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Oil Price and the Renewable Energy Consumption in Bangladesh: An Empirical Analysis

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Oil price is known for its volatility and due to the sudden fluctuation of oil price, developing countries are affected more than the developed countries. To the best of our knowledge, no studies have been conducted to investigate the relationship between oil price and renewable energy consumption in Bangladesh and so the aim of this paper is to analyze how oil price impacts renewable energy consumption with the help of time series data (1980-2015). Johansens conintegration test reveals that our variables are cointegrated and Granger causality test results show a unidirectional causality is running from renewable energy consumption to oil price in the long run. Through Vector Error Correction Model (VECM) we found no causality in the short run. CUSUM and CUSUMSQ test was employed to check the stability of the model and results show that the model is stable. Dynamic Ordinary Least Square (DOLS) approach being used for long run estimation and we found that the coefficient of oil price is positive and inelastic as well. Thus proper policies should be taken to develop the renewable energy sector to reduce the effects of oil shocks in Bangladesh.

Field of Research: Economics

1. Introduction

Oil dependency level became increasingly more evident after the oil shocks of 1973 and 1979. During both times, it was the decisions taken in the Middle East that caused such global crisis, especially when the OPEC countries placed an embargo on Arab oil in 1973, and at the beginning of the Iranian Revolution when output decreased for oil and there had been a price hike. Oil is one of the key components of the global economy, and its price is known for its volatility. Developing countries got more affected than the developed countries, because of sudden fluctuation of oil prices. For that reason, countries need to come up with alternative sources of renewable energy. Energy plays a pivotal role in poverty eradication, development, economic growth, sustainable infrastructure and security of any country. According to the literature reviewed, the causal effects and linkages among the oil price, consumption of energy and macroeconomic performance have significant policy implications on the benefits of

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energy conservation and regulation of macroeconomic policy. (Bekhet and Yusop 2009)Sustainable energy supply is needed for Bangladesh to prosper in the upcoming decades. As a result, if energy supply is not proliferated then there will be severeadverse consequences for the nation's economic as well as social development. Government of Bangladesh (GOB) is giving best effort to develop the indigenous resources of energy. Energy consumption in Bangladesh is relatively lower than any peer developing countries of South East Asia. In 2015, energy consumption was only about 0.20% of world's consumption.Rural areas receive service of very poor quality, involving frequent outages, voltage fluctuations and unreliable and erratic supply. Biomass has a 60% contribution in the aggregate primary energy consumption of Bangladesh. Biomass and kerosene are used mainly by a majority of households. Natural gas and connection for cooking are at only 34% of the households, of 23% households utilize kerosene for cooking and the rest of above 90 are dependable on biomass. Bangladesh had been ranked as having the 6th largest renewable energy related workforce in the world, of 114, 000 job, according to the International Renewable Energy Agency (IRENA) in 2013.

The aim of this paper is to analyze how oil price impacts renewable energy consumption in Bangladesh with the help of time series data (1980-2015). In doing so,number of research questions are considered which are as follows: What are the short run long run causalities among the variables of interest? Is the Chosen model Stable? What is the estimated coefficient of oil price with respect to renewable energy consumption?

The rest of the paper is organized as follows. The next section provides the literature review followed by the section that discusses the attributes of data and the methodology of research. Moving on, the subsequent sections provide discussions on econometric results and finally followed by concluding remarks and policy recommendations.

2. Literature Review

Heal and Hallmeyer (2015) attempted to study the effects of lowering oil prices on the market for renewable fuel alternatives. This study focused on specific markets and seeing how the low oil prices affected their renewable competitors. This was observed by constructing a temporal frame and observing how the market of the renewable competitor behaved, when oil prices were reduced. Specific market such as transportation and power were taken as a sample. Observation on the behavior of renewable alternatives when oil prices were reduced. The result was found to vary. In case of transportation low oil price reduced the appeal for electric vehicles even though bio-fuels and electric vehicles are still less costly than their traditional counterparts. In the case for power generation, oil cannot complete with renewable alternatives. The price of oil needs to be drastically low in order to be competitive ($15/barrel) to the margin where oil producers will lose money, thus making it untenable.

