationship between exchange rate and economic growth in Bangladesh have not been addressed in Bangladesh. It would, therefore, not be unjustified to state that present study is the first of its kind in Bangladesh and can be used for guidelines for the similar studies in years ahead.

Methodology and Data Collection

To avoid the seasonal biases annual data are used in this study. A long run span of data is required for giving the tests for co-integration more power than merely increasing the data frequency. This is because the co-integration is a long run concept (Hakkio and Rush, 1991). Secondary data are mainly used in this study. The data were collected from the website of Bangladesh Bank (BB), Bangladesh Bureau of Statistics (BBS), website of World Bank (WB) and Asian Development Bank (ADB), Key Indicators (KI), World Development Indicators (WDI), International Financial Statistics (IFS). Finally, for the analysis the econometric software, namely Microfit 4.1 and Eviews 7 are used.It is seen from the literature of the time series that if the series are non-stationary or I(1) process, the regression results with variables at level will be spurious (Granger and Newbold, 1974; Phillips, 1986). Thus, we start with examining the time series properties of the series through the Augmented Dickey-Fuller (ADF) stationarity tests.

The Econometric Model

The model that tries to establish the relationship between ER and EG in Bangladesh can be expressed in the following basic bivariate model:

$$Y_t = \alpha + \beta X_t + \varepsilon_t \qquad (1)$$

where, Y_t is real GDP and X_t is the ER and ε_t is error term. Logarithmic transformation of the above equation and inclusion of a trend variable would leave the basic equation as follows:

$$LY_t = \alpha_0 + \alpha_1 t + \beta\, XE_t + \varepsilon_t \tag{2}$$

where, *t* is the trend variable.

The standard Granger causality test (Granger, 1988) seeks to determine whether past values of a variable helps predict changes in another variable. In the context of this analysis the Granger method involves the estimation of the following equations:

$$LY_t = \beta_0 + \sum_{i=1}^{q} \beta_{1i} LY_{t-i} + \sum_{i=1}^{q} \beta_{2i} LX_{t-i} + \varepsilon_{1t} \tag{3}$$

$$LX_t = \varphi_0 + \sum_{i=1}^{r} \varphi i_{1i}\, LX_{t-i} + \sum_{i=1}^{r} \varphi_{2i}\, LY_{t-i} + \varepsilon_{2t} \tag{4}$$

where, LY_t and LX_t represent real GDP and ER, respectively, ε_{1t} and ε_{2t} are uncorrelated stationary random process, and subscript *t* denotes the time period. Failing to reject $H_0 : \beta_{21} = \beta_{22} = ... = \beta_{2q} = 0$ implies ER does not

Granger cause real income activities. On the other hand, failing to reject $H_0 : \varphi_{21} = \varphi_{22} = ... = \varphi_{2r} = 0$ implies that real GDP does not Granger cause ER.

Empirical works based on time series data assume that the underlying time series is stationary. However, many studies have shown that majority of time series variables are non-stationary or integrated of order 1 (Engle and Granger, 1987). The time series properties of the data at hand are therefore studied in the outset.

The above specification of the causality test assumes that the time series at hand are mean reverting process. However, it is highly likely that variables of this study are non-stationary. Formal tests will be carried out to find the time series properties of the variables. If the variables are *I* (1), Engle and Granger (1987) assert that causality must exist in, at least, one direction. The Granger causality test is then augmented with an error correction term (ECT) as shown below:

$$\Delta LY_t = \beta_0 + \sum_{i=1}^{q} \beta_{1i} \Delta LY_{t-i} + \sum_{i=1}^{q} \beta_{2i} \Delta LX_{t-i} + \alpha_1 Z_{t-1} + \varepsilon_{1t} \tag{5}$$

$$\Delta LX_t = \varphi_0 + \sum_{i=1}^{r} \varphi i_{1i}\, \Delta LX_{t-i} + \sum_{i=1}^{r} \varphi_{2i}\, \Delta LY_{t-i} + \lambda_1 Z_{t-1} + \varepsilon_{2t} \tag{6}$$

where Z_{t-1} is the ECT obtained from the long run co-integrating relationship between real GDP and ER. The above error correction model (ECM) implies that possible sources of causality are two: lagged dynamic regressors and lagged co-integrating vector. Accordingly, by equation (5), ER Granger causes real GDP, if the null of either $\sum_{i=1}^{q} \beta_{2i} = 0$ or $\alpha_1 = 0$ is rejected. On the other hand, by equation (6), real GDP Granger causes ER, if λ_1 is significant or $\sum_{i=1}^{r}\varphi_{2i}$ are jointly significant. Real GDP and ER granger causes each other (i.e. presence of bidirectional causality), if causality exists in both directions.

