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Energy-Growth Nexus in Bangladesh: An Empirical Study

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The relationship between energy and output is one of the important topics in economic research. There are so many variables that affect this relationship that neither theory nor econometric analysis gives us any conclusive result. The objective of the current study is to investigate the causal relationship between energy and output in Bangladesh using annual data from 1973-2007 in a bivariate framework. To check the stationarity properties, we have employed Augmented Dickey Fuller (ADF) test and found that variables are stationary considering only constant. Using Johansen cointegration method, the empirical findings indicate that there exists long run cointegration among the variables. Then applying the Granger causality test we have revealed some interesting causal relationships between economic growth and different energy indicators in Bangladesh.

Field of Research: Role of Energy in Bangladesh Economy

1. Introduction

Although economic theories do not have a conclusive relationship between energy consumption and economic growth, their relationship is well documented in empirical literature**.** This has been a significant issue of concern among economist and policymakers. During the last few decades, there have been a number of studies addressing with the issue of causality between economic growth and energy. Since the seminal work of Kraft and Kraft (1978), recent studies Payne (2010), Ouedrago (2010), Tsani (2010), Odhiambo (2009), Halicioglu (2009), Bellourni (2009), Zamani (2007), Al-Irani (2006), Wolde-Rufael (2006), Narayan and Smith (2005), Yoo (2005),Oh and Lee (2004), Shiu and Lam (2004), Moritomo and Hope (2004), Jumbe (2004),Sari and Soytas (2003), and Ghosh (2002) have focused on the causal relationship between energy consumption and economic growth for several developing countries. Strong interdependence and causality between economic growth and energy is a stylized economic fact, but the existence and direction of causality is still not clearly defined.

Broadly speaking, existing empirical literature finds support for four possible hypotheses between energy consumption and economic growth; they are growth, conservation, neutrality and feedback hypotheses. The growth hypothesis suggests that causality runs from energy consumption to economic growth and an economy is energy dependent where energy consumption leads to growth. Conversely, a shortage of energy may negatively affect economic performance, leading to a fall in income and employment (Jumbe, 2004). On the other hand, the conservation hypothesis suggests that causality runs from economic growth to energy consumption and an economy is not energy-dependent where energy conservation

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policies may be implemented with no adverse effect on growth and employment (Masih and Masih, 1997). However, it is possible that a growing economy constrained by politics, weak infrastructure, or mismanagement of resources could generate inefficiencies and the reduction in the demand for goods and services, including energy consumption (Squalli, 2007). The feedback hypothesis suggests that energy consumption and real GDP are interrelated and complementing each other. Finally, the neutrality hypothesis suggests that there is no causality in either direction and changes in energy consumption are not associated with changes in GDP, so that energy conservation policies may be pursued without adversely affecting the economy (Jumbe, 2004).

To the best of our knowledge, except a paper by Mazumder and Marathe (2007), there are no studies addressing the causal relationship between energy and economic growth for the case of Bangladesh. This article tries to fill the gap the relation between energy and economic growth and more generally the role of energy in economic production for Bangladesh. The following two questions are addressed in this study:

1. Is there any long run equilibrium relationship between energy consumption and economic growth?
2. Is causality running in either directions or both directions?

Rest of the paper is organized as follows. Next section presents the review of literature. The following section provides a brief description of the energy sector in Bangladesh. The section after that discusses methodology and attributes of data. Econometric results and their discussion follow in the subsequent section with concluding remarks.

2. Literature Review

Relationship between energy and the economy has been addressed in several studies. These studies have their own approach and scope. Traditional growth theory considers energy as an intermediate input whereas capital, labor, land, and productivity as primary factors of production; hence the importance of energy in production remains in the sideline.