Bekhet and Yusop (2009) investigated the relationship between oil price, energy consumption and macroeconomic performance in Malaysia. A sample had been taken from 1980-2005 and tested to find a relationship of the oil price, employment, economic growth and growth rate of energy consumption. The study found a negative correlation between real economic growth and energy consumption, and positive relationship between energy consumption and employment growth. The implication of the finding suggests that the energy consumption projects does in fact lead to increase in employment but does not lead to a general economic growth. This shows that the current energy saving policy in Malaysia does in fact have significant impact on achieving higher economic growth and reducing oil, gas and coal consumption in the long run. The results suggest that following the trend of the consumption non-renewable energies would in fact increase the deficit in Malaysia's balance of payment.

Jemmali et al.(2017) investigated the inter-linkages among Renewable energy consumption, International trade, oil price and economic growth for Tunisia. They used bounds testing method to co integration and the methodology on ARDL model for the period of 1980–2011, in Tunisia. The major empirical results showed the presence of a short-run bidirectional relationship between renewable energy consumption and international trade. It had been proven that raising oil prices may mean an increase of renewable energy consumption. Moreover, a short run unidirectional relationship between renewable energy and oil price had also been proven. Sadorsky (2009) estimated an empirical model of renewable energy consumption for the G7 countries. Increases in real GDP per capita and CO2 per capita had been proven to be major drivers behind per capita renewable energy consumption in the long term, according to the Panel cointegration estimates. Increases in oil prices increases have a smaller but negative effect on renewable energy consumption. Deviations taken from equilibrium are mostly driven mostly by the error correction term. Short term deviations take anywhere from between 1.3 years (France) and 7.3 years (Japan) to correct, from the long term equilibrium

Rentschler (2013) examined the adverse effects of oil price volatility on economic activity and the degree to which countries can hedge against such effects by using renewable energy. They took into account the Realized Volatility of oil prices, instead often standard approach of considering oil price shocks in levels. The impacts of factor price uncertainty on economic activity had been analyzed. Sample countries stand for developed and developing, oil importing and exporting and service/industry-based economies, like United States, Germany, South Korea, Japan India, and Malaysia. Vector auto-regressive setting and Granger causality tests had been conducted, impulse response functions, and variance decompositions illustrate that oil price volatility has higher adverse effects in all sample countries than oil price shocks alone can explain. Oil price volatility depends from country to country, factors like sectoral composition and the energy mix. Standard approach of solely considering net oil importer-exporter status is not enough, according to the study. Renewable energy expansions can decrease an economy's vulnerability to oil price volatility, but a country-specific analysis would be essential to recognize concrete policy measures.

Omri and Kahouli (2013) conducted a study to find out causal relationships between energy consumption, FDI and economic growth in Tunisia, by using dynamic simultaneous-equations models, for 65 countries. They collected data for the period of 1990–2011 inclusive. They investigated this interrelationship for a number of sub-panels, to make the panel data analysis highly homogenous. It had been constructed based on the income level of countries. They got three income panels in this way, which are: namely, high income, middle income, and low income panels. According to empirical findings, they drew on growth theory and expanded the classical growth model, which holds capital stock, inflation and labor force, along with FDI and energy. Mixed results had been shown in general, for the interrelationship between energy consumption, FDI and economic growth. The high-income countries have a bi-directional causal relationship among energy consumption, FDI inflows and economic growth. The middle-income countries have a bi-directional causal relationship among economic growth and energy consumption, and between economic growth and FDI inflows, as well as a uni-directional causal relationship from FDI to energy consumption. In addition, for the low-income countries, a bi-directional causal relationship had been found between economic growth and FDI inflows. Uni-directional causal relationship exists from economic growth to energy consumption and from energy consumption to FDI inflows. For the global panel, the findings show that there is bi-directional causal relationship between economic growth and energy consumption, and between economic growth and FDI inflows.

