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Examine the Empirical Relationship between Energy Consumption and Industrialization in Bangladesh: Granger Causality Analysis

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ABSTRACT

The current study examines the empirical relation between energy consumption and industrialization concerning other macroeconomic variables like as infrastructure, manufacturing, and capital formation with covering the period from 1975 to 2018. The Johansen co-integration estimation asserts the long-run association in this process. Whatever granger causality shows the bidirectional causality between electricity consumption and industrialization. Capital formation and industrialization have the bidirectional causality also. A unidirectional causality exists between oil and industrialization where manufacturing and industrialization have bidirectional causality. The estimated result of the error correction mechanism (ECM) shows the speed of long-run equilibrium at 45% within the time. The ECT has been significant at a 1% level with a pessimistic sign. The assistances of this attempt ensuring the importance of energy use and energy supervision in the aspect of industrial enlargement with making an allowance for the other macroeconomic indicators.

Keywords: Industrialization, Energy, DOLS, Granger Causality
JEL Classifications: O13, 014, P18, Q43

1. INTRODUCTION

At present, energy plays a vital role in the world economy. Industrialization in Bangladesh is one of the major burning issues in the South Asian economy due to the rapid growth of the industrial and services sectors (Alam et al., 2019), (Pan et al., 2019). Industrialization is a process that happens in countries when they start to use machinery to do work that way once done by people. It is a way of diversification of human group as of agriculture sector to industrial sector with involving the widespread reorganization of an economy for manufacturing, infrastructure, energy utilization, and production (Barro, 2006), (Ali and Memon, 2019) (Mehmood and Hunjra, 2019). The diversification of industrialization in Bangladesh has explained the leave of the agricultural sector to the industrial sector and started to do jobs in factories at a high wage which gives the evidence of rapid industrialization and urbanizations.

After the liberation war of 1971, the industrial development of Bangladesh was very poor. Table 1 presents that Industry value-added in GDP (Annual %) in 1975 was 11.61% where the service sector was 26.43%. In 2015 and 2018 the industrial contributions increase to26.83 and 28.54 respectively. The GDP growth rate was extremely poor after independence. In 1975 it was a negative growth rate of –4.09%. Whatever, at present in the 2018-19 and 2019-2020 fiscal years, it increases to 7.86% and 8.13% respectively. Urbanization is the additional result of rapid industrialization. In 1975 people's lives in urban areas were 9.84%. The rate increased more than twice in 1990. In 2018 the

Table 1: Major development needles of Bangladesh economy

Indicators	1975	1990	1995	2000	2005	2010	2015	2018
Population (millions)	72.27	100.73	119.86	132.38	143.13	151.12	157.9	161.4
Population G. R (Annual)	1.93	2.46	2.11	1.84	1.34	1.08	1.13	1.0488
GDP Per Capita ($ US)	268.4	280.57	316.51	355.97	421.12	762.8	1385	1906.0
GDP G. R (Average. Annual %)	-4.09	5.94	4.92	5.94	5.95	5.57	6.55	8.13
Industry value added in GDP (annual %)	11.61	20.14	23.58	22.27	23.29	24.95	26.83	28.54
Urban population (% of total)	9.84	19.81	21.69	23.59	26.8	30.46	33.5	38.85
Service sector value added in GDP (annual %)	26.434	46.700	45.128	50.566	52.879	53.498	53.713	52.96
Poverty rate (% of total population)		58.6		48.9	40	31.5	24.3	21.8
Human development index value	n/a	0.386	0.423	0.468	0.506	0.545	0.579	0.614

Source: WDI (2019), BBS (2019), BB (2019)

rate of urban population increases to 38.85%. The reduction of poverty rate decreases significantly and the HDI index increase concerning time in Bangladesh (Baniamin, 2019).

The ready-made garments (RMG) sector started during the liberation period and now becomes a successful one (Hasan et al., 2018), (Chowdhury et al., 2014; Majumder and Ferdaus 2020). Besides ICT development and the pharmaceutical industry also have positive growth. Industrialization is a part of a wider transformation route with the progress of larger-scale productions based on energy expenditure. Energy consumption is the amount of energy or power used in the production and nonproduction sectors. Whatever the electricity, natural gases, coal, and oil are the main source of energy sectors to the expansion of industrial productions. The demand for energy largely in industrial areas like EPZ, heavy industrial zone, and shipbreaking industry also used energy resources (Ferdaus et al., 2020 and Uddin et al., 2019).

Therefore, we prepare the following objectives that confirm the findings of this study. The main intention of this cram shows the relationship between energy consumption and rapid industrialization in Bangladesh.