Results and Discussion

In this study annual data on ER (X) and RGDP (Y) of Bangladesh are used. ER with US dollar is extracted from the BB, BBS, WB, ADB, KI, WDI and IFS. RGDP is calculated by GDP at current market price divided by consumer price index and both are extracted from BB, WB, ADB, KI, WDI and IFS. Data are used in original as well as in natural logarithms. To understand the tendency of economic activity, a primary analysis of the data is done. The following Table 1 shows the descriptive statistics of both variables in original and natural logarithmic form.

From the Table 1 it is seen that average RGDP and ER are 16745.76 and 40.38098 respectively, whereas the RGDP ranges from a maximum 36149.16 to a minimum 4812.71. On the other hand, the ER ranges from a maximum 81.82 to a minimum 7.88. The average of LNRGDP and LNER are 9.584895 and 3.522879 respectively.

Table 1: Descriptive Statistics

	RGDP	ER	LNRGDP	LNER
Mean	16745.76	40.38098	9.584895	3.522879
Median	15034.1	39.14	9.618076	3.667145
Maximum	36149.16	81.82	10.49541	4.404522
Minimum	4812.71	7.88	8.479016	2.064328
Std. Dev.	8650.819	21.44652	0.557682	0.649816
Skewness	0.603652	0.225133	-0.30798	-0.67078
Kurtosis	2.457912	1.917331	2.27588	2.546723
Jarque-Bera	2.99205	2.348807	1.543921	3.425642
Probability	0.224019	0.309003	0.462106	0.180356
Observations	41	41	41	41

The maximum values of LNRGDP and LNER are 10.49541 and 4.404522 respectively. The following Table 2 represents the pair-wise correlation between RGDP and ER and Table 3 depicts the pair-wise correlation between LNRGDP and LNER. The tables show there is a strong positive relation between RGDP and ER at original value as well as natural logarithmic value and which is statistically significant at 1% level of significance.

Table 2: Correlation between ER and RGDP

	RGDP	ER
RGDP	1	0.982**
Sig. (2-tailed)		0.000
ER		1

** Correlation is significant at the 1% level.

Table 3: Correlation between LNER and LNRGDP

	LNRGDP	LNER
LNRGDP	1	0.973**
Sig. (2-tailed)		0.000
LNER		1

** Correlation is significant at the 1% level.

The estimation procedure starts with testing the time series properties of RGDP, ER, LNRGDP and LNER. Table 4 (See in Appendices) shows the Correlogram RGDP at level. It is seen from the table that Autocorrelation Coefficient (AC) and Partial autocorrelation coefficient (PAC) cross the boundary line. Moreover, in the case of AC at 1st to 6th lag crosses boundary lines. At 1st lag PAC crosses boundary line. Apart from that all the values of Box Pierce Ljung statistic (Q statistic) more than 25 and p value for hypothesis that all autocorrelation coefficient to this point are zero and it shows significant at 1 percent level. Therefore it indicates non stationary trend and it follows stochastic trend.

Table 5 (See in Appendices) depicts the Correlogram of RGDP at 1st difference. The table shows that AC and PAC do not cross the boundary line except at lag 5. The p-value for all autocorrelation coefficients are more than 0.05 except at lag5 and lag6 and it shows insignificant at 1 percent level. That’s why it indicates stationary trend due to 1st difference and it follows deterministic trend.

Table 6 (See in Appendices) shows the Correlogram of LNRGDP at level. Table shows that AC crosses boundary lines at 1st to 6th lag. At 1st lag PAC crosses boundary line. Apart from 1st lag all the values of Box Pierce Ljung statistic (Q statistic) are more than 28 and p value for hypothesis for all autocorrelation coefficients to this point are zero and it shows significant at 1 percent level. That’s why it indicates non stationary trend and it follows stochastic trend.

Table 7 (See in Appendices) shows the Correlogram of LNRGDP at 1st difference. Table shows that AC crosses boundary lines at 1st, 4th and 5th lag. At 1st and 4th lag PAC crosses boundary line. Apart from 1st to 5th lag all the values of Box Pierce Ljung statistic (Q-statistic) are more than 22 and p value for hypothesis for most of the autocorrelation coefficients to this point are insignificant. That’s why it indicates stationary trend and it follows deterministic trend.