The neoclassical growth models imply that demand is derived demand, so that energy consumption is a result of macroeconomic conditions (Lermit and Jollands, 2001). Central arguments of the proponents of neoclassical theory emphasize the role for substitution possibilities and technological progress to ameliorate resource scarcity and facilitate sustained growth in the presence of diminishing energy resources (Gounder and Bartleet, 2010). Within the mainstream neoclassical theory of economic growth, for example, the focus has been on exploring the sustainability or complementarity between energy and other factors of production as well as on the interaction between energy, technical progress and productivity using aggregate or sector-specific production functions or general equilibrium approaches. Conversely, the ecological economy focuses on the material basis of economic production, a perspective from which a number of limitations appear in the theoretical substitution and technological change arguments of the neoclassical theory. Despite the divergent views, both perspectives of neoclassical and ecological economics schools of thought imply that a long run relationship may exist between energy consumption and economic output.

However Table 1(See Appendix) provides a brief list of literature on the causal relationship between energy consumption and economic growth by country, time frame, methodology, variables included in the analysis and empirical results. As expected, the empirical results have yielded mixed results in terms of the aforementioned hypotheses on the causal relationship. The variation in results may be attributed to variable selection, model specifications, time periods of the studies, and econometric approaches undertaken. But the result of the studies reveals that energy drives economic growth mostly across the world.

3. Overview of Energy Sector in Bangladesh[i]

Bangladesh is one of the developing countries of the world trying to move up from current economic condition and in this endeavor energy consumed might play a key role. Access to commercial power and energy has become essential for higher economic growth, poverty alleviation and social development. But Bangladesh's energy infrastructure is relatively small, insufficient and poorly managed. According to Temple (2002), the coverage of the energy sector in Bangladesh is limited, service quality is low, theft of power and gas is rampant, and utilities are all bankrupt and live on state subsidy. The current rate of energy consumption has been constraining the country's endeavor towards attracting sizeable foreign direct investment, accelerating regional development, improving the life standards of local people, participating in the globalization process and achieving socio economic development.

Despite having the low per capita consumption, Bangladesh is lucky to have substantial reserves of natural gas, small reserves of oil and very high quality bituminous coal. The problem is that, the country is not skilled enough to make the utilization of these resources. Commercial energy in Bangladesh has conquered by natural gas, particularly in power generation which is supplemented by imported liquid fuel. Indigenous coal is yet to make any significant impact in the energy scenario. Traditional energy sources like wood, animal wastes and crop residues are estimated to account for over half of the country's energy consumption.

While sustained energy supply is a precondition for economic development, current available information indicates that the existing gas reserves will be able to meet the gas demand (at 7% per annum) up to 2016 though with the present production capacity it can not meet the existing demand. It is also alarming that the exploration of gas did not have keeping in pace with growing demand which has resulted in stranded gas in one region and huge hungry demand in other region. As such there exists a demand and supply gap. As the current reserves (12 trillion cubic feet) would be unable to meet the gas demand which would reach to 5.6 billion cubic feet by 2025, there will be a requirement of investments of over $9 billion for exploration, development and transmission network expansion by 2025. About 3.3 billion tons of coal reserves comprising 5 deposits at depths of 118-1158 meters have been discovered so far. Utilization of own coal started in 2006, hydro-electric generation is in place since the late 60's, solar power generation is gathering momentum; biogas production has also found its feet. If the country could make effective plan and implement its energy sector development activities with visions and commitments, certainly, the country would become a medium earning country. Table 2 shows the present power availability in Bangladesh.

Table 2: Some Key Power Sector Parameters in Bangladesh (2009-2010)	
Installed Capacity	6033 MW
Generation Capacity	5776 MW (September, 2010)
Production	3900-4300 MW
Highest Production	4606 MW (14 April, 2010)
Per Capita Generation	200 KWh (Grid); 236 KWh including Captive
Electricity Growth	10 percent in FY-2010 (Average 7 percent since 1990)
Electricity Demand (Peak)	5800 MW
Access to Electricity	47 percent
Per Capita Electricity Consumption	220 KWh
Total Consumers	12 Million
Transmission Lines	8500 km
Distribution Lines	270000 km
Distribution Losses	13.1 percent
Load Shedding	1000-1500 MW (September, 2009)
Source: Power Division	

4. Methodology, Variables and Data Set

We tested existence of unit root to check the stationarity of the variables. Macro variables are well known for their non stationarity. We performed Augmented Dickey Fuller (ADF) test to find the existence of unit root. We found that the variables are non stationary and thus can not be regressed without making them stationary. Then we ran cointegration test to find out possible linear combination of the variables that can be considered stationary. If we found that the variables are cointegrated, then we ran Granger casualty test to check the possible direction of causality.

