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CAUSAL RELATIONSHIP BETWEEN ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN ASSAM, INDIA

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Abstract: The aim of this study is to find the causal relationship between electricity consumption (EC) and economic growth in terms of Gross State Domestic Product (GSDP) in Assam considering the time period 1980-81 to 2018-19 with the help of Granger Causality Test. The stationarity of the series are tested through the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests and reveal that both the series become stationary in first order differences but the result of Johansen Cointegration test indicates no cointegration between them. Applying Granger Causality test, no causal relationship is observed in either direction between EC and GSDP during the considered time period in Assam implying that energy conservation policies may not harm the economic growth in Assam.

Keywords: assam; economic growth; electricity consumption; Granger causality.

2010 AMS Subject Classification: 62P20, 62M10.

1. INTRODUCTION

Electricity, one of the most widely used forms of energy plays a crucial role for the inclusive economic growth and development of each and every country of the world. The demand for electricity has increased rapidly with increased uses from domestic to industrial, commercial,

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agricultural, service sector etc. There is a close relationship between economic growth and electricity consumption of a country and that's why the demand for electricity of a country reflects its standard of living, economic development and geographic variations [7].

Assam, situated in North-Eastern Region of India has the largest economy of this region and like the global scenario; the consumption of electricity in Assam has also increased continuously. But in comparison to the other developed states of India, the supply of electricity in Assam is not sufficient with respect to its demand and the pace of economic development is also falling behind the rest of the country in spite of its immense potentialities.

Therefore, in this study we would like to find out whether any causal relationship between these two variables viz. electricity consumption and economic growth in terms of Gross State Domestic Product exist and for this purpose Granger Causality Test is applied.

The paper is organized as: the first section gives a brief introduction of the study along with its objective; section 2 discusses the existing literature; section 3 provides the data and methodology used for this study; section 4 gives the findings and the last section gives the conclusion part of the present study.

2. LITERATURE REVIEW

To study the relationship between economic growth and energy consumption, large numbers of studies have been made by the researchers in the last three decades using various types of causality tests and it formally starts with Kraft and Kraft [9] where they found unidirectional causality running from Gross National Product (GNP) to energy consumption for USA considering the time period 1947-74. Azlina [1] employed a Vector Error Correction Model (VECM) to test the existence and direction of causality between energy consumption and economic development in Malaysia and found unidirectional causality from economic development to energy consumption. Similarly while studying the relationship between Gross Domestic Product (GDP) and Energy consumption (EC) in Belgium, Faisal et al. [4] found the

long-run relationship between EC and GDP by applying Autoregressive Distributed Lag (ARDL) and unidirectional causality is observed from GDP to EC by Toda Yamamoto (T-Y) approach.

Huseyin et al. [8] while investigating causality relationship between GDP and energy consumption found no cointegration for Georgia and Azerbaijan, again unidirectional causality is found from per capita GDP to per capita energy consumption for Armenia. Zahid [19] while investigating the relationship between GDP and different types of energy consumption for five South Asian Countries viz. Pakistan, India, Sri Lanka, Bangladesh and Nepal using Error Correction Model and Toda Yamamoto approach, found different results for these five countries. While for Pakistan unidirectional Granger causality from coal to GDP, GDP to electricity and total energy consumption, for Sri Lanka also GDP to electricity consumption and total energy consumption, for Bangladesh GDP to electricity consumption and from gas consumption to GDP and for Nepal petroleum to GDP have been found but for India no causality in either direction between GDP and different energy consumption is detected. Yu and Choi [18] also identified no causal relationship between GNP and total energy consumption for the United States, the United Kingdom and Poland.

Narayan et al. [11] found cointegration among the variables electricity consumption, employment and real income for Australia and in the long-run, employment and real income Granger cause electricity consumption and for short run there is weak unidirectional Granger causality running from income to electricity consumption and from income to employment.

Nazlioglu et al. [13] employed linear and non-linear Granger causality to examine the relationship between electricity consumption and economic growth for Turkey and found bi-directional Granger causality in both the short and the long run between them from linear approach while non-linear causality analysis produced the neutrality hypothesis implying no causal relationship between the considered variables. Ugur et al. [16] found bi-directional causality in Argentina, unidirectional causality from GDP to energy consumption for Italy and Korea and from energy consumption to GDP for Turkey, France, Germany and Japan.

In India, Sajal Ghosh [5] found unidirectional Granger causality from economic growth in terms of GDP to electricity consumption for the period 1950-51 to 1996-97. Asit Mohanty [10] and Gupta and Sahu [6] again found unidirectional causality from electricity consumption to GDP considering the time period 1970-71 to 2011-12 and 1960-2006 respectively which is contradictory to the result of Sajal Ghosh [5]. Smita Nath [12] while re-investigating the relationship between economic growth and electricity consumption for the period 1971-72 to 2016-17 for the whole country as well as for agricultural and industrial sectors separately, found long run positive relationship between economic growth and electricity consumption while for agricultural sector also unidirectional Granger causality from Gross Value Added (GVA) to electricity consumption is found but no causality is observed in either direction for industrial sector. K. K. Pandey et al [14] while investigating the interrelationship among the variables real GDP, electricity consumption and CO_2 emission to study the impact of energy consumption and economic growth on environmental degradation, found bidirectional causality