Table 8 (See in Appendices) shows the Correlogram of ER at level. It is seen from the table that AC crosses boundary lines at 1st to 6th lag and PAC crosses boundary line at 1st lag. Apart from 1st lag all the values of Box Pierce Ljung statistic (Q statistic) are more than 50 and p value for hypothesis that all autocorrelation coefficients to this point are zero and it shows significant at 1 percent level. That's why it indicates non stationary trend and it follows stochastic trend.

Table 9 (See in Appendices) shows the Correlogram of ER at 1st difference. It is observed from the table that AC and PAC do not cross the boundary line. Apart from 1st lag all the values of Box Pierce Ljung statistic (Q statistic) are more than 5 and p value for hypothesis that most of AC is insignificant. That's why it indicates stationary trend and it follows deterministic trend.

Table 10 (See in Appendices) shows the Correlogram of LNER. It is seen from the table that AC crosses boundary lines at 1st to 6th lag and PAC crosses boundary line at 1st lag. Apart from 1st lag all the values of Box Pierce Ljung statistic (Q statistic) are more than 50 and p value for hypothesis of all autocorrelation coefficients to this point are zero and it shows significant at 1 percent level. That's why it indicates non stationary trend and it follows stochastic trend.

Table 11 (See in Appendices) shows the Correlogram of LNER at 1st difference. The table exhibits that AC and PAC do not cross the boundary line. Apart from 1st lag all the values of Box Pierce Ljung statistic (Q-statistic) are more than 2 and p-values for hypothesis of the most of autocorrelation coefficients are insignificant. That's why it indicates stationary trend and it follows deterministic trend.

In the 2nd step of testing the time series properties of the data the unit root test is done. The following Table 12 shows the results of unit root test by using Augmented Dickey-Fuller (ADF). For ADF, both with constant and constant and trend, one is unable to reject a null hypothesis at level but is able to reject the null hypothesis when 1st differenced series are used.

Table 12: Unit root test of the variables

Variables	Augmented Dickey-Fuller (ADF) Test			Process	Test Critical Value		
	Statistics	P-values	Unit Root		At 1%	At 5%	At 10%
Test Equation: Intercept							
LGDP	2.60016	1.0000	Yes	I(1)	-3.62102	-2.94342	-2.61026
ΔGDP	-2.92325*	0.0528	No	I(0)	-3.63290	-2.94840	-2.61287
LLNGDP	1.54190	0.9989	Yes	I(1)	-3.75294	-2.99806	-2.63875
ΔLNGDP	-1.99815*	0.0863	No	I(0)	-3.63292	-2.94840	-2.61287
LER	0.51986	0.9853	Yes	I(1)	-3.61559	-2.94115	-2.60907
ΔER	-6.55002***	0.0000	No	I(0)	-3.61558	-2.94114	-2.60906
LLNER	-2.58082	0.4109	Yes	I(1)	-3.61559	-2.94115	-2.60907

ΔLNER	-5.28964***	0.0001	No	I(0)	-3.61045	-2.93898	-2.60793
Test Equation: Trend and Intercept							
LGDP	0.537206	0.9991	Yes	I(1)	-4.24364	-3.544284	-3.20469
ΔGDP	-5.02106***	0.0000	No	I(0)	-4.24364	-3.54428	-3.20472
LLNGDP	-2.11446	0.5101	Yes	I(1)	-4.44073	-3.632896	-3.25467
ΔLNGDP	-23.4143***	0.0000	No	I(0)	-4.49830	-3.658446	-3.26897
LER	-2.87645	0.1816	Yes	I(1)	-4.23497	-3.540328	-3.20244
ΔER	-5.26192***	0.0007	No	I(0)	-4.24364	-3.544284	-3.20469
LLNER	-2.40238	0.3724	Yes	I(1)	-4.22681	-3.536601	-3.20032
ΔLNER	-5.68401***	0.0002	No	I(0)	-4.23497	-3.540328	-3.20244
Source	BB, WB, ADB, KI, WDI, IFS.						

Note: L stands for level, Δ denotes the first difference of the variable. The null hypothesis states that the variable has a unit root. P-values are used to decide the unit roots at the 1%, 5% and 10% significance level. The critical values and details of the tests are presented in Dickey and Fuller (1979, 1981). The AIC determines the lag length (P) in the ADF tests (see Stock and Watson 2007:561 for details). Test equation: trend and intercept. *,**, and *** denote rejection of null at 10%, 5%, and 1% level of significance.