Ackah and Asomani (2015) showed empirical analysis of renewable energy demand in Ghana with Auto metrics. They identified increased investment in renewable energy (RE) as a potential solution to the irregular power supply in Ghana. To enhance supply, effort had been made through feed in tariffs, education and tax reduction on RE related equipment. This study investigates to fill up both policy and research gap on renewable demand trend in Ghana. General unrestricted model through auto metrics had been used in this study, to estimate the determinants of RE demand in Ghana. The results specify that both economic factors and non-economic factors affect the demand for Renewable Energy. In addition, the underlying energy demand trend exhibits energy using behavior. It had been recommended that economic factors like consumer subsidies should be considered for promoting RE demand.

Sharaf (2016) tested the hypothesis that reduced energy consumption dampens the economy by taking the sample of Egypt from 1980 to 2012. The sample is relevant as post 2011 Egyptian revolution the government of Egypt adopted the policy to balance the energy deficit by reducing the power subsidies on heavy industries and household electricity use. In addition, the government also rationed energy usage by introducing smart card which issues a certain quota of fuel consumption for each registered car per month. Granger Causality Test is used in this paper to see if there is causation between energy consumption economic growth. The finding supports the neutrality hypothesis as no relationship was observed between energy consumption and economic growth. There was however, a positive unidirectional relationship between economic growth and energy consumption.

After the wide discussion of different literatures, we can set our hypothesis relevant to our research question. The considered a set of null hypothesis as follows,

H_1: Oil price does not cause renewable energy consumption
H_2:Renewable energy consumption does not cause.

In addition, we will also estimate the coefficient of the variables. In this case, we do not need any hypothesis testing.

3. Methodology and Data Set

To check the stationarity of the variables, existence of unit root has to be tested. Macroeconomic and financial data are well known because of their non-stationarity. There are several ways to find out the existence of unit root of the variables. For example, Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test are broadly employed. For our study, we have performed the (ADF) test to test the existence of unit root and found that all of the variables are non- stationary at levels and thus cannot be regressed without making them stationary. After the ADF test, we performed cointegration test to investigate possible linear combination of the variables that can be considered stationary. If cointegration is established, then we ran the causality test to check the possible direction of causality between the variables of interest.

Non stationary data may lead to specious regression in the context of time series analysis unless there is at least one cointegration relationship. The Johansen technique is employed to test for cointegration. A unified framework of estimation and testing cointegration relations are provided in the context of Vector Autoregressive (VAR) error correction models. Here, one has to estimate Unrestricted Vector of Autocorrelation of the form:

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

In the equation above, Δ is the difference operator, $x_t\ (n \times 1)$ is a vector of non-stationary variables (in levels) and is the vector of random errors. The information on long run relationship is articulated by the matrix θ_k the variables are not cointegrated, if the rank of θ_k =0. Nevertheless if rank (usually represented by r) is equal to one, there exists one cointegrating vector and in conclusion if, $1 < r < n$ there are multiple cointegrating vectors. Johansen and Juselius (1990) have derived two tests for cointegration, which are trace test and the maximum Eigen value test. The trace statistic assesses the null hypothesis that there are at most r cointegrating vectors while the maximal eigen value test, estimates the null hypothesis that there are r exactly cointegrating vectors in x_t

If two variables are cointegrated, then there is at least one direction of causality. Granger-causality is one of the important issue that has been enormously studied in empirical finance of macroeconomics. Granger-causality is introduced by Granger (1969, 1980 & 1988). Engle and Granger (1987) asserted that the presence of non-stationary can lead to distorted conclusions in Granger-causality test. In this test, we can only infer long run relationship between non stationary time series when the variables are cointegrated.

