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An Empirical Investigation on the Relationship between Remittance and Energy Consumption towards Bangladesh Economy

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Remittances are known to make a positive contribution to the overall GDP of an economy. In recent years, it has become a major source of financial inflow for Bangladesh. On the other hand, for a substantial growth of an economy, the right amount of energy consumption is required. According to our knowledge, energy consumption has not been associated with remittance in any previous empirical studies, although significant studies are found to exist with other macroeconomic variables. This is the first multivariate model investigating the relationship between remittances and energy consumption of Bangladesh over the period 1980-2015. The main objective of this study is to examine the cointegration and causality of the variables in both short run and long run. In order to conduct the study, a number of econometric techniques have been performed. The Augmented Dickey Fuller (ADF) Unit Root test shows that all the concerned variables are stationary at their first difference. Afterwards, the Johansen Cointegration method was performed which indicates that long run cointegration exists in most of the concerned variables. Then, applying the Granger Causality test, there seems to be a causal relationship among remittance, energy use and some of the other indicators. Lastly, the Vector Error Correction Model (VECM) test has been employed to find the changes in the short run. The study therefore points out that there exists a long run causal relationship between remittance and energy consumption in Bangladeshi industrialization, financial development and thus economic growth supporting the multiplier effect of inward remittance. Policy makers of the country should encourage higher remittance inflow for higher standards of living and development.

1. Introduction

The inflow of international remittance, especially in developing countries, is known to be an important source of income for the families left behind in the home countries. For most of the recipient households, remittance received appears to be possibly the only source of income. Remittance therefore is expected to improve the standard of living of the recipient households and alleviate budget constraints that allow a positive change in the pattern of domestic expenditure (Démurger & Wang 2016).

It is important to mention the calculations of the overall global remittance made by World Bank (2017) is at US $596 billion, and $582 in the year 2015. The consumption smoothing effect of remittance allows a more stable path of

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consumption of the local goods and services through increased disposable income received by the households in the home country.

For Bangladesh economy, remittance plays a vital role in contributing to the foreign exchange reserves with a multiplier effect and a positive spill over effect. However, Khairan (2015) argues that the occurrence of a positive effect on growth depends on how productively remittances are used and how actively it responds to investment opportunities. Remittance help to raise the domestic savings which leads to development in financial intermediation, and that can be perceived as an improvement in the overall growth prospect (Ratha 2013). The possible role of migrant remittance carries a lot of weight for most of these underdeveloped and developing countries as the inflow of the foreign currency makes a significant contribution to the GDP. For example, Nepal currently stands at 31% as the highest personal remittance received as a percentage of GDP (World Bank 2016).

Since we can safely conclude that remittance influences the consumption pattern of an economy, we can assume that remittance may possibly enhance energy use through higher investment leading to higher industrialization. Energy consumption of an economy includes both renewable and non-renewable sources (electricity, coal, gas, solar energy etc.) which individuals gain access for energy use. A number of economists and policymakers highlight the importance of energy consumption, especially electricity consumption, in order to analyze a country's improvement and economic growth (Pirlogea & Cicea 2012; Nasreen & Anwar 2014; Nondo, Kahsai & Schaeffer, 2010). Energy is the backbone of an economy, and the increasing population around the world has a significant impact in the overall energy demand. Every household in the world today is dependent on at least one source of energy. Many researchers in their findings have also shown that with a poor access to electricity the economy faces a downturn in its growth, indicating that electricity access and consumption plays a vital role in influencing the economic growth and industrialization (Akçay & Demirtaş, 2015; Ogundipe & Apata, 2013; Nondo et al 2010).

A number of studies have shown that the impact set by remittance on developing countries significantly plays a massive role in economic growth, proving to be more sustainable than Official Development Assistance (ODA) and capital inflows such as foreign direct investments (FDI) (World Bank, 2017; Lubambu 2014; Ratha 2003; Begum &Sudradhar2012). This unidirectional causality from energy consumption to economic growth is addressed by few empirical studies in the past such as the study done by Shahbaz et al., (2013). However, causality running from economic growth to energy consumption is inferred by the influential study of Kraft and Kraft (1978) followed by recent studies where it is found that higher economic development is supported by higher energy use (Aqeel& Butt 2001; Amar 2013; Balitskiy, Bilan& Strielkowski 2014).