It is observed from the Table 12 that all the examined series are integrated of order one, I (1). These results are consistent with the notion that most of the macroeconomic variables are non-stationary at level, but become stationary after first differencing (Nelson and Plosser, 1982). Once it is established that variables are I (1), the next step is to test for existence of any co-integration relationship between RGDP and ER. To test the co-integration, the Johansen (1991) LR test is applied and results are showed in Table 13. The appropriate VAR lag length is selected using BIC.

Table 13: Cointegration test between RGDP and ER (Johansen Cointegration Test) [VAR lag k = 2, [Y,X]

Null	Eigen values	Trace Test		Max Eigen value Test	
		$\lambda - trace$	p–value	$\lambda - \max$	p–value
$r \leq 0$	0.276458	14.70855	0.0654	11.64947	0.1245
$r \leq 1$	0.081464	3.059073	0.0803	3.059073	0.0803

Since trace statistic is 14.71 and p-value is 0.0654 which means that the statistics is significant at 10% level and we can reject the null hypothesis of no co-integration vector and accept the alternative of one co-integrating vector. Again trace statistic is 3.06 and p-value is significant at 10% level, so we can reject the null hypothesis of one co-integrating vector and accept the alternative hypothesis of more than one co-integrating vector. Same thing is not happened when λ-max test is used. Therefore we have to test co-integration between LNRGDP and LNER.

Table 14: Co-integration Test between LNRGDP and LNER (Johansen Co-integration Test) VAR lag k = 2, [Y,X]

Null	Eigen values	Trace Test		Max Eigen value Test	
		$\lambda - trace$	p–value	$\lambda - \max$	p–value
$r \le 0$	0.584236	40.55613	0.0000	31.59495	0.0000
$r \le 1$	0.220359	8.961178	0.0028	8.961178	0.0028

Since trace statistic is 40.55613 and p-value is 0.0000 which means that the trace statistic is significant and we can reject the null hypothesis of no co-integration vector and accept the alternative of one co-integrating vector. Again trace statistic is 8.961178 and p-value is 0.0028 which means that the statistic is significant at 1% level and we can reject the null hypothesis of one co-integrating vector and accept the alternative hypothesis of more than one co-integrating vector. Same thing is happened when λ-max test is used. Both p-values for r=0 and r=1 are significant. The Eigen value tests based on stochastic matrix indicate existence of the co-integration relationship between RGDP and ER. Therefore, the Granger causality tests are to be modeled using ECM as explained in equations (5) and (6).

Table 15**:** Granger causality test between RGDP and ER

Pairwise Granger Causality Tests

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
GDP does not Granger Cause ER	36	2.46217	0.10176
ER does not Granger Cause GDP		2.18212	0.12983

Table 15 summarizes the Granger Causality results between RGDP and ER of Bangladesh from 1973 to 2013. F-statistic and probability values are constructed under the null hypothesis of no causality. Here we cannot reject the null hypothesis because p-values are more than 0.10, i.e., RGDP does not cause ER and ER does not cause RGDP.

Table 16: Granger causality test between LNRGDP and LNExchange Rate

Pairwise Granger Causality Tests

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
LNGDP does not Granger Cause LNER	36	13.9469	0.00004
LNER does not Granger Cause LNGDP		9.68586	0.00054

Table 16 summarizes the Granger Causality results between LNRGDP and LNER of Bangladesh from 1973 to 2013. F-statistic and probability values are constructed under the null hypothesis of no causality. Here we can reject the null hypothesis at 1% level of significance. It is evident from the results that there is a bi-directional causal relationship between the variables i.e. the both way causality runs through LNRGDP to LNER and LNER to LNRGDP.

Conclusion

The main objective of this paper is to examine empirically the relationship between EG and ER in Bangladesh with the latest time series econometric method. Time series econometric tools are used to examine the relationship between the variables. We use the ADF test, Granger Causality Test and Johansen Co-integration models by taking care of stochastic properties of the variables. From the results of unit root test it is seen that both the variables are integrated of order 1 in both original values and logarithmic values of the variables. By using natural logarithmic form of the variables we find that there is a long-term equilibrium relationship between EG and ER. The Eigen value tests based on stochastic matrix indicate the existence of the co-integration relationship between EG and ER. The result of Granger's Causality test denotes that there is bi-directional causality runs through EG to ER and through ER to EG.