If x and y are variables of interest, then by applying Granger-causality test we can determine whether past value of y augment the explanation of present values of x given that by information in past values of x itself. y does not Granger cause x if changes past values of y does not explain changes in x values at present. Likewise, we can probe whether x Granger causes y. There are four probable outcomes in the Granger causality test:

a. neither variable Granger cause each other
b. y causes xbut not otherwise
c. x causes y but not otherwise
d. both x and y Granger cause each other

Following two sets of equation will be estimated:

$$x_t = \alpha_0 + \alpha_1 x_{t-1} + \cdots + \alpha_l x_{t-l} + \beta_1 y_{t-1} + \cdots + \beta_l y_{t-l} + u_t \qquad (2)$$

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \cdots + \alpha_l y_{t-l} + \beta_1 x_{t-1} + \cdots + \beta_l x_{t-l} + v_t \qquad (3)$$

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

Engle and Granger (1987) asserted that a vector error correction model (VECM) is an appropriate method to model the long-run as well as short-run dynamics among the cointegrated variables. Causality inferences in the multi-variate framework are made by estimating the parameters of the following VECM equations.

$$\Delta Y = \alpha + \sum_{i=1}^{m} \beta i \Delta Y_{t-i} + \sum_{j=1}^{n} \gamma_j \Delta X_{t-j} + \sum_{k=1}^{0} \delta \Delta M^s + \sum_{l=1}^{p} \zeta \Delta N + \theta Z_{t-1} + \varepsilon_t \qquad (4)$$

$$\Delta X = a + \sum_{i=1}^{m} b_i \Delta Y + \sum_{j=1}^{n} c_j \Delta X_{t-j} + \sum_{k=1}^{0} d \Delta M^s + \sum_{l=1}^{p} e \Delta N + f Z_{t-1} + \xi_t \qquad (5)$$

z t-1 is the error-correction term which is the lagged residual series of the cointegrating vector. Deviations of the series from the long run equilibrium relation are measured by the error-correction term. For instance, from equation (4), the null hypothesis that X does not Granger-cause Y is rejected if the set of estimated coefficients on the lagged values of X is jointly significant.Furthermore, in those instances where X appears in the cointegrating relationship, the hypothesis is also supported if the coefficient of the lagged error-correction term is significant. Changes in an independent variable may be interpreted as representing the short run causal impact while the error-correction term provides the adjustment of Y and X toward their respective long run equilibrium. Thus, the VECM representation allows us to differentiate between the short- and long-run dynamic relationships. The Chi-Square test statistic is used to determine the short run causalities between pairs of variables in the model.

Usually we use CUSUM test to investigate any systematic changes or movements in which there are possibilities of change in values of the coefficient revealing structural instability. Let us assume a linear regression model with K coefficients over the time period t

$$Y_t = X_t\beta_t + \varepsilon_t \text{ , } t\text{= 1,2 ,…, } T(6)$$

Estimated coefficient by OLS method based on our time period t will be,

$$\widehat{\beta_t} = (X'_tX_t)^{-1}X'_tY_t \text{ , } K\text{ ,…, } T\ (7)$$

$\widehat{\beta_t}$ofβ_t is actually identical to the OLS estimator. Thus, recursive estimators can be written as follows,

$$\widehat{B_{t-1}} = (X'_{t-1}X_{t-1})^{-1}X'_{t-1}Y_{t-1}(8)$$

Therefore, the estimator $\widehat{\beta_t}$ of β_t can be written finally as,

$$\widehat{\beta_t} = \widehat{B_{t-1}} + \left(X'_{t-1}X_{t-1}\right)^{-1}x_t\frac{y_t - x'^{\widehat{B_{t-1}}}}{1+\left[x'_t\left(X'_{t-1}X_{t-1}\right)^{-1}x_t\right]}(9)$$

Coefficient stability test based on recursive residuals through one step error prediction approach was proposed by Brown, Durbins and Evans (1975). We can write down the one step prediction error term below

$$e_t = y_t - x'_t\widehat{\beta_{t-1}} = x'_t\left(\beta_t - \widehat{\beta_{t-1}}\right) + \varepsilon_t(10)$$

Now recursive residual can be expressed in the form of normalized prediction errors

$$w_t = \frac{e_t\gamma_\varepsilon}{\gamma_e} = \frac{y_t - x'^{\widehat{B_{t-1}}}}{\sqrt{1+\left[x'_t\left(X'_{t-1}X_{t-1}\right)^{-1}x_t\right]}}(11)$$