1.1. Specific Objective

i. To measure the impact of electricity and oil consumption on rapid industrializations in Bangladesh
ii. Examining the Impact of, how energy consumption works with infrastructure, manufacturing, and capital formation to accelerate industrialization
iii. To estimate the long-run relations and causality among the working variables.

The logical statement is that it is necessary to investigate how the energy use accelerates the industrializations rapidly with efficient contributions in the GDP growth rate. The regulatory authority can observe the importance and effective use of energy resources to the expansion of industrial activities. The current study will follow the structure as the literature section present in Section 2. Theoretical overview present in segment 3. Section 4 explains the methodology of the study. Part 5 has presents the econometric results and explanation. In section 6 represent the crucial findings and finally draw a summary and conclusion in the last section.

2. LITERATURE REVIEW

The relevant literature is examined in Table 2. The current study examines the long-run relationship between energy consumption and industrializations in Bangladesh concerning other macroeconomic variables like as infrastructure, manufacturing, and capital formations. Most of the researchers examine the relationship between energy consumption GDP growth rates with an effect on carbon emission. No one examines the impact of energy use on industrialization by considering other macroeconomic variables by using the unique methodology.

2.1. Hypotheses Development

The examinations of those kinds of hypotheses have been presented in Table 12 which consequences are analyzed based on empirical findings. Whatever, those hypotheses are implicated as the null hypothesis. Those statements are presenting in the following section:

H_1: There is no optimistic and significant relationship between energy consumption and industrialization
H_2: There is a negative relationship between manufacturing and industrialization
H_3: Capital formation does not promote industrialization
H_4: There is no positive and significant relation between infrastructure development and industrialization.

The first hypotheses assume the energy consumption does not accelerate rapid industrialization in Bangladesh. This study has preferred to reject the hypothesis with cooperating the economic theory and practices. Besides the energy sector has been dominated by industrial growth and productivity significantly (Mohiuddin et al., 2016), (Ozturk, 2010). H_2 represents there is a negative relation between manufacturing and industrialization. The statement should be rejected because of manufacturing accelerate the industrialization (Ozturk, 2010). The 3rd statement (H_3) presents the capital formation does not promote industrializations where the statement not supportive of economic theory and practices. So the hypothesis should be rejected. The last one presents the negative impact of infrastructure development on industrialization. More infrastructure development can promote more industrialization. This statement has been rejected by (Bjorvatn, 2000), (Veloso and Soto, 2001 and (Bjorvatn, 2000; Veloso and Soto, 2001 and Majumder, 2016).

3. THEORETICAL OVERVIEW

It is commonly known as Bangladesh is a growing developing country in the world. The growth of Bangladesh's economy is highly appreciable in the South Asian region and Bangladesh takes a suitable place in the next 11 countries with a high GDP growth

Table 2: Concise of literature review

Name of author	Type of data, country and duration	The framework of the study	Variables	Results
Akhmat et al. (2014)	Panel data; SAARC countries; 1975–2011	VECM and Granger causality	Energy, GDP, CO_2	Energy discharge accelerate the GDP growth rate and CO_2
Ghosh et al. (2014)	Times series data; Bangladesh; 1972 – 2011	VAR modeling	GDP, Energy, CO_2	Utilizes of energy boost the GDP growth rate and negatory relation between CO_2 and GDP
Ahmed et al. (2013)	Time series data; Bangladesh; 1973-2007	Granger causality analysis	Energy discharge and GDP	Energy consumption cause to GDP growth rate
Rahman and Kashem (2017)	Times series data; Bangladesh; 1972-2011	VAR methodology	Energy, industrialization, and CO_2	Energy and industry pick up the pace of CO_2 emanation.
Lean and Smyth (2010)	Times series data; Malaysia; 1970–2008	VECM; Causality	GDP, electricity, CO_2	Constructive relation between electricity and CO_2, nonlinear relation with output and emission
Shahbaz et al. (2014)	Quarterly; Bangladesh; 1975–2010	ARDL	CO_2, Industrialization, electricity	Long run association and EKC exist between Industrialization CO_2 emanation
Amir (2017)	Panel data; 72 countries; 1990–2012	EKC Hypothesis	GDP, energy, CO_2	Industrialized countries have inverted U shape and developing countries have U shape in case of energy and pollution
Khandker et al. (2018)	Time series data; Bangladesh; 1980–2015	VECM	Renewable energy, FDI	There is bidirectional causality between those variables.
Sarker et al. (2019)	Time series data; Bangladesh; 1981–2017	GLS, Granger causality	GDP, energy consumption	Economic growth and energy have a positive association
Lu (2017)	Panel data; 16 Asian Countries; 1990–2012	Granger causality	GHG, GDP, energy	Bidirectional causality among the variables
Islam et al. (2017)	Time series data; Bangladesh; 1998–2013	VAR framework	GDP, energy, CO_2, industry	Industry and GDP have a significant impact on CO_2 emission. ENC accelerate industrial productivity
Wang et al. (2019)	Panel data; 186 countries; 1993–201	VAR framework	GHG, GDP, energy discharge	Energy consumption increases the economic growth
Nasreen and Anwar (2014)	Panel data; ASIAN countries; 1980–2011	Granger causality	ENC, GDP, trade ope.	Energy and economic enhancement have bidirectional causality