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Appendices

Table 4: Correlogram of Real GDP at Level

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |****** |	. |****** |	1	0.780	0.780	25.011	0.000
. |***** |	. |. |	2	0.610	0.003	40.712	0.000
. |**** |	. |. |	3	0.487	0.027	51.016	0.000
. |*** |	. |. |	4	0.385	-0.010	57.643	0.000
. |** |	. |. |	5	0.307	0.009	61.997	0.000
. |** |	. |. |	6	0.248	0.006	64.919	0.000
. |** |	. |. |	7	0.198	-0.004	66.840	0.000
. |*. |	. |. |	8	0.169	0.028	68.283	0.000
. |*. |	. |. |	9	0.143	0.001	69.359	0.000
. |*. |	. |. |	10	0.120	-0.000	70.142	0.000
. |*. |	. |. |	11	0.098	-0.006	70.686	0.000
. |*. |	. |. |	12	0.079	-0.004	71.048	0.000
. |. |	. |. |	13	0.064	0.003	71.299	0.000
. |. |	. |. |	14	0.052	-0.002	71.468	0.000
. |. |	. |. |	15	0.040	-0.004	71.571	0.000
. |. |	. |. |	16	0.028	-0.007	71.625	0.000

Table 5: Correlogram of Real GDP at 1st Difference

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>1</td><td>-0.090</td><td>-0.090</td><td>0.3270</td><td>0.567</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>2</td><td>0.130</td><td>0.123</td><td>1.0288</td><td>0.598</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>3</td><td>0.033</td><td>0.056</td><td>1.0745</td><td>0.783</td></tr>
<tr><td>.**| . |</td><td>.**| . |</td><td>4</td><td>-0.274</td><td>-0.291</td><td>4.3659</td><td>0.359</td></tr>
<tr><td>. |*** |</td><td>. |*** |</td><td>5</td><td>0.406</td><td>0.393</td><td>11.782</td><td>0.038</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>6</td><td>-0.158</td><td>-0.084</td><td>12.947</td><td>0.044</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>7</td><td>0.120</td><td>0.024</td><td>13.641</td><td>0.058</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>8</td><td>0.008</td><td>-0.051</td><td>13.644</td><td>0.092</td></tr>
<tr><td>. | . |</td><td>. |* . |</td><td>9</td><td>-0.048</td><td>0.193</td><td>13.764</td><td>0.131</td></tr>
<tr><td>. |**. |</td><td>. | . |</td><td>10</td><td>0.231</td><td>0.008</td><td>16.625</td><td>0.083</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>11</td><td>-0.073</td><td>0.045</td><td>16.917</td><td>0.110</td></tr>
<tr><td>. |* . |</td><td>. | . |</td><td>12</td><td>0.105</td><td>-0.011</td><td>17.552</td><td>0.130</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>-0.035</td><td>0.042</td><td>17.625</td><td>0.172</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>14</td><td>0.002</td><td>0.006</td><td>17.626</td><td>0.224</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>0.064</td><td>-0.028</td><td>17.897</td><td>0.268</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>16</td><td>-0.008</td><td>0.049</td><td>17.902</td><td>0.330</td></tr>
</table>

Table 6: Correlogram of LN Real GDP at Level

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |****** |</td><td>. |****** |</td><td>1</td><td>0.832</td><td>0.832</td><td>28.405</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. |. |</td><td>2</td><td>0.681</td><td>-0.034</td><td>47.977</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. |. |</td><td>3</td><td>0.572</td><td>0.049</td><td>62.191</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. *|. |</td><td>4</td><td>0.455</td><td>-0.087</td><td>71.450</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. |. |</td><td>5</td><td>0.355</td><td>-0.014</td><td>77.240</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. |. |</td><td>6</td><td>0.267</td><td>-0.033</td><td>80.632</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |. |</td><td>7</td><td>0.190</td><td>-0.023</td><td>82.402</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |. |</td><td>8</td><td>0.151</td><td>0.065</td><td>83.557</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |. |</td><td>9</td><td>0.114</td><td>-0.024</td><td>84.236</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. |. |</td><td>10</td><td>0.080</td><td>-0.007</td><td>84.581</td><td>0.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>11</td><td>0.047</td><td>-0.038</td><td>84.704</td><td>0.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>12</td><td>0.019</td><td>-0.010</td><td>84.724</td><td>0.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>13</td><td>0.001</td><td>0.001</td><td>84.724</td><td>0.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>14</td><td>-0.013</td><td>-0.002</td><td>84.735</td><td>0.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>15</td><td>-0.022</td><td>0.004</td><td>84.768</td><td>0.000</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>16</td><td>-0.028</td><td>-0.002</td><td>84.821</td><td>0.000</td></tr>
</table>