Existence of any unknown break point resultsrejecting the specification throughout the period. Through hypothesis testing, we can find out whether the model is stable or not by rejecting or accepting null hypothesis (Farhani 2012).

$$W_m = \sum_{t=K+1}^{m}\frac{w_t}{\gamma_w}(12)$$

Under null hypothesis W_m must be inside the corridor ($-L_m$ toL_m)

$$L_m = \frac{a(2m+t-3k)}{\sqrt{T-K}} \qquad (13)$$

We will reject the null hypothesis (i.e. the model is stable) if W_m cuts the given range of corridor actually means the variables are not stable enough. If we want to check sudden or random movements in our model, then CUSUM of Square Test is appropriate. It is based on the squared recursive residuals of the model.

$$S_m = \frac{\sum_{t=K+1}^{m}{w_t}^2}{\sum_{t=K+1}^{T}{w_t}^2} = \frac{s'}{\dot{s}}(14)$$

For the null hypothesis S_m is a beta distribution. If S_m crosses the corridor than we will reject the null hypothesis just like the CUSUM Test.

The Dynamic OLS (DOLS) approach was proposed by Stock and Watson in 1993. DOLS is an improvement version of OLS approach where we can deal with small sample size and dynamic sources of bias. It is a robust single equation approach corrects the regressor endogeneity by incorporating lags and leads. DOLS can estimate long run equilibrium where variables are integrated in same or different order. This is one of the major advantages of this approach. Moreover, it has the same kind of optimality like Johansen distribution. Since our sample size is small, we applied DOLS approach for avoiding false estimation. If Y_t is the dependent variable with regressors $X_{i,t}$i=1,2,3…,n then,

$$Y_t = \beta_0 + \beta_1 X_{1,t} + \beta_2 X_{2,t} + \ldots + \beta_k X_{k,t} + \sum \alpha_{i\Delta} X_{1,t-i} + \sum \gamma_{i\,\Delta} X_{2,t-i} + \ldots + \sum \delta_{i\Delta} X_{k,t-l} + \varepsilon_t \qquad (15)$$

The paper is based on annual data covering the period of 1980-2015. Data of total population of Bangladesh, carbon emission (kilo ton) per capita are taken from World Development Indicator (WDI). On the other hand, international crude oil price per barrel and total renewable energy supply data are taken from OECD data bank and British Petroleum data bank respectively. It should be mentioned here that as Bangladesh got her independence in 1971 and this research paper focuses over the period 1980-2015 for which 36 observations are available at most. Small sample size might be problematic in finding the long run relationship. We resorted to use of the E-Views 9.5 software for carrying out all econometric tests in our study. All the econometrics results are available on request.

4. Results and Discussions

Unit root tests are conducted to determine the order of integration of the data series.Table 1 shows the ADF statistics and corresponding critical values of all the variables in their level and first differenced forms.Unit root tests have non-standard and non-normal asymptotic distribution. These distributions are extremely affected by the inclusion of deterministic terms such as constant, time trend etc. An extraneous regressor whose enclosure reduces the power of the test is called time trend. Yet if the true data generating process were trend stationary, failing to include a time trend also results in a decline in power of the test. Additionally, this loss of power from without 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. One of the main issues in unit root testing is lag length selection. Including a moderately long lag length and select the model by the usual t-test is one of the approaches. When the t-statistics on lag p is insignificant at some stated critical value, the regression should be frequently assessed using a lag length (p-1) until the lag is significantly different from zero. From the unit root test, it is clear that all the variables are found to be stationary at their first differences (considering both constant and trend).From the table it is clear that the variables would yield spurious results unless the variables are cointegrated. The results, however, allow to the next stage of testing for cointegration.