The available existing literature on remittances and economic growth evaluate that there are both positive and negative impacts of remittance on economic development; positive overweighing the negative in most findings. For example, remittance is popularly found to contribute to the economic growth of the source province countries by boosting up capital accumulation (Senbeta 2013) and the savings ratio (Ziesemer 2012; Haider, et al., 2016), encouraging domestic investment and reducing the poverty ratio (Mirza et al., 2014; Yoshino et al. 2016)

and thereby stabilizing the economy at macro level. On the other hand, one study supports that remittance flows may be statistically significant but negatively impact the economic growth (Ahmed 2010). Other papers also centralize the negative findings such as remittance decreasing trade competitiveness (Chowdhury & Rabbi 2014), reducing the labour supply (Kim 2007), lowering tax revenues (Ziesemer2012) and thus slowing down the economic development.

We have found most of the studies to be centralizing their focus on either the nexus between remittance and economic growth, or between energy consumption and economic growth or/and other macroeconomic variables. To the best of our knowledge, there is no paper that identifies possible relationship between remittance and energy consumption in the context of Bangladesh. Hence, the objective of this study is to fill the research gap on an empirical analysis of these two variables at an aggregate and disaggregate level in the context of Bangladesh. This research paper is likely to show the dynamic bivariate correlation and the direction of causality between remittances and energy consumption on Bangladesh over the period 1980-2015.

The rest of the paper is organized as follows. The existing literature review in section 2 will highlight the importance and correlation between remittances and economic growth, and energy consumption and economic growth of some developing countries. Section 3 will be about a detailed data analysis on remittances and energy consumption of Bangladesh providing the current condition and progress. The next section will include the econometric methodology to conduct the empirical tests for this paper and methods will be thoroughly discussed. Section 5 analyzes the overall findings of each test and outcomes followed by the final section providing a conclusion and policy recommendations on future aspects.

2. Literature Review

Although there is only one study discussing the causal relationship between the bivariate model of remittances and energy consumption, a broader literature has mainly been focused on observing the empirical evidence on remittances and energy consumption individually with respect to economic growth and few other macroeconomic variables.

Akçay & Demirtaş (2015) analyzed the data set from the period 1975-2010 on remittances and energy consumption in the context of Morocco. Using the Granger causality test, it is found that remittance has a direct influence on energy consumption both in the short run and long run. Variance decomposition and impulse response tests have shown that the changes in energy consumption in the future can be influenced by the change in international remittances. It is also observed that energy consumption is indirectly influenced by remittances through economic growth and industrialization of Morocco. This is the only available study that investigated on causality between remittance and energy consumption, specifically focusing on these two variables.

In order to recognize the factors influencing the commercial energy consumption empirical evidence on Pakistan has been presented by Zaman, Khan and Ahmad (2012) between the years 1980 to 2011.They investigate on whether there exists a

two-way relationship between four energy consumption variables and four macroeconomic factors including balance of payment (BOP) factors. They have used the unit root test, ECM and Granger causality test to find that workers' remittances have a unidirectional causality running to gas consumption. However, according to the findings of Zaman et al., oil consumption negatively affects workers' remittances in Pakistan. The paper concludes with a long run positive relationship between total commercial energy consumption and macroeconomic factors including the determinants of remittances.

One study was implemented on three SAARC countries, mainly Bangladesh, India and Pakistan, to find any existence of causality between economic growth, electricity consumption, export values and remittances using the time series data for the period 1976-2009 (Hossain 2014). Granger causality test shows that there exists a bidirectional causality running from remittances to economic growth in the short run in Bangladesh, and a unidirectional causality from economic growth to electricity consumption in Pakistan. Long run causality was failed to be found. Co-integration test and unit root test conclude that all the panel variables are co-integrated for Bangladesh and India. As a result, higher electricity consumption and higher remittances boosts up the economic growth. However, it is concluded that any restriction on energy use will not directly affect the economic growth of these SAARC countries.

As for poverty reduction in the recipient countries of international remittances, enough evidence from multiple research papers determine that remittances have a statistical significant impact on the reduction of household poverty. For example, Yoshino et al. (2017) have examined how remittances as a percentage of GDP significantly lead to a decline in poverty gap ratio and poverty severity ratio in the context of 10 Asian developing countries. They have used unit root test and Hausman test to conduct their research using data from the time series of 1981-2014. Yoshino et al. (2017) have revealed that a rise in remittance as a percentage of GDP can lead to decline in the poverty gap ratio and poverty severity ratio and the impact on the variables are statistically significant. A previous paper evaluating foreign remittances and household poverty by Mirza et al. (2014) also provides empirical evidence that remittances reduce the poverty of households in the rural and urban areas. Using PMS technique and Kernel matching method, it is found that remittances increase the per capita income compared to the per capita income of households that don't receive remittances.