Source: Author's assortment

rate. The GDP growth rate of this country is 8.13% in 2018. It is about more than 6% GGDP growth rate sustain from the last decade. The expansionary GDP growth rate has been sustain due to rapid industrialization, increasing FDI, readymade garments (RMG) industry, foreign remittances, ICT sector, and acceleration of the pharmaceutical industry. Whatever the contribution of energy plays a significant impact on economic growth. The energy demand has been an increase with respect to the expansion of the economy and industrial contribution to the economy.

3.1. Industrial Growth of Bangladesh

Industrialization in Bangladesh has created a new door in this economy. The industrial value-added in GDP has a positive trend since the last two decades. The significance of industrialization in this country depends on the business-friendly environment, transport facilities, and the availability of raw materials in domestic and imported. To analyzing the industrial contribution on GDP in Bangladesh demonstrate that after independence, the contribution of the industrial sector to GDP in 1975 was only 11.61% due to the liberation war and lace of infrastructure and capital. The contribution was significantly increased in 1990 and the volume was 20.14%. Besides, the increase of privatization in RMG and Jute industries increases the contribution to GDP. After trade liberalization in 1991, the industrial sector gets the opportunity to expand rapidly, RMG and pharmaceutical industries are highly extended in this period. In 2005 the industrial contribution has been showing a continuous positive trend with a contribution of 23.29%. The industrial contribution to the expansion of GDP volumes was 26.83% in 2015 and 29.65% in 2019.

3.2. Overview of the Energy Sector

Bangladesh is located in the south of the Bay of Bengal. Besides, Bangladesh gets transit facilities with other countries. But the concern is that Bangladesh is the country affected by climate change because of geographical locations and variations of weather. Natural disorders and climate hazards are vastly affected by the country's economy. Flood and cyclone make losses in production and transport facilities in every year.

Whatever, the concentration of energy reserve is quite poor and has a limited reserve in energy like oil, cole, and measurable gases. There is an internal shortage of energy since 1990. Most of the power plant has been derived by using natural gases. But, the concern is that natural gases are badly needed for the industrial sector due to the unavailability of domestic natural gases. Fossil fuel, natural gas, and coal are the deterministic sources of power production. It is about 62% of electricity has been generated from natural gas consumption, 10% from diesel consumption, about 5% from coal, and only 3.3% for the renewable sources (Bangladesh Petroleum Corporation, 2019).

Besides, the concentration of Bangladesh energy sector uses the electricity product of petroleum, gas, coal, solar, and biomes consumptions. Electricity is the most vital use in this country but the consequence is that there is a gap between electricity demand and supply. The supply of modern energy is badly needed for the growing population and industries. Electricity access in Bangladesh was only 3% after independence. The estimated ration goes up to 59.6% in 2012. In 2016, electricity access accelerated to 76%. Electricity consumption in 2018 was 95%.

Table 3 presents the energy calculation for 2017-18. Results show the heights unit for Oil consumption. LPG has the MTOE 0.5, 12.3 for natural gas. Local coal consumption at this time has 0.6 and imported has 2.1 MTOE. Lowest MTEO has 0.3 for renewable energy.

Bangladesh suffers a crisis of regular power outage, about 3-4 h in rural areas. Sustainability of energy consumption and generation must be needed for industrial development with accelerations of renewable energy consumptions.

4. METHODOLOGY

A current study completed by using secondary time series data. Whatever, the time series data collected from World Development Indicator (WDI) and International Energy Statistics (IES) with covering the period from 1975 to 2018. Here we used the econometric model to measure the nexus between energy consumption and industrialization with considering other macroeconomic variables. The estimated result measured by using the Eviews, data analysis software. In this study estimate the DOLS regression, Wald test for long-run association with estimating the ECM and Granger causality analysis.