Table 7 Correlogram, LN Real GDP, 1st Difference

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>***| . |</td><td>***| . |</td><td>1</td><td>-0.349</td><td>-0.349</td><td>4.8761</td><td>0.027</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>2</td><td>0.029</td><td>-0.106</td><td>4.9101</td><td>0.086</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>3</td><td>0.047</td><td>0.025</td><td>5.0054</td><td>0.171</td></tr>
<tr><td>***| . |</td><td>***| . |</td><td>4</td><td>-0.353</td><td>-0.373</td><td>10.466</td><td>0.033</td></tr>
<tr><td>. |**** |</td><td>. |**. |</td><td>5</td><td>0.481</td><td>0.306</td><td>20.905</td><td>0.001</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>6</td><td>-0.172</td><td>0.054</td><td>22.286</td><td>0.001</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>7</td><td>0.034</td><td>0.031</td><td>22.340</td><td>0.002</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>8</td><td>-0.028</td><td>-0.146</td><td>22.381</td><td>0.004</td></tr>
</table>

. *| . |	. |* . |	9	-0.087	0.152	22.775	0.007
. |* . |	. | . |	10	0.147	-0.049	23.930	0.008
. *| . |	. | . |	11	-0.095	-0.038	24.435	0.011
. | . |	. | . |	12	0.043	-0.057	24.540	0.017
. | . |	. | . |	13	-0.052	0.045	24.702	0.025
. | . |	. *| . |	14	-0.044	-0.109	24.825	0.036
. | . |	. | . |	15	0.035	-0.057	24.905	0.051
. | . |	. | . |	16	-0.029	-0.010	24.961	0.071

Table 8: Correlogram of Exchange Rate(level)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |*******|	. |*******|	1	0.852	0.852	29.804	0.000
. |***** |	. *| . |	2	0.698	-0.101	50.352	0.000
. |**** |	. | . |	3	0.561	-0.026	64.018	0.000
. |*** |	. | . |	4	0.457	0.032	73.373	0.000
. |*** |	. | . |	5	0.363	-0.042	79.447	0.000
. |** |	. | . |	6	0.295	0.032	83.572	0.000
. |** |	. | . |	7	0.240	-0.002	86.386	0.000
. |*. |	. | . |	8	0.191	-0.017	88.240	0.000
. |*. |	. | . |	9	0.144	-0.027	89.320	0.000
. |*. |	. | . |	10	0.107	0.007	89.943	0.000
. |*. |	. | . |	11	0.083	0.016	90.333	0.000
. | . |	. | . |	12	0.061	-0.017	90.554	0.000
. | . |	. | . |	13	0.042	-0.005	90.663	0.000
. | . |	. | . |	14	0.032	0.015	90.728	0.000
. | . |	. | . |	15	0.024	-0.005	90.766	0.000
. | . |	. | . |	16	0.016	-0.004	90.785	0.000

Table 9: Correlogram of Exchange Rate(1st Difference)

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
. |* . |	. |* . |	1	0.167	0.167	1.1124	0.292
***| . |	***| . |	2	-0.333	-0.371	5.6916	0.058
. *| . |	. | . |	3	-0.095	0.051	6.0778	0.108
. | . |	. *| . |	4	-0.014	-0.151	6.0863	0.193
. *| . |	. *| . |	5	-0.137	-0.148	6.9321	0.226
. | . |	. |* . |	6	0.054	0.087	7.0698	0.314
. | . |	. *| . |	7	0.054	-0.119	7.2097	0.407
. *| . |	. | . |	8	-0.093	-0.057	7.6381	0.470
. | . |	. | . |	9	-0.005	0.014	7.6394	0.571
. |* . |	. | . |	10	0.138	0.056	8.6591	0.565
. *| . |	. *| . |	11	-0.064	-0.111	8.8890	0.632
. *| . |	. | . |	12	-0.095	0.006	9.4112	0.667
. *| . |	. *| . |	13	-0.076	-0.172	9.7624	0.713
. | . |	. | . |	14	-0.037	-0.016	9.8472	0.773
. |* . |	. |* . |	15	0.110	0.089	10.637	0.778
. |* . |	. *| . |	16	0.070	-0.099	10.977	0.811