In time series analysis, non stationary data may lead to spurious regression unless there exists at least one Cointegrating relationship. The Johansen procedure is applied to test for cointegration. This method provides a unified framework for estimation and testing of cointegration relations in the context of Vector Autoregressive (VAR) error correction models. For this approach one has to estimate an Unrestricted Vector of Autocorrelation of the form:

$$\Delta x_t = \alpha + \theta_1 \Delta x_{t-1} + \theta_2 \Delta x_{t-2} + \theta_3 \Delta x_{t-3} + \cdots\cdots + \theta_{k-1} \Delta x_{t-k+1} + \theta_k \Delta x_{t-k} + u_t$$

Where Δ is the difference operator, x_t is a $(n \times 1)$ vector of non-stationary variables (in levels) and u_t is also the $(n \times 1)$ vector of random errors. The matrix θ_k contains the information on long run relationship between variables. If the rank of $\theta_k = 0$, the variables are not cointegrated. On the other hand if rank (usually denoted by r) is equal to one, there exists one cointegrating vector and finally if $1 < r < n$, there are multiple cointegrating vectors. Johansen and Juselius (1990) have derived two tests for cointegration, namely the trace test and the maximum Eigen value test. The trace statistic evaluates the null hypothesis that there are at most r cointegrating vectors whereas the maximal eigen value test, evaluates the null hypothesis that there are exactly r cointegrating vectors in x_t .

According to cointegration analysis, when two variables are cointegrated then there is at least one direction of causality. Granger-causality, introduced by Granger (1969, 1980, 1988), is one of the important issue that has been much studied in empirical macroeconomics and empirical finance. Engle and Granger (1987) have indicated that the existence of non-stationarity, can give misleading conclusions in the Granger causality test. It is only possible to infer a causal long run relationship between non stationary time series when the variables are cointegrated.

If y and x are the variables of interest, then the Granger causality test determines whether past values of y add to the explanation of current values of x as provided by information in past values of x itself. If past changes in y does not help explain current changes in x, then y does not Granger cause x. Similarly, we can investigate whether x Granger causes y by interchanging them and repeating the process. There are four likely outcomes in the Granger causality test: (1) neither variable Granger causes each other, (2) y causes x but not otherwise, (3) x causes y but not otherwise, (4) both x and y Granger cause each other.

In this study the causality test between GDP and Energy indicators will be conducted. For this the following two sets of equation will be estimated:

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots\cdots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \cdots\cdots + \beta_l y_{t-l} + u_t$$
$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots\cdots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \cdots\cdots + \beta_l x_{t-l} + v_t$$

For all possible pairs of (x, y) series in the group. The reported F-statistics are the Wald statistics for the joint hypothesis $\beta_1 = \beta_2 = \beta_3 = \cdots\cdots = \beta_l = 0$

As explained in the introduction, this paper examines the long run relationship and the direction of causality between energy and national output of Bangladesh. The measure of Real GDP (RGDP) can be considered as an indicator of economic development. For energy we have used different Energy Indicators (EI) like Energy Production (EP), Energy Use (EU), Electricity Production (ECP) and Electricity Consumption (ECC). Additionally, the variable Final Consumption Expenditure (FCE) has been considered to see the role of energy towards the consumption expenditure.

The Data for all the variables have been collected from World Development Indicators managed by the World Bank. Our data set spans over the period of 1973-2007 for which 35 observations are available at most. Expansion of data set is not possible due to unavailability of data. Also since the relationship is dynamic one, so inclusion of very old data can produce us wrong outcomes. Small sample size might be problematic in finding the long run relationship. Eviews 5.0 and Microfit 4.1 have been used as statistical software packages for all the tests run in this study. All the econometrics results are available on request.