Table 1: Augmented Dickey Fuller Unit Root Test for the Variables

Variable	ADF Statistics (Only Constant)	ADF Statistics (Constant & Trend)	Decision
Panel 1: Levels			
LNRC	-0.92	-4.72	Non Stationary at constant but Stationary at constant and trend
LNOILP	-2.39	-2.70	Non Stationary
LNCO	-1.14	-4.66	Non Stationary at constant but Stationary at constant and trend
LNPOP	-2.52	-1.59	Non Stationary
Panel 2: First Differences			
LNRC	-3.63	-3.26	Stationary
LNOILP	-5.25	-5.47	Stationary
LNCO	-5.32	-5.43	Stationary
LNPOP	-4.34	-4.45	Stationary

The Johansen cointegration test results indicates that our variables have five cointegrating relationship. Maximum Eigen value test and the trace test (Table 2 and 3) both point out 3 cointegrating relationships at 90%. After the Contegration test, we performed Granger Causality Test at lag 2.

Table 2: Johansen Test for Cointegration (Trace Test)

	Null Hypothesis	Alternative Hypothesis	Statistics	90% Critical Value
LNRC, LNOILP, LNCO and LNPOP	None	(At Most One)	80.16 (28.40)	32.12 (25.82)
		At Most Two	22.38	19.39
		At Most Three	4.09	12.52

Table 3: Johansen Test for Cointegration (Maximum Eigen Value Test)

	Null Hypothesis	Alternative Hypothesis	Statistics	90% Critical Value
LNRC, LNOILP, LNCO and LNPOP	None	(At Most One)	135.03 (54.87)	63.88 (42.92
		At Most Two	26.48	25.85
		At Most Three	4.09	12.52

Table 4: Granger Causality Test Results

Variable	**Null Hypothesis**	**F-Statistic**	**P-Value**	**Conclusion**
Granger Causality Test Statistics between LNRC and LNOILP				
LNRC	LNOILP does not Granger Cause LNRC	0.6681	0.9955	LNRC Granger Causes LNOILP
LNOILP	LNRC does not Granger Cause LNOILP	3.32543	0.0506	
Granger Causality Test Statistics between LNRC and LNCO				
LNRC	LNCO does not Granger Cause LNRC	5.67518	0.0085	LNCO Granger Causes LNRC
LNCO	LNRC does not Granger Cause LNCO	1.71718	0.1970	
Granger Causality Test Statistics between LNRC and LNPOP				
LNRC	LNPOP does not Granger Cause LNRC	3.67370	0.0383	LNPOP Granger Causes LNRC
LNPOP	LNRC does not Granger Cause LNPOP	0.45070	0.6417	

From the Table 4, first set hypothesis is concerned with our research objective. From the first two null hypothesis, we can reject the second one as the static value is significant but not the first one. So, there is a unidirectional causality running from renewable energy consumption to oil price but not vice versa. It answers a portion of the research question from long run perspective. It refers that an increase in renewable energy consumption might indicate a higher oil price in the international market in the long run. According to Amin (2015), renewable energy consumption in Bangladesh could increase due to oil price hikes or fluctuations. From the granger causality test, empirically similar result has been seen as well.

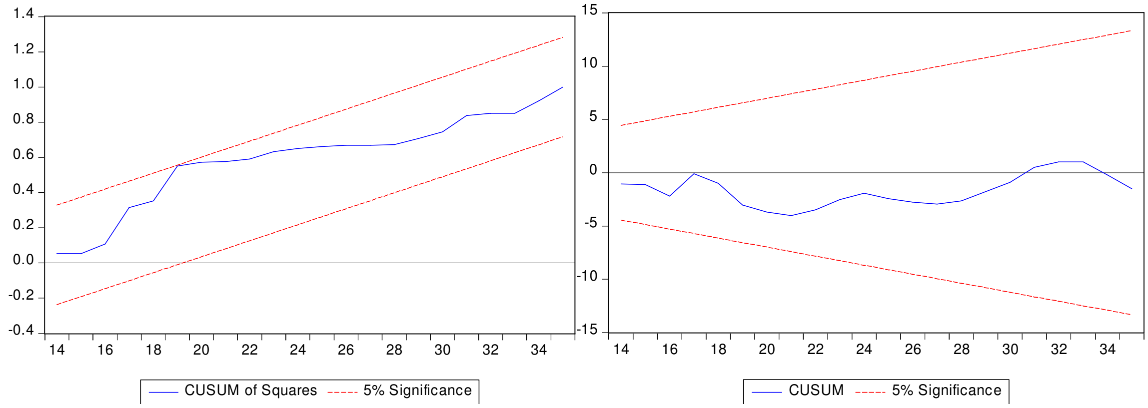
After observing the long run causal relationship, we now move to investigate the short run causal relationship among the variables through VECM approach (from the same set of hypothesis). The results from the VECM approach are given in the table 5. According to the VECM results, no causality was found between our variables of interest (renewable energy consumption and oil price). The results answer the first research question from short run perceptive. One of the possible reasons for this is that the effect of energy consumption is subject to time lag to be observed in different scenarios.