Electricity consumption and economic growth have been further examined on Nigerian economy by Ogundipe and Apata (2013) for the time period 1980-2008. They have applied unit root test, co-integration test, causality test and VEC model and have found that bidirectional causal relationship exists between the two variables mentioned, implying that electricity consumption and economic growth both cause each other. There exists a co-integrating relationship between electricity consumption and economic growth.

Shahbaz, Khan and Tahir (2013) tested a multivariate framework analysis to investigate the relationship between energy use and economic growth of China using ADRL bounds testing and Granger causality testing. Evidences from this paper provide that there is a unidirectional causal relationship running from energy consumption to economic growth, and bidirectional causality is found to exist

between financial development and energy consumption. The data was collected from the time series of 1971 to 2011.

More papers on Bangladesh economy are found to directly focus on the empirical relationship between remittance and economic growth. However, there are few papers where it is discovered that there may be negative relationship between remittance and economic growth. According to Ahmed (2010), remittances received by Bangladesh are found to have a negative impact on the economic growth and it does not appear to be a significant source of capital for economic development. His period of study was between 1995 to 2006 using unit root test and co-integration test. A similar result on Bangladesh has been found which states that initially remittance reduces the per capita GDP growth rate but eventually improves economic growth rates (Hassan and Shakur, 2017). They have statistically proved that remittance may only affect Bangladeshi economy depending on the level of financial development.

Remittances are also found to have a mixed effect on the economic growth in the short run by another empirical literature (Kumar & Stauvermann, 2014). These researchers studying the period of 1979-2012 have noted that in the long run, the effect is positive on the output per worker. From the Granger causality test, bidirectional causality is found between remittances and output, and a unidirectional causality running from capital to remittances. Therefore, remittance and GDP both influence each other in the long run, supporting the initial hypothesis.

The empirical evidence from Egypt represented by Sharaf (2014) shows that remittances and GDP are co-integrated, and that remittance is statistically significant and positively influences GDP. With the help of unit root test, co-integration test, ADRL bounds test, and VEC model conducted on data from he time period 1977-2012, this paper provides the conclusion that remittances improve the economic conditions of the recipients.

Remittance plays a significant role in consumption of households (Demurger & Wang 2016; Haider, Hossain&Siddiqui2016). In addition to that, Demurger and Wang (2016) have analyzed that remittances lead to a rise in consumption of households rather than a rise in the investment level in the case of China for the year 2007. They have used propensity score matching framework to conduct their study. On the other hand, Haider, Hossain and Siddiqui (2016) have used hypothesis testing and path model analysis to prove that remittance received in the selected rural areas of Bangladesh has a statistically significant positive impact on consumption expenditure with respect to the savings.

Bettin, Presbitero and Spatafora (2014) investigated on data over the time series of 2005-2011 to address the vulnerability of remittance on 107 developing countries. They have discovered that the remittance recipient countries face a negative correlation between remittance and business cycle. However, remittance is found to be positively correlated with economic conditions of the countries the remittance is coming from, i.e. source province. Thus, their findings suggest that remittance positively impacts financial development in source province and negatively impacts financial development in the recipient country.

3. Overview of Bangladesh

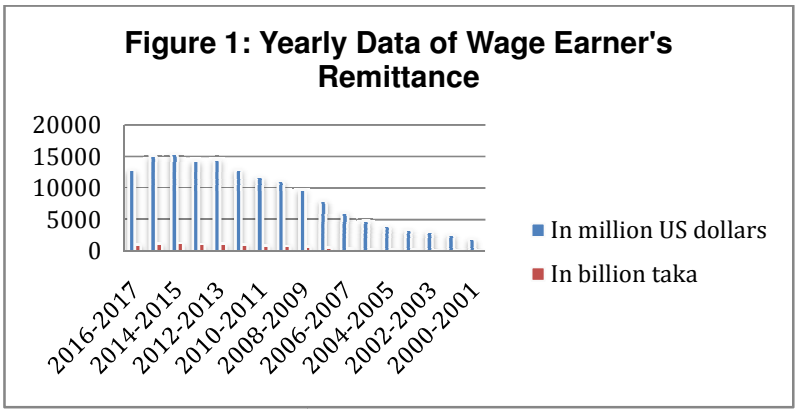
As an overpopulated developing country, Bangladesh has been experiencing a substantial economic growth throughout the years. The upward trend of the GDP growth rate of Bangladesh reached to a rate of 7.1% in 2016 (CPD 2017). The GDP rate has remained above 5% in the last decade mainly due to the rise in net exports by the garments industries, international remittances, and development in micro-credit and the agricultural sector. With the population of about 163 million people, 31.5% of them are still living under the poverty line (Sulaiman & Misha 2016). Even though there is a persistent rise in the annual growth rate, the demand for energy use and the growing size of the economy are both increasing day by day. This section discusses the remittance sector and the energy sector of Bangladesh.