5. Results Obtained

Unit root tests were conducted to determine the order of integration of the data series for each of the variables. Table 3 shows the ADF statistics and corresponding critical values of all the variables in their level and first differenced forms.

Here it is worth mentioned that unit root tests have non-standard and non-normal asymptotic distribution which are highly affected by the inclusion of deterministic terms, e.g., constant, time trend etc. A time trend is considered as an extraneous regressor whose inclusion reduces the power of the test. However if the true data generating process were trend stationary, failing to include a time trend also results in a reduction in power of the test. In addition, this loss of power from excluding a time trend when it should be present is more severe than the reduction in power associated with including a time trend when it is extraneous (Lopez et al, 2005).So, in this study we have also considered time trend for more robust results.

From table 3, the null hypothesis of unit root in levels of the variables and the first differences of the variables at 90%, 95% and 99% confidence level cannot be rejected. It is clear that all concerned variables are non stationary in their level and first differences. The above results also imply that the variables would yield spurious results unless the variables are cointegrated.

Table 3: Augmented Dickey Fuller(ADF) Unit Root Test for the selected variables

Panel 1: Levels			
	ADF Statistics (Only Constant)	ADF Statistics (Constant & Trend)	Decision
RGDP	7.758181	0.663860	Stationary considering only constant and non stationary considering constant and trend
EP	5.650633	0.769237	Do
ECP	9.079676	1.480448	Do
ECC	6.031491	0.066159	Do
EU	4.428512	0.392258	Do
FCE	3.953230	-0.249242	Do
Panel 2: First Differences			
	ADF Statistics (Only Constant)	ADF Statistics (Constant & Trend)	Decision
RGDP	Not Applicable as RGDP is I (0) considering only intercept.	-7.482504	Stationary
EP	Do	-6.426445	Stationary
ECP	Do	-4.304878	Stationary
ECC	Do	-5.481294	Stationary
EU	Do	-8.251110	Stationary
FCE	Do	-7.929053	Stationary
Note: All regression is estimated with and without trend. Selection of the lag is based on Schwartz Information Criterion (SIC). Eviews 5.0 software automatically selects the most significant lag length based on this criterion.			

These results, however, allow us to proceed to the next stage of testing for cointegration. Results of Johansen test for cointegration is given in table 4 and 5 (See Appendix).The Granger causality test has been done with specific lag period and the results are reported in table 6. Lag length has been chosen by using Schwarz Information Criterion (SIC).

6. Discussion on Results Obtained

Now, summarizing the results that we have obtained, we see that all macroeconomic and energy variables are stationary with constant. However with trend the results reveal non stationarity among the variables which is somewhat expected. Tests of cointegration tell that all variables are cointegrated. The compiled result of Granger Causality test among the variables has the following conclusions:

1. The expansion in economic activities causes energy production which facilitates the energy use and the use of energy in turn ensures higher economic growth. So, in Bangladesh, economic growth is achieved through the production and use of energy.

2. In Bangladesh, it is the RGDP that derives the electricity consumption and not vice versa. Economic growth causes expansion in the industrial and commercial sectors where electricity has been used as basic energy input. The interesting finding is that although electricity consumption does not cause real GDP but Energy Use causes RGDP. So, electricity per se. is not a good source of energy in Bangladesh economy rather we have other primary sources (Table 7).

Table 7: Annual Energy Consumption (2009)

Type	Unit (Million Metric Ton Oil Equivalent)	Percent
Gas	18	50
Biomass	12	33.33
Oil	4	11.11
Others	2	5.55
Total	36	100
Source: Energy and Mineral Resources Division		

3. Electricity production causes electricity consumption and energy production causes energy use which is very much consistent on the theoretical background. However the both way causality found between RGDP and electricity production is also very interesting because as expected electricity consumption does cause RGDP. This might be the outcome of data discrepancy between the concerned variables. It might happen Electricity production accounts both the private and public sector whereas electricity consumption accounts only one sector. Another plausible explanation of this unexpected result is that the consumers are underestimating the actual electricity consumption consumed by them. This gives somewhat an indication that the distribution of produced electricity is not as efficient as one could expect.