4.1. Model Specification

The constructed model is derived by the author self selections. Whatever the estimated model used the variables based on economic theory and practices in the context of Bangladesh's economy. The industrializations are largely depending on capital accumulations, infrastructure, and manufacturing development. The oil and electricity work as the blood of industrialization of an economy. The current study creates uniqueness by the mix of those variables in the aspects of rapid industrializations. The details descriptions of the variables are given in Table 4.

$$Ind=f(Oil, Elec, Manuf, K, Infra) \quad (1)$$

Now, the multivariable econometric model is that:

$$Ind_t = \beta_0+\beta_1 Oil_t+\beta_2 Elec_t+\beta_3 Manuf_t+\beta_4 K_t+\beta_5 Infra_t+\varepsilon_t \quad (2)$$

Table 3: Total energy calculation 2017-2018 (MTOE)

Energy name	Unit	MTOE
Oil (crude+refined LPG in K ton)	6948	6.9
LPG	554	0.5
Natural Gas	961	12.3
Coal (local KT)	923	0.6
Coal (imported KT)	3325	2.1
Electricity (imported MW)	625	0.5
Renewable energy	350	0.3

Source: BPC, 2019. MTOE: Metric ton of oil equivalent

The log transformation has been taken by equation 3.

$$LnInd_t=\beta_0+\beta_1 LnOil_t+\beta_2 LnElec_t+\beta_3 LnManuf_t +\beta_4 LnK_t+\beta_5 LnInfra_t+\varepsilon \quad (3)$$

Where,

β_0 is the intercept term

β_1, β_2, β_3, β_4, and β_5 are the slope coefficient. The ε is present the residual, and t present the time.

4.2. Unit Root Test

In time series estimations explain unit root has a problem where the data series have inconsistent mean value and variance has unstable (Perron, 2009), (Maddala and Wu, 1999). Time series of a linear stochastic explains that if we assume 1 present a unit root of a stochastic process and present the H_0. If the assumption takes root inside the 1 and less than 1 of a nonnegative constant (absolute value) whatever, taking the first differences then this process has been stationary.

Consider a discrete-time stochastic process,

$$[y_t, t=1,\ldots..\alpha] \quad (4)$$

And suppose that it can be written as an autoregressive process of order p:

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots\ldots\beta_p y_{t-p} = \varepsilon_t \quad (5)$$

Here, $\{\varepsilon_t, t = 0, \alpha\}$ is a serially uncorrelated, mean zero stochastic process with constant variance σ^2. For convenience, assume $y_0 = 0.ifM = 1$ If is a root of the attribute equation as

$$\{m^p - m^{p-1}\beta_1 - m^{p-2}\beta_2 - \ldots\ldots - \beta_p = 0\} \quad (6)$$

Then the estimated stochastic progression has a stationary in characteristics.

Whatever, the ADF unit root process gives the equation:

$$\delta Y_t = \vartheta_1 + \vartheta_{2t} + \varphi(Y_{t-1}) + \alpha_t \sum_{i=1}^{f} \delta Y_{t-1} + \varepsilon_t \quad (7)$$

Where; ε_t is an error component and ADF δYt–1 is the criteria of lagged of the stochastic process to take stationary of time series.

4.3. Johansen Co-integration Test

One of the important aims of this study is to investigate the long-run relationship among those selected explained and explanatory variables. The variables are industry value-added in GDP, oil, electricity, capital, infrastructure, and manufacturing. The system in the equation can be presented as follow:

$$Z_t=\alpha_0+c_i I_t+d_i O_t+e_i K_t+f_i E_t+g_i In_t+h_i M_t+\varepsilon_t \quad (8)$$

i=1,2,3…N; t=1,2,3,……..T

The likelihood and track test proposed by Johansen (1988) has been used to implementing the estimation for the co-integration results.

4.4. Granger Causality Analysis

Engle and Granger (1987) (Engele and Granger, 1987) developed a causality based error correction model (ECM). Whatever the experiment follows two steps as short run and long-run dynamics. The first step of the following six equations demonstrates the long run with the divergence of residual correspondence which is known as the speed of adjustment or moves towards the equilibrium. In the second stem determine the short-run dynamics of parameters. The ensuing equations have been used in agreement with the Granger causality test.

$$\Delta Z_{1,t} = \varphi_{1,t} + \sum_{k=1}^{g} \varphi_{1,1,k} \;.\Delta\gamma_{1,t-k} + \sum_{k=1}^{g} \varphi_{1,2,k} \;.\Delta\gamma_{2,t-k} + \sum_{k=1}^{g} \varphi_{1,3,k} \;.\Delta\gamma_{3,t-k} + \sum_{k=1}^{g} \varphi_{1,4,k} \;.\Delta\gamma_{4,t-k} + \sum_{k=1}^{g} \varphi_{1,5,k} \;.\Delta\gamma_{5,t-k} + \vartheta_1, ECT_{t-1} + \varepsilon_{1,t} \quad (9)$$