3.1 Remittance Sector of Bangladesh

Bangladesh is one of the developing countries that has a moderately upward trend of overseas employment since 1970, and the economy is fairly dependent on remittance received into the economy increasing the GDP, balance of payment and the foreign exchange reserves (Khairun, 2015). A major source of external fund for Bangladesh is the inward remittance exceeding the size of FDI and ODA received by the country as discussed earlier. According to the estimates made in a study by Akter (2016), workers' remittance was 'nine times greater than FDI, twenty-five times higher than portfolio investment, and four times higher than ODA' in Bangladesh during the period 2014-2015. This signifies that remittance has the potential to augment the economic development with its high share of external fund inflow.

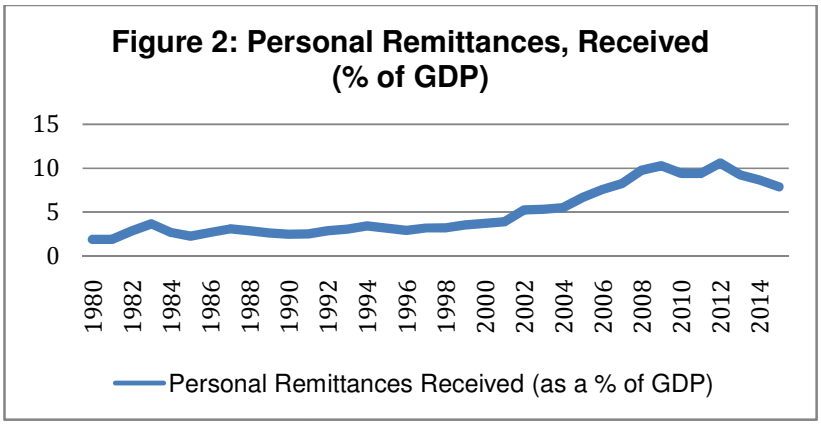
Data from 2015 propose that Bangladesh stood as one of the top ten remittance recipient countries in the world receiving around 15 billion US dollars (World Bank Factbook 2015). Previously in the fiscal year 2014, Bangladesh was the 8th largest remittance receiving country in the world (World Bank 2014). It can be profoundly stated that one of the major sources of financial inflows for Bangladesh is international remittance over the past few years. As for migration, a number of 6078 workers initially migrated for employment in overseas from the year 1976, and the number reached to annual migration of about 0.2 to 0.3 million (Islam 2010). This calculates to around 200,000 or more citizens immigrating overseas in search of work (BMET 2015). A part of their earnings is sent back home to their families on a regular or irregular basis through official and unofficial channels. Sources from BMET also state that Bangladesh has sent more than 10 million workers, both skilled and unskilled, to 143 countries until May 2015.

Most of the remittance mainly come from the Middle East such as Saudi Arabia, UAE and Kuwait followed by industrialized countries such as USA and UK and so on (Bangladesh Bank 2016). The economy is now receiving international remittances from these migrant workers at a level of $14.9 million US dollars in 2015-2016 (Bangladesh Bank 2016). It is found that yearly remittance received in terms of national currency accounts to 1189.93 billion taka in the period 2014-2015 illustrated in the chart below. However, in the recent years remittance inflow has been following a downward trend after the short rise of 7.65% in the fiscal year 2014-2015.



Source: (Complied from Bangladesh Bank, 2016)

A moderate amount of the GDP of Bangladesh is contributed by the personal remittance the economy receives from the immigrant workers. The remittance received as a percentage of GDP in 2012 was 10.6% which fell down to 7.9% in the year 2015 according to data from the World Bank (2017).