4. In Bangladesh, Economic Growth drives all kind of energy production and consumption which is not true in the other way.

5. The unidirectional causality running from RGDP to final consumption expenditure supports the conventional economic theory where consumption expenditure is considered as a stable function of income. The follower of Consumption-Led Growth might find this result ambiguous and conclude that there are some other sources of consumption than the conventional channels. And these other sources of consumption as they are not reflected in Bangladesh GDP will be reflected in unofficial economy. In that case we would expect that underground economy of Bangladesh will very high. In fact different measures of underground economy of Bangladesh has pointed out that the figure is at least 35% of official economy which is a large value and sufficient enough to distort results. (Schneider, 2004).

7. Conclusion

This paper has attempted to analyze empirically the dynamic relationships between energy and output in Bangladesh and we have found that output and energy reinforces each other which is found in studies done on many other countries as well. With the advancement of the country's economy, there has been a rapid growth in energy consumption in different sectors. Increased in disposable income, individuals have come to consume progressively more energy. Economic growth causes expansion in the industrial and commercial sectors where energy has been used as a basic input.

The results reveal a unidirectional causality form RGDP to electricity consumption which provides evidence in support of the proposition that electricity consumption is a result of economic activity rather than being an essential input to production. But we have also found some relationships that are not compatible with the economic theories. Following the existing literature we have tried to explain them. Perhaps it is very important for government to ensure a safe, dependable and cost-effective supply of economy for higher economic growth. The ambiguous result of having unidirectional causality from electricity production to RGDP coupled with the unidirectional causality running from RGDP to electricity consumption might be the outcome of severe transmission and distribution losses in Bangladesh. So government policies should emphasize on efficient production and utilization of disaggregated source of energy like electricity.

Further research could be done to test the validity of nexus between output-energy and output-environment pollutants in Bangladesh. A new direction for future research would be to examine the causal relationship between energy growth, pollution emissions and other potentially relevant variables such as automobile use, health expenditure and urbanization.

Endnotes

[i] All figures provided in this section have been compiled from " Bangladesh Development Forum 2010, Dhaka, Feb 2010", published by Ministry of Power, Energy & Mineral Resources, Government of the People's Republic of Bangladesh.

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APPENDIX

Table 1: Overview of Country specific studies on the link between energy consumption and GDP

Authors	Analyzed Countries and Periods	Variables Used	Method	Causality
Halicioglu (2009)	Turkey (1960-2005)	GDP and energy Consumption	Cointegration, Granger Causality	No causal relationship between GDP and energy consumption
Ang (2008)	Malaysia (1971-1999)	GDP and energy Consumption	Cointegration and Error Correction	GDP causes energy consumption
Karanfil (2008)	Turkey (1970-2005)	GDP and energy Consumption	Cointegration, Granger Causality	GDP causes energy consumption
Ang (2007)	France (1960-2000)	GDP and Energy Use	Cointegration and VECM	Energy use to RGDP
Zamani (2007)	Iran (1967–2003)	GDP and Energy	Cointegration, Granger Causality and Error Correction	GDP causes Total Energy
Ghali and El-Sakka (2004)	Canada (1961-1997)	GDP and energy Consumption	Co-integration, VEC, Granger causality	No causal relationship among the variables
Morimoto and Hope (2004)	Srilanka (1960-1998)	GDP and Electricity Production	Granger Causality	Electricity Production causes GDP
Oh and Lee(2004)	Korea (1970-1999)	GDP and Electricity Consumption	Granger Causality Error Correction	Bidirectional causality
Fatai et al. (2002)	New Zealand (1960-1999)	Employment, energy consumption and GDP	Granger Causality and ARDL Model	No causal relationship among the variables
Hondroyiannis et al. (2002)	Greece (1960–1996)	GDP and energy Consumption	Error Correction Model	No causal relationship among the variables
Aqeel and Butt (2001)	Pakistan (1955-1996)	GDP and energy Consumption	Cointegration, Granger Causality	GDP causes energy consumption
Soytas et al. (2001)	Turkey (1960–1995)	GDP and energy Consumption	Co-integration and Granger causality	Energy Consumption to RGDP
Stern (2000)	USA (1948-1994)	GDP and energy Consumption	Cointegration, Granger Causality	Energy Consumption to RGDP
Glasure and Lee (1997)	South Korea and Singapore (1961-1990)	GDP and energy Consumption	Cointegration, Granger Causality	No causal relation for South Korea and GDP causes energy consumption in Singapore
Masih and Masih (1997)	Korea (1955-1991) and Taiwan (1952-1992)	Income, energy consumption and energy prices	Cointegration, Vector Error Correction and Impulse Response Function	Bidirectional causality
Stern (1993)	USA (1947–1990)	GDP and energy Consumption	Multivariate VAR Model	Energy Consumption to RGDP
Yu and Jin (1992)	USA (1974–1990)	GDP and energy Consumption	Co-integration and Granger causality	No causal relationship among the variables
Hwang and Gum (1991)	Taiwan (1961-1990)	GDP and energy Consumption	Cointegration and Error Correction	No causal relationship among the variables
rAbosedra and Baghestani (1989)	US (1947-1987)	GDP and energy Consumption	Cointegration, Granger Causality	GNP causes energy consumption
Kraft and Kraft (1978)	USA (1947-1974)	GNP and Gross energy input(GNI)	Sims Techniques	GNP causes GNI