$$\Delta\gamma_{1,t} = \varphi_{2,t} + \sum_{k=1}^{g} \varphi_{2,1,k} \;.\Delta\gamma_{1,t-k} + \sum_{k=1}^{g} \varphi_{2,2,k} \;.\Delta\gamma_{2,t-k} + \sum_{k=1}^{g} \varphi_{2,3,k} \;.\Delta\gamma_{3,t-k} + \sum_{k=1}^{g} \varphi_{2,4,k} \;.\Delta\gamma_{4,t-k} + \sum_{k=1}^{g} \varphi_{2,5,k} \;.\Delta\gamma_{5,t-k} + \vartheta_1, ECT_{t-1} + \varepsilon_{2,t} \quad (10)$$

$$\Delta\gamma_{2,t} = \varphi_{3,t} + \sum_{k=1}^{g} \varphi_{3,1,k} \;.\Delta\gamma_{1,t-k} + \sum_{k=1}^{g} \varphi_{3,2,k} \;.\Delta\gamma_{2,t-k} + \sum_{k=1}^{g} \varphi_{3,3,k} \;.\Delta\gamma_{3,t-k} + \sum_{k=1}^{g} \varphi_{3,4,k} \;.\Delta\gamma_{4,t-k} + \sum_{k=1}^{g} \varphi_{3,5,k} \;.\Delta\gamma_{5,t-k} + \vartheta_1, ECT_{t-1} + \varepsilon_{3,t} \quad (11)$$

$$\Delta\gamma_{3,t} = \varphi_{4,t} + \sum_{k=1}^{g} \varphi_{4,1,k} \;.\Delta\gamma_{1,t-k} + \sum_{k=1}^{g} \varphi_{4,2,k} \;.\Delta\gamma_{2,t-k} + \sum_{k=1}^{g} \varphi_{4,3,k} \;.\Delta\gamma_{3,t-k} + \sum_{k=1}^{g} \varphi_{4,4,k} \;.\Delta\gamma_{4,t-k} + \sum_{k=1}^{g} \varphi_{4,5,k} \;.\Delta\gamma_{5,t-k} + \vartheta_1, ECT_{t-1} + \varepsilon_{4,t} \quad (12)$$

$$\Delta\gamma_{4,t} = \varphi_{5,t} + \sum_{k=1}^{g} \varphi_{5,1,k} \;.\Delta\gamma_{1,t-k} + \sum_{k=1}^{g} \varphi_{5,2,k} \;.\Delta\gamma_{2,t-k} + \sum_{k=1}^{g} \varphi_{5,3,k} \;.\Delta\gamma_{3,t-k} + \sum_{k=1}^{g} \varphi_{5,4,k} \;.\Delta\gamma_{4,t-k} + \sum_{k=1}^{g} \varphi_{5,5,,k} \;.\Delta\gamma_{5,t-k} + \vartheta_1, ECT_{t-1} + \varepsilon_{5,t} \quad (13)$$

$$\Delta\gamma_{5,t} = \varphi_{6,t} + \sum_{k=1}^{g} \varphi_{6,1,k} \;.\Delta\gamma_{1,t-k} + \sum_{k=1}^{g} \varphi_{6,2,k} \;.\Delta\gamma_{2,t-k} + \sum_{k=1}^{g} \varphi_{6,3,k} \;.\Delta\gamma_{3,t-k} + \sum_{k=1}^{g} \varphi_{6,4,k} \;.\Delta\gamma_{4,t-k} + \sum_{k=1}^{g} \varphi_{6,5,,k} \;.\Delta\gamma_{5,t-k} + \vartheta_1, ECT_{t-1} + \varepsilon_{6,t} \quad (14)$$

Note: Δ is present the change, k is nonnegetive constant, t is time and ε is the residuals.

Where, Z:*Ind*, γ_1:*Elec*, γ_2: *Oil*, γ_3: *Infra*, γ_4: *Manuf*, γ_5: *K*

5. THE ECONOMETRIC RESULT ANALYSIS

Descriptive statistics presented in Table 5. These statistics have been presented with considering the mean, median, minimum values, maximum values, std. dev., skewness, and J-B statistics. The J-B statistics represent the normality assumptions with the significance level. The statistics have demonstrated the consistency of each variable and there are no spurious calculations in this data series.

Outcomes of Table 6 present the estimated unit root result. The nominal hypothesis is the series have unit root and the alternative hypothesis is there is no unit root in series or the variables have stationary. Whatever, the selected variables reject the null after taking the first difference meaning that the variables are stationary at first differences. So the estimated result gives the evidence of I (1) is the order of integrations.

Johansen co-integration test result has been presented in Table 7. The estimated outcomes consider the likelihood or Eigenvalue and trace statistics criteria with 0.05 critical values. The tract statistics suggest that the first two hypotheses have the long run co-integrating liaisons with Industry value-added in GDP is defined as industrializations. The empirical results reject the null hypothesis of no cointegration. The result supports the long-run effects of energy consumption (Proxies by oil, electricity), manufacturing, infrastructure, and capital formation on industrialization in Bangladesh.