Source: (Compiled from World Bank Data, 2017)

The fall in remittance may have taken place due to factors such as fewer job opportunities for migrants in the Golf Cooperation Countries (GCC) countries, and as mentioned before, most of the remittance throughout many years had previously been coming from Saudi Arabia and UAE who are part of the GCC countries. Migrants have returned back to Bangladesh due to departures and deportation for illegal stay which explains the downfall in the total remittance in recent years (Dhaka Tribune 2014). Another potential reason for a fall in remittance could be due to the appreciation of taka against dollars in 2013 making taka more expensive and failing to make the same investment as planned in the home country (World Bank 2014). It is generally assumed that migrants use savings from the remittance to make local investments specially when the economy is booming.

Remittance could have shown larger figures if Bangladesh was rich in human resources and skilled labours. Most of the labours who are migrating overseas are unskilled and working for a very small salary, and a part of the salary is sent back to the home country. Remittance would have been twice its figure if the migrants were better skilled (Khairun 2015). Since remittance has a multiplier effect actively playing

in the economy, the deterioration in this sector must be strictly scrutinized to attain economic growth in the long run.

3.2 Energy Sector of Bangladesh

Since Bangladesh is facing an average economic growth rate of 7%, it plays an essential role to have better access to commercial power and energy in order to raise the economic growth, poverty alleviation and social development (Amin & Rahman 2011). The infrastructure of Bangladesh is moderately small compared to the economy, and it is not enough to meet its targeted demand. According to the study of Power System Master Plan (PSMP 2010) of the Bangladesh Power Development Board (BDPB), the forecasted demand for the year 2015 was 10,283 MW and by 2025, it is forecasted to reach to 25,199 MW. This means that the electricity infrastructure is required to be developed and maintained to meet the demand. The rapid urbanization throughout the decade driven by the stable economic growth has led to a huge demand of energy.

Electricity is the most widely used form of energy in Bangladesh, and the future economic growth is significantly dependent on electricity. The present installed electricity capacity in Bangladesh is trying to cope with the growing demand with the help of new power stations permitted by the government (Bangladesh – Power & Energy 2017). The favourable government policies have encouraged electricity generation through private investments and Independent Power Producers (IPP) who are currently producing 46% of the total electricity power in Bangladesh (BIDA 2015).

Table 2: Projected Production of Electricity 2015-18

Year	2015	2016	2017	2018	Total
Government sector	848	885	2020	1397	5150
Private Sector	1110	428	630	630	2798
Total	1958	1313	2650	2027	7948

Source: Bangladesh Open Data, 2017 (www.data.gov.bd)

The power plants of Bangladesh are heavily dependent on natural gas and it has been accounted for about 81% of the energy production serving as the main source in 2011 (Gunatilake & Roland-Holst 2016). As noted by BPDB, 8430 MW were generated using 337.4 BCF natural gas in the fiscal year 2014. The government of Bangladesh plans to reduce the dependence on natural gas as the frequent usage of gas over the years has resulted in fast depletion of gas reserves in the economy, and the present reserve may not be sufficient enough to support the country for long term economic growth (Islam 2011). The projected plan is to generate 50% of total electricity using coal-based power plants by the year 2030 (Bangladesh – Power & Energy 2017). According to data collected by the World Banka Indicator (WDI), electricity production from coal sources account to just around 3% which means that this source can be extensively used for power generation in future.

On the other hand, Bangladesh has been importing around 500MW of electricity from India, and plans to import from potential countries such as Bhutan, Burma and Nepal in the future since these neighbouring countries are rich in hydroelectric generation (Ministry of Finance 2014). Even though Bangladesh is rich in natural

reserves, small oil reserves untapped coal fields which have been discovered, it fails to utilize all of its resources efficiently due to lack of skills and development (Islam & Khan 2017). The grid infrastructure of the economy is poorly handled, and the power cuts and low reliability of power supply results to an adverse effect on the production capacity. The total number of consumers who have access to electricity via grid extensions accounts to 21.8 million that includes approximately 50% of the households receiving grid electricity and the government plans to connect 98% of households through grid extensions by 2021 (BDPB 2017).

However, this plan may not be too realistic as for the financial constraints, inaccessibility and low consumer density in many rural areas. Renewable energy such as solar energy may be able to play a significant role for off-grid electrification. Bangladesh Investment Development Authority (BIDA) states that a large scale Solar Home System (SHS) project has been implemented targeting to produce 2000 MW by 2021. Other sources of renewable energy such as biogas and biomass are expected to have a high capability in progressive usage specially in the rural areas.