Table 10: Correlogram of LN Exchange Rate(level)

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |*******|</td><td>. |*******|</td><td>1</td><td>0.857</td><td>0.857</td><td>30.147</td><td>0.000</td></tr>
<tr><td>. |***** |</td><td>. *| . |</td><td>2</td><td>0.703</td><td>-0.114</td><td>51.042</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. | . |</td><td>3</td><td>0.564</td><td>-0.038</td><td>64.842</td><td>0.000</td></tr>
<tr><td>. |**** |</td><td>. |*. |</td><td>4</td><td>0.479</td><td>0.117</td><td>75.095</td><td>0.000</td></tr>
<tr><td>. |*** |</td><td>. *| . |</td><td>5</td><td>0.397</td><td>-0.063</td><td>82.372</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>6</td><td>0.324</td><td>-0.021</td><td>87.345</td><td>0.000</td></tr>
<tr><td>. |** |</td><td>. | . |</td><td>7</td><td>0.250</td><td>-0.028</td><td>90.408</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. *| . |</td><td>8</td><td>0.175</td><td>-0.066</td><td>91.960</td><td>0.000</td></tr>
<tr><td>. |*. |</td><td>. | . |</td><td>9</td><td>0.101</td><td>-0.051</td><td>92.494</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>10</td><td>0.048</td><td>0.016</td><td>92.618</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>0.012</td><td>-0.000</td><td>92.626</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>12</td><td>-0.020</td><td>-0.036</td><td>92.649</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>13</td><td>-0.045</td><td>0.003</td><td>92.775</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>14</td><td>-0.054</td><td>0.038</td><td>92.958</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>-0.052</td><td>0.010</td><td>93.136</td><td>0.000</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>16</td><td>-0.046</td><td>0.004</td><td>93.284</td><td>0.000</td></tr>
</table>

Table 11: Correlogram of LN Exchange Rate(1st Difference)

<table>
<tr><th>Autocorrelation</th><th>Partial Correlation</th><th></th><th>AC</th><th>PAC</th><th>Q-Stat</th><th>Prob</th></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>1</td><td>0.129</td><td>0.129</td><td>0.6682</td><td>0.414</td></tr>
<tr><td>.**| . |</td><td>.**| . |</td><td>2</td><td>-0.222</td><td>-0.242</td><td>2.6938</td><td>0.260</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>3</td><td>-0.097</td><td>-0.033</td><td>3.0953</td><td>0.377</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>4</td><td>-0.087</td><td>-0.130</td><td>3.4274</td><td>0.489</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>5</td><td>-0.069</td><td>-0.075</td><td>3.6420</td><td>0.602</td></tr>
<tr><td>. |**. |</td><td>. |* . |</td><td>6</td><td>0.210</td><td>0.195</td><td>5.7009</td><td>0.458</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>7</td><td>0.179</td><td>0.085</td><td>7.2486</td><td>0.403</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>8</td><td>-0.038</td><td>0.002</td><td>7.3203</td><td>0.503</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>9</td><td>-0.027</td><td>0.057</td><td>7.3585</td><td>0.600</td></tr>
<tr><td>. |* . |</td><td>. |* . |</td><td>10</td><td>0.135</td><td>0.185</td><td>8.3284</td><td>0.597</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>11</td><td>-0.050</td><td>-0.043</td><td>8.4678</td><td>0.671</td></tr>
<tr><td>. *| . |</td><td>. | . |</td><td>12</td><td>-0.103</td><td>-0.047</td><td>9.0795</td><td>0.696</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>13</td><td>-0.086</td><td>-0.144</td><td>9.5266</td><td>0.732</td></tr>
<tr><td>. *| . |</td><td>. *| . |</td><td>14</td><td>-0.065</td><td>-0.084</td><td>9.7917</td><td>0.777</td></tr>
<tr><td>. | . |</td><td>. | . |</td><td>15</td><td>0.053</td><td>0.029</td><td>9.9753</td><td>0.821</td></tr>
<tr><td>. | . |</td><td>. *| . |</td><td>16</td><td>0.034</td><td>-0.127</td><td>10.056</td><td>0.864</td></tr>
</table>