The estimated DOLS regression result is present in Table 8. The estimated outcomes demonstrate that manufacturing sectors and industrializations have positive relations. A consistent enhancement in the manufacturing sector accelerates the rapid industrializations. One unit manufacturing increase then the output of industrialization increase by 0.68 percent. The result is a positive and significant 1% level. The energy use as like oil and electricity explains that, oil consumption support increasing the industrializations. Whatever, the findings have been similar to (Rahman and Majumder, 2020). One percent of oil consumption increases the industrializations at 0.21 percent. On the other hand, Electricity consumptions also have a positive sign to accelerate the rapid industrialization. The efficient availability of electricity increases industrial productivity (Ahamad and Islam, 2011). Capital accumulation is the vital source of industrial development. The expansions of capital one more unit can help to increase the industrializations at 0.10 percent and the result is significant at a 5% level. The infrastructure shows a negatory relation on industrial development. The DOLS regression has

Table 4: The details of selected variables

Variables	Details
Ind	Industry (including construction), value added (% of GDP)
Menuf	Manufacturing, value added (% of GDP)
Infra	Fixed telephone subscriptions (per 100 people)
Oil	Energy use (kg of oil equivalent per capita)
Elec	Electric power consumption (kWh per capita)
K	Gross capital formation (% of GDP)

Table 5: Descriptive statistics

	LnInd	LnInfra	LnManuf	LnK	LnOil	LnElec
Mean	3.054	–1.285	2.636	2.942	4.893	4.249
Median	3.094	–1.455	2.667	2.932	4.858	4.282
Maximum	3.270	–0.101	2.810	3.353	5.404	5.738
Minimum	2.452	–2.475	1.952	1.816	4.547	2.832
Std. Dev.	0.174	0.737	0.175	0.338	0.255	0.916
Skewness	–1.593	0.151	–2.158	–1.086	0.523	0.026
Kurtosis	5.678	1.686	7.917	4.416	2.121	1.763
Jarque-Bera	28.88***	53.029	71.33***	11.21***	3.109	2.557

1% significance level denoted by ***

Table 6: ADF unit root test results

Variables	At level		At first difference	
	t-Statistic	Prob.	t-Statistic	Prob.
LnInd	–2.958	0.156	–11.027***	0.000
LnManuf	–3.024	0.138	–10.127***	0.000
LnInfra	1.115	1.000	–4.808***	0.002
Lnoil	–0.939	0.942	–9.119***	0.000
Lnelec	1.449	1.000	–6.434***	0.000
Lnk	–2.223	0.465	–9.899***	0.000

1% significance level denoted by ***

Table 7: Johansen co-integration test results

Hypothesized No. of CE (s)	Eigen value	Trace Statistic	0.050 Critical value	Prob.**
None*	0.859	150.170	95.754	0.000
At most 1*	0.584	73.655	69.819	0.024
At most 2	0.442	39.408	47.856	0.244
At most 3	0.231	16.643	29.797	0.666
At most 4	0.113	6.393	15.495	0.649
At most 5	0.043	1.704	3.841	0.192

*Point out 5% significance level

Table 8: DOLS regression results

Variables	Coefficient	Std. Error	t-Statistic	Prob.
	LnInd (dependent variable)			
LnElec	0.15***	0.022	6.96	0.00
Lninfra	–0.07***	0.02	–3.37	0.00
LnK	0.10**	0.04	2.41	0.02
LnOil	0.21***	0.07	–3.06	0.00
LnManuf	0.68***	0.04	14.49	0.00
C	1.24***	0.31	4.00	0.00
Long-run var.		0.00		
Sum Squ. Res.		0.002		
R/R		0.99/0.98		

1% and 5% significance level denoted by *** and **

been required R^2 value as 0.99 and Adjusted R^2 is 0.98. Sum squire residual statistics present the result of 0.00 which gives the consistency evidence of this model. The diagnostics test of this model presented in Table 9. The residuals diagnostics show the residuals have been normally distributed. The Jarque-Bera statistics show the probability of 0.39 percent. Whatever, there is no inconsistency in this process.