Even though the per capita production of commercial energy increased since 2010, it is still one of the lowest in the world. Energy consumption per capita is .23 tonne of oil equivalent with 330 kWH of electricity for the year 2015. The economy's total consumption has risen by around 5% per year since 2000 where gas is the main source of energy (PSMP 2016). Data from the World Bank also shows an upward trend of energy use per capita accounting to 222.22 in year 2014.

4. Methodology and Data Set

To evaluate the influences between remittances and energy consumption in both short run and long run, a number of econometric tests have been carried out using the software Eviews 7.0.

The unit root test is carried out to check whether the variables are stationary or not since financial and macro variables tend to be non-stationary. The Augmented Dickey Fuller (ADF) test, which is the cointergration test, is then carried out to test any presence of unit root where it is discovered that some of the variables are non-stationary and regression cannot take place until they are made stationary. It is thus used to find any possible linearity of the variables which could be considered to be stationary.

Once cointegration is found to exist between the variables, the Granger Causality test is run to check the possible direction of causality. A non-stationary data may lead to a spurious regression in time series analysis unless there exists at least one cointegrating relationship.

In order to test the cointergration, the Johansen test is carried out. This test is known to deliver a unified framework for estimation and cointegration testing with regards to Vector Autoregressive (VAR) error correction models. For this approach, an Unrestricted Vector of Autocorrelation of the following form is required to be estimated:

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

where Δ = the difference operator
$x_t = (n \times 1)$ vector of non-stationary variables (in levels)
$u_t = (n \times 1)$ vector of random errors

The matrix θ_k grasps the long run relationship between variables. If the rank of $\theta_k = 0$, the variables are not cointegrated. However, if rank which is usually denoted by r is equal to one, one cointegrating vector will exist and finally if $1 < r < n$, there will be multiple cointegrating vectors.

The Johansen cointegrating test has 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 .

When two variables in the cointergration analysis are cointegrated, there is at least one direction of causality. Granger-causality is one of the important issues that has been much studied in empirical macroeconomics and empirical finance. Engle and Granger (1987) have denoted that misleading conclusions can be drawn due to the existence of non-stationary in the Granger causality test. Only when the variables are cointegrated, it is then possible to infer a causal long run relationship between non-stationary time series.

Suppose y and x are the given variables, 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 cause 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 Remittance, Energy Consumption, Economic Growth, Industrialization, and Financial Development 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 F-statistics are the Wald statistics for the joint hypothesis $\beta_1 = \beta_2 = \beta_3 = \cdots = \beta_l = 0$

Lastly, **Vector Correction Error Model (VECM)** is conducted to find out the short run scenario of our variables. A possible limitation of the Granger causality tests us that it only shows the long run causal relationships but not for the short run.

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

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

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

z_{t-1} is the error-correction term which is the lagged residual series of the cointegrating vector. The error-correction term measures the deviations of the series from the long run equilibrium relation. For example, from equation (i), 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 cases 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 used to interpret the short run causal impact while the error-correction term adjusts Y and X leading to their respective long run equilibrium.

Thus, the VECM representation allows us to differentiate between the short-run 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.

As mentioned previously, this paper studies the long run relationship and the direction of causality between remittance and energy consumption of Bangladesh. Although numerical representations of the relationships among remittance, GDP and energy use are possible, a simple linear function in this study has been considered based on considerations of simplicity. The measure of GDP per capita at constant US currency can be considered as the indicator of the economic development. All the variables used in this study have been drawn out from World Development Indicator (WDI) 2017 which is published by the World Bank. For remittance, data available on personal remittance has been used and for energy consumption data on the energy use (kg of oil equivalent per capita) is used to conduct the econometric calculations. It should be mentioned here that this research concentrates over the period 1980-2015 for which there are 35 available observations. However, a small sample size may be challenging to find any long run relationship. The focus of this study is not to develop any new model for the investigation of the causal relationship between remittances and energy consumption, but it is rather to identify the existing linkage between the variables.

5. Results

The following tables below demonstrate the results obtained after conducting the mentioned tests.

5.1 Unit Root Test

In order to determine the order of integration of the data series for each of the variables, unit root tests are conducted for the selected variables. Table 3 below shows the Augmented Dickey Fuller (ADF) statistics of all the variables in their levels and first difference forms.