Table 5: VECM Test Results

Variable	Null Hypothesis	Chi-Statistic	P-Value	Conclusion
Causality Test Statistics between LNRC and LNOILP				
LNRC	LNOILP does not Granger Cause LNRC	1.183499	0.3250	No Causality
LNOILP	LNRC does not Granger Cause LNOILP	2.366997	0.3062	
Causality Test Statistics between LNRC and LNCO				
LNRC	LNCO does not Granger Cause LNRC	1.123125	0.3432	No causality
LNCO	LNRC does not Granger Cause LNCO	2.246250	0.3253	
Causality Test Statistics between LNRC and LNPOP				
LNRC	LNPOP does not Granger Cause LNRC	5.662148	0.0104	Bidirectional Causality
LNPOP	LNRC does not Granger Cause LNPOP	11.3240	0.0005	

After investigating short run causal relationships, now we can check the stability of the long run parameters with short run movements of the equation, through CUSUM CUSUMSQ tests. The tests are relied upon residuals of error correction model.

Figure 1: CUSUM SQ and CUSUM Test



As we can see from the above figure that both plots do no cross the red corridor, indicating the chosen model is stable in terms of systematic and sudden changes. This answers our second research question regarding stability of the model.

Table 6 shows the DOLS estimation results. For running DOLS, fixedleads and lags (lead=2, lag=3) has been chosen. The R^2, the standard error of regression and the long run variance value suggest that the proposed model is significant. On the other hand, the coefficient values have expected sign as well as significant. As can be seen that the coefficient of oil price is positive indicating a positive relationship with renewable energy consumption. It means that oil price hikes can turn consumers to consume renewable energy more in the long run. Furthermore, the value is very inelastic as well. One of the possible reasons for is that government always provides subsidy on imported oil products to reduce the effect of oil price shocks in the economy. Hence the observed magnitude of renewable energy consumption is not high enough. The estimation results answer the third research question.

Table 6: DOLS Estimation Results

Variable	Coefficient
LNOILP	0.12 (0.0001)
LNCO	0.48 (0.0002)
LNPOP	0.15 (0.0204)
Adjusted R-Squared	0.977066
S.E of Regression	0.019051
Long Run variance	0.000100

Probability in ( )

5. Conclusion

In this paper we have examined the relationship between oil price and renewable energy consumption pattern in Bangladesh with the help of annual data covering from 1980 to 2015. We found that there is a unidirectional causality running from renewable energy consumption to oil price in the long run but no causality in the short run. The short run causality is different from (Jemmaliet al.2017). Estimated long run coefficient of oil price is very inelastic but positive and significant as well.

As Bangladesh is walking on the path of development in terms of economic and social, it is important to ensure energy security in the country. As we know that developing countries suffer most when there is an oil price volatility in the international market, policies should be taken so that Bangladesh can tackle the price volatility. Improving renewable energy sector can be a great option to tackle any oil price fluctuations as well as sustaining the speed of growth and development while not harming environment as well.

Using a small data set is one of the major limitations of this paper. Due to lack of data of different variables, we could not able to incorporate those in the model as well. Such as technology penetration in the market, intra sectoral changes and attitude of consumers etc. and the results could have been empirically more underpinning in terms of explaining the relationship between our variables of interests. This paper can be further extended by incorporating more control variables in the model. Furthermore, an analysis can be done by panel data (South Asian region) for generalization for creating options of a common policy framework.

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