Now we estimate the long-run association by using another technique known as Wald test which results are presented in Table 10. The test examines the relation between regressed and regressor variables. Whatever the estimated nominal hypothesis is H_0: C(1)=C(2)=C(3)=C(4)=C(5)=0, or manuf = oil = k = elec = infra = 0 to estimate the long run with industrializations. The estimated result can reject the null hypothesis if the F statistics large than the upper bound of 5% Peasaran critical value. In this situation, F statistics shows the value 540.30 and the 5% critical value in Peasaran et al. (2001) (Pesaran et al., 1999) and Narayan (2005) (Narayan, 2005) table shows the lower bound is 3.79 and upper bound is 4.85 so the F statistics exceed the upper bound value that's why the nominal hypothesis (H_0) does not accept and accept the unconventional hypothesis (H_1). So the variables have long run associations and all are variables that move together in the long-run equilibrium.

Table 9: Diagnostics test of DOLS estimation

Normality Test	J-B stat	Prob.
	1.87	0.39

Table 10: Long run relationship measured by Wald test

Wald Test			
Test Stat.	Value	Df	Prob.
F-stat.	540.3070	(5, 34)	0.0000
Chi-square.	2701.535	5	0.0000
Null hypothesis: C(1)=C(2)=C(3)=C(4)=C(5)=0			
C(1)		0.174148	0.039305
C(2)		0.041359	0.017601
C(3)		0.977597	0.053639
C(4)		–0.201	0.682431
C(5)		–0.012	0.007243

Restrictions are linear in coefficients

The result of the error correction mechanism (ECM) has been presented in Table 11. ECT estimates for the long-run equilibrium where the independent variables are gives the short-run coefficient values. ECT presents the speed of adjustment towards long-run equilibrium. The decision is that ECT should be negative and econometrically significant. Now, concentrated in ECM estimation the ECT shows a value of -0.45% with a negative sign and also significant at a 1% level. The econometric result can conclude that the whole system is back long-run equilibrium at the speed of 45%. Whatever, the variable Industrializations is exceeding or underneath its equilibrium point, it has adjusted almost 0.45% speed within the time.

The causality analysis noticed in Table 12. The empirical results explain that a bidirectional relation subsists between industrializations and manufacturing sectors. Infrastructure is the cause of rapid industrialization with means a unidirectional liaison, The result is similar to (Fan, 2018). Capital accumulation and industrializations have bidirectional relations. Oil consumption is the cause of industrializations is accepted one percent level that means bidirectional causality exists between those variables. An important result is that electricity consumption has been caused to industrialization and industrial development also causes electricity production. The result shows the bidirectional relationship. Capital formation is the cause of manufacturing and vies versa which gives the evidence of bidirectional causality with a one percent significance level. Whatever, ultimate result fill the main objective of this study. The rapid industrializations have the cause and effect of other macroeconomic indicators concerning energy consumption.

Whatever, Table 13 has vacated the decision analysis of the hypothesis statement based on empirical results and findings. The H_0 to estimate the empirical relation between energy consumption and industrialization, assume as the negative relation between those variables. Moreover, the empirical result rejects the null hypothesis and the result is significant. The second statement measures the relationship between the expansion of the manufacturing sector and industrialization. The statement declared there is a negative and insignificant relationship between those variables but the empirical results complete the evidence against the statement. Whatever the result has been rejected the null hypothesis that means there is a positive relationship between them. Increasing of the manufacturing sector has support to increase the industrialization (Thomas and D'Aveni, 209 C.E.). In the third case, H_0 declared that capital formation does not accelerate industrialization which statement has been rejected. The current study finds the capital formation increases the industrialization in Bangladesh and these findings support the economic theory in practices. The last one, states the negative and insignificant relationship between infrastructure development and industrialization. Current findings showed a negative sign in regression analysis which is unexpected for the economy. The hypothesis has been accepted but the result is not significant. As a developing country, Bangladesh has several lacking in the infrastructure sector (Hulland et al., 2013). Large Investment and expansionary policy should be effective to increase the physical and non-physical infrastructure.

Table 11: Results of error correction mechanism

Dependent Variable: D (and)				
Method: Least squares				
Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	0.044	0.096	0.456	0.651
D (LnK)	0.082	0.068	1.203	0.238
D (LnInfra)	0.317	1.046	0.303	0.764
D (LnManuf)	1.026***	0.060	17.068	0.000
D (LnElec)	–0.002	0.008	–0.312	0.757
D (LnOil)	0.015	0.016	0.914	0.368
ECT(–1)	–0.458***	0.161	–2.849	0.008
R2	0.92	Mean depe. var		0.377
Adj R2	0.91	S.D. depe. var		1.133
S.E. of regression	0.33	AIC		0.811
S S resid	3.58	SIC		1.110
LR	–8.81***	HQC		0.918
F-stat.	67.02***	D-W Stat.		2.427