Unit root tests such as ADF have non-standard and non-normal asymptotic distribution, and as deterministic terms such as constant, time trend, etc are included the test becomes highly influenced. When time trend is included, the power of the test may be decreased. On the other hand, failing to include a time trend if the true data generating process is stationary, the capability of the test will also be reduced. In addition, the loss in power because of elimination of a time trend is more severe than a reduction in the power of the test due to including a time trend when it is unnecessary (Lopez *et al.*2005).

It is very important to select the appropriate lag length while conducting a unit root test. By using the t-test statistics the model can be selected where a long lag length will be included. If the t-statistics using lag p comes out insignificant at some specified critical value, then the regression could be estimated repeatedly using a lag length of p-1 until the lag becomes significantly different from zero. Different lags have been taken to check whether the variables are stationary and they generate homogenous results. This means that the variable are either stationary in their levels or in the first differenced form.

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
Energy Use	1.282694	-2.095293	Non-stationary considering only constant, and stationary considering constant & trend
GDP	7.546805	0.734436	Stationary considering only constant, and non-stationary considering constant & trend
Industry	-0.194029	-2.811686	Non-stationary considering only constant, and stationary considering constant & trend
Broad Money	0.823677	-3.174261	Non-stationary considering only constant, and stationary considering constant & trend
Remittance	0.284424	-1.511619	Non-stationary considering both constant and constant & trend
Panel 2: First Differences			
	ADF Statistics (Only Constant)	ADF Statistics (Constant & Trend)	Decision
Energy Use	-7.398308	-8.068020	Stationary
GDP	Not Applicable as GDP is I(0) considering only intercept	-7.540110	Stationary
Industry	-5.191263	-5.127409	Stationary
Broad Money	-4.777730	-4.752054	Stationary
Remittance	-4.832849	-4.799738	Stationary
Note: All regression is estimated with and without trend. Selection of the lag is based on Schwartz Information Criterion (SIC). EViews 7.0 software automatically selects the most significant lag length based on this criterion.			

From the table above, it can be clearly stated that most of the variables are non-stationary in their levels. GDP is found to be the only stationary variable in its level, but the rest of the relevant variables is found to be stationary in the first differenced

form. In order to make the rest of the variables stationary, the first differences are created to obtain the homogenous result. Since most of the variables are non-stationary, they would yield spurious result unless cointegrated. Thus, the next stage is to proceed to test for cointegration using the Johansen test.

5.2 Cointegration Test

In the Johansen test, it is evident that the null is rejected when the max-eigen statistics or the trace statistics is greater than the critical value of 90%. The following tests for cointergration, including maximum eigenvalue and trace test, confirm that there are at least two cointegrating relationships at the 0.10 level as shown in the tables below.

Table 4: Johansen Test for Cointegration (Trace Test)
Lag Intervals 1

Trend assumption: Linear deterministic trend (restricted)				
Null	Alternative	Statistics	90% Critical Value	Conclusion
r=0	r=1	52.84195	31.23922	At least two cointegrating relationship at the 0.1 level
r≤1	r=2	27.23463	25.12408	
r≤2	r=3	24.90757	18.89282	
r≤3	r=4	4.521389	12.29652	
r≤4	r=5	1.024094	2.705545	

Table 5: Johansen Test for Cointegration (Maximum Eigenvalue Test)
Lag Intervals 1

Trend assumption: Linear deterministic trend (restricted)				
Null	Alternative	Statistics	90% Critical Value	Conclusion
r=0	r=1	90.52964	65.81970	At least two cointegrating relationship at the 0.1 level
r<1	r=2	47.68769	44.49359	
r≤2	r=3	29.45306	27.06695	
r≤3	r=4	5.545483	13.42878	
r≤4	r=5	1.024094	2.705545	

Table 4 shows the result of the trace test confirming at least two cointegrating vectors while the maximum eigenvalue test in table 5 suggests at least one cointegrating vector. Both tests provide that cointegration exists among the variables. In other words, there is a long run equilibrium relationship between the selected variables. Since all the series are I(1) and cointegrated, causality in at least one direction can be expected.