Table 4: Johansen Test for Cointegration (Maximum Eigen value Test)

	Null Hypothesis	Alternative Hypothesis	Statistics	95% Critical Value	Conclusion
RGDP and EP	None	At Most One	76.54 (0.00)	11.03 (4.16)	One Cointegrating Relationship
RGDP and ECP	None	At Most One	90.15 (0.72)	11.03 (4.16)	One Cointegrating Relationship
RGDP and ECC	None	At Most One	80.04 (0.41)	11.03 (4.16)	One Cointegrating Relationship
RGDP and FCE	None	At Most One	64.26 (0.53)	11.03 (4.16)	One Cointegrating Relationship
RGDP and EU	None	At Most One	69.64 (0.00)	11.03 (4.16)	One Cointegrating Relationship
ECC and FCE	None	At Most One	56.57 (0.41)	11.03 (4.16)	One Cointegrating Relationship
ECP and ECC	None	At Most One	82.23 (3.15)	11.03 (4.16)	One Cointegrating Relationship
EP and ECC	None	At Most One	73.62 (0.82)	11.03 (4.16)	One Cointegrating Relationship
EU and ECC	None	At Most One	68.16 (0.86)	11.03 (4.16)	One Cointegrating Relationship
EP and ECP	None	At Most One	94.98 (0.94)	11.03 (4.16)	One Cointegrating Relationship
EU and ECP	None	At Most One	86.93 (1.20)	11.03 (4.16)	One Cointegrating Relationship
ECP and FCE	None	At Most One	78.39 (0.51)	11.03 (4.16)	One Cointegrating Relationship
EP and FCE	None	At Most One	67.05 (1.03)	11.03 (4.16)	One Cointegrating Relationship
EP and EU	None	At Most One	63.73 (0.13)	11.03 (4.16)	One Cointegrating Relationship
EU and FCE	None	At Most One	52.46 (1.36)	11.03 (4.16)	One Cointegrating Relationship

Table 5: Johansen Test for Cointegration (Trace Test)