1%, significance level denoted by ***

Table 12: Granger causality test

Variables	Critical Value/F-stat	Pro.	Decision Rule
LNINFRA>LNIND	6.77***	0.01	Unidirectional
LNIND>LNINFRA	0.46	0.50	
LNMANUF>LNIND	12.91***	0.00	Bidirectional
LNIND>LNMANUF	8.01***	0.01	
LNK>LNIND	24.06***	0.00	Bidirectional
LNIND>LNK	7.47***	0.01	
LNOIL>LNIND	12.87***	0.00	Unidirectional
LNIND>LNOIL	2.65	0.11	
LNELEC>LNIND	15.28***	0.00	Bidirectional
LNIND>LNELEC	2.85*	0.10	
LNMANUF>LNINFRA	0.50	0.49	Unidirectional
LNINFRA>LNMANUF	3.84*	0.06	
LNK>LNINFRA	0.01	0.94	Unidirectional
LNINFRA>LNK	15.14***	0.00	
LNOIL>LNINFRA	3.18*	0.08	Bidirectional
LNINFRA>LNOIL	3.10*	0.09	
LNELEC>LNINFRA	0.24	0.63	No Causality
LNINFRA>LNELEC	1.79	0.19	
LNK>LNMANUF	14.69***	0.00	Bidirectional
LNMANUF>LNK	15.14***	0.00	
LNOIL>LNMANUF	5.67**	0.02	Bidirectional
LNMANUF>LNOIL	2.93*	0.09	
LNELEC>LNMANUF	6.19**	0.02	Unidirectional
LNMANUF>LNELEC	1.82	0.18	
LNOIL>LNK	6.42**	0.02	Unidirectional
LNK>LNOIL	1.42	0.24	
LNELEC>LNK	6.50***	0.01	Unidirectional
LNK>LNELEC	0.11	0.74	
LNELEC>LNOIL	1.46	0.23	No Causality
LNOIL>LNELEC	0.82	0.37	

1%, 5%, 10% significance level denoted by ***,** and * respectively

5.1. Foremost Findings at a Glance

The current study shows a positive or significant relation to industrialization and energy utilization where energy consumption shows the causality between energy discharge and industrializations (Hulland et al., 2013), (Krausmann and Haberl, 2016). There is a significant chance to expand the industry sector by using electricity and oil consumptions. The empirical result shows a positive marginal effect of oil and electricity consumption to accelerate rapid industrializations that exist (Hepbasli, 2005), (Shahbaz and Hooi, 2012), (Ang, 1987). As a developing nation, Bangladesh has a great opportunity to expand the industry through capital accumulations. The manufacturing sector is statistically positive in relation to the expansion of industrializations. This finding has similar to (Zhou, 2009). The test of Error correction mechanism shows the long-run equilibrium speed at a smooth rate at 45%. The result is significant with a negative sign. The causality estimation also determines the consistent result among the industrialization, energy consumption, and other macroeconomic variables.

Table 13: Hypothesis decision analysis

Null hypothesis (H0)	Decision criteria
H_1	Reject H_0
H_2	Reject H_0
H_3	Reject H_0
H_4	Fail to reject the H_0 (insignificant)

6. CONCLUSION AND POLICY IMPLICATIONS

The summary of this study determines the energy consumption has promoted industrialization. Oil and electricity consumption support to accelerate the industrial size and activity to increase the industry value added in nations GDP (Khatun and Ahamad, 2015) Das et al., 2013). Domestic investment and foreign direct investment in Bangladesh are largely increasing due to the enhancement of industrial promotions and the business-friendly environment (Faruk, 2013), (Islam, 2014), (Maroof et al., 2018). The current study aims to measure the relation between energy consumption and rapid industrializations were, energy consumption proxies by oil and electricity consumption concerning other macroeconomic variables like infrastructure development, manufacturing sectors, and capital formations. Whatever, this study used data from World Development Indicators and International Energy Statistics from 1975 to 2018. ADF unit root test occurred firstly to test the data series with zero mean values and constant variance. Johansen test implied to estimate the co-integration in the long run. The OLS estimation runs to measuring the marginal effect of how the independent variables explained the dependent variables. Manufacturing and infrastructure have a positive impact on industrializations, oil, and electricity consumption also supports to accelerate the industrializations. The long-run estimation completed by using the technique of ECM with a 45% speed of adjustment when disequilibrium occurred. Granger causality analyses explain the electricity consumption cause industrializations and oil consumption also has a unidirectional causality with industrialization. Infrastructure and manufacturing have the bidirectional causality in nature.

The recommendation of this study suggests that infrastructure development and decentralization policy can highly encourage in this process. Energy use especially renewable energy use can be effective in increasing industrial activities with safe environmental damage. Appreciation policy by government and legal authority would be effective in the case of capital formation and logistic development. The contributions of this attempt ensuring the importance of energy use and energy management in aspects of industrial development with considering the other macroeconomic indicators.

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