5.3 Causality Test

Next, the Granger causality test has been conducted to describe the causal relationships between the variables. It is done for two different lags (lag 1 and lag 2) to check robustness. The results of lag 2 are demonstrated in the following table

Table 6: Granger Causality Tests (Lags 2)

Hypothesis	F-Statistics	P-Value	Granger Causality
LREM does not Granger Cause LEU	5.13729	0.0123	Unidirectional Causality LREM -> LEU
LREM does not Granger Cause LGDP	4.2678	0.0237	Bidirectional Causality Remittance and GDP both cause each other
LGDP does not Granger Cause LREM	3.19089	0.0559	
LREM does not Granger Cause LIND	5.85304	0.0073	Unidirectional Causality LREM -> LIND
LREM does not Granger Cause LM2	7.6836	0.0021	Unidirectional Causality LREM -> LM2

The results obtained from the test shows that there exists a unidirectional causality running from remittances (LREM) to energy consumption (LEU). A bidirectional causality between remittance (LREM) and economic growth (LGDP) is reported to exist. We also found a unidirectional causality running from remittance to industrialization (LIND), and remittance to financial development (LM2). This means that remittance influences energy uses in Bangladesh in the long run.

5.4 Vector Error Correction Model

Finally, from the Vector Error Correction Model test we have tried to investigate whether there is any short run causality within the control variables.

Table 7: VECM Test Results

Dependent Variable	Null Hypothesis	Chi-Square Statistic	Prob. Value	Conclusion
EU	Remittance does not cause Energy Use	3.340763	0.1882	No Causality
REM	Energy use does not cause Remittance	3.595826	0.1656	No Causality

Table 8 as shown above confirms that we have failed to find any causality between remittance and energy use in the short run. However, as mentioned earlier, there exists unidirectional causality in the long run. We have found similar results for

renewable energy consumption in Bangladesh which indicates that remittance causes renewable energy consumption in Bangladesh in the long run.

The long run results of this study replicate findings of Akçay and Demirtaş (2015) who concluded that a unidirectional causality between remittance and energy consumption directly both in the long run and short run. The possible ways for remittance to attain a long run impact on energy consumption may be through the multiplier effect channelling through financial development and industrialization. When remittance is received, part of it is generally known to be invested which therefore boosts the industrial sector. Standard of living rises with a rise in remittance and access to credit which contributes to the financial development.

6. Conclusion and Policy Recommendations

According to previous studies and literature, remittance has been associated with various macroeconomic variables. Bangladesh is one of the top remittance-receiving developing countries and the results of a number of previous studies offer both positive and negative impacts of remittance on the economic growth and GDP based on their empirical findings. However, linking remittance and energy consumption is relatively a new idea and it has been first analyzed in one study based on the Moroccan economy to the best of our knowledge (Akçay&Demirtaş 2015). The research gap on the nexus between remittance and energy consumption especially in the context of Bangladesh motivated the present study. This research searches for the cointegration and causality between remittance and energy consumption within a multivariate model in Bangladesh using data from the time series of 1990-2015.

Our empirical results imply that there is an existence of cointegration between remittance, energy use, industrialization, financial development and economic growth of Bangladesh obtained from ADF statistics and Johansen test. The short run causality test results indicate that there is no causality between remittances and energy consumption, signifying that energy use of Bangladesh is not dependent on the capital received from remittance in the short run. The long run results obtained from Granger casualty test indicate that there is a significant unidirectional causality running from remittance to energy consumption; remittance to industrialization; remittance to financial development and a bidirectional causality between remittance and economic growth. Thus, our findings infer that remittance influences energy consumption in the long run through industrialization, financial development and thus economic growth supporting the multiplier effect of inward remittance.

This unidirectional causality revealed in this study suggests that Bangladesh should maintain favourable policies to increase or stabilize the remittance inflow into the country and strengthening official sources of remittance. Recently the remittance received as a percentage of GDP in Bangladesh has declined by 11.1 % from the year 2015 (World Bank 2017) and this drop may affect the energy consumption through industrialization and financial development in the long run.

The cost of remittance transfer services are often high which allows money entering the economy in illegal channels and government must have strict supervision and encourage money to be transferred legally. Bangladesh can also reduce the transfer cost by reducing taxation and providing a more flexible access to financial inclusion.

Productive use of remittance must be channelled through businesses and investments boosting the local economy followed by overall growth. Also, to prevent any exhaustion in the energy consumption of the economy, government should also take steps to ensure efficient use of energy.

Future research could involve in revealing the causal relationship between remittance and energy consumption among the South Asian countries using panel data and observations.

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