	Null Hypothesis	Alternative Hypothesis	Statistics	95% Critical Value	Conclusion
RGDP and EP	None	At Most One	76.54 (0.00)	12.36 (4.16)	One Cointegrating Relationship
RGDP and ECP	None	At Most One	90.87 (0.72)	12.36 (4.16)	One Cointegrating Relationship
RGDP and ECC	None	At Most One	80.46 (0.41)	12.36 (4.16)	One Cointegrating Relationship
RGDP and FCE	None	At Most One	64.80 (0.53)	12.36 (4.16)	One Cointegrating Relationship
RGDP and EU	None	At Most One	69.64 (0.00)	12.36 (4.16)	One Cointegrating Relationship
ECC and FCE	None	At Most One	56.97 (0.41)	12.36 (4.16)	One Cointegrating Relationship
ECP and ECC	None	At Most One	85.39 (3.15)	12.36 (4.16)	One Cointegrating Relationship
EP and ECC	None	At Most One	74.44 (0.82)	12.36 (4.16)	One Cointegrating Relationship
EU and ECC	None	At Most One	69.02 (0.86)	12.36 (4.16)	One Cointegrating Relationship
EP and ECP	None	At Most One	95.92 (0.94)	12.36 (4.16)	One Cointegrating Relationship
EU and ECP	None	At Most One	88.14 (1.20)	12.36 (4.16)	One Cointegrating Relationship
ECP and FCE	None	At Most One	78.91 (0.51)	12.36 (4.16)	One Cointegrating Relationship
EP and FCE	None	At Most One	68.08 (1.03)	12.36 (4.16)	One Cointegrating Relationship
EP and EU	None	At Most One	68.87 (0.13)	12.36 (4.16)	One Cointegrating Relationship
EU and FCE	None	At Most One	53.82 (1.36)	12.36 (4.16)	One Cointegrating Relationship

Table 6: Granger Causality Tests			
Hypothesis	**F-Statistics**	**P-Value**	**Granger Causality**
RGDP does not Granger Cause EP	4.38160	0.04460	Bidirectional Causality RGDP↔EP
EP does not Granger Cause RGDP	3.32507	0.07789	
RGDP does not Granger Cause ECP	4.42142	0.04371	Bidirectional Causality RGDP↔ECP
ECP does not Granger Cause RGDP	3.63316	0.006595	
RGDP does not Granger Cause ECC	6.85139	0.01357	Unidirectional Causality RGDP →ECC
ECC does not Granger Cause RGDP	1.14921	0.29199	
RGDP does not Granger Cause EU	3.62894	0.06610	Bidirectional Causality RGDP↔EU
EU does not Granger Cause RGDP	5.71109	0.02312	
RGDP does not Granger Cause FCE	6.77004	0.01409	Unidirectional Causality RGDP →FCE
FCE does not Granger Cause RGDP	0.07889	0.78067	
ECC does not Granger Cause FCE	4.50665	0.04185	Bidirectional Causality ECC↔FCE
FCE does not Granger Cause ECC	3.01308	0.09253	
ECP does not Granger Cause ECC	4.68538	0.03824	Unidirectional Causality ECP →ECC
ECC does not Granger Cause ECP	1.62105	0.21241	
EP does not Granger Cause ECC	4.15214	0.05019	Unidirectional Causality EP →ECC
ECC does not Granger Cause EP	1.01684	0.32108	
EU does not Granger Cause ECC	5.81987	0.02195	Unidirectional Causality EU →ECC
ECC does not Granger Cause EU	1.04491	0.31459	
EP does not Granger Cause ECP	5.87546	0.02138	Unidirectional Causality EP →ECP
ECP does not Granger Cause EC	1.40323	0.24519	
EU does not Granger Cause ECP	5.08706	0.03131	Unidirectional Causality EU →ECP
ECP does not Granger Cause EU	1.61378	0.21341	
ECP does not Granger Cause FCE	8.21145	0.00741	Unidirectional Causality ECP→FCE
FCE does not Granger Cause ECP	0.32739	0.57133	
EP does not Granger Cause FCE	21.4230	0.00006	Unidirectional Causality EP→FCE
FCE does not Granger Cause EP	0.54161	0.46730	
EP does not Granger Cause EU	3.11106	0.08762	Unidirectional Causality EP →EU
EU does not Granger Cause EP	0.03879	0.84515	
EU does not Granger Cause FCE	8.66703	0.00609	Unidirectional Causality EU →FCE
FCE does not Granger Cause EU	2.12400	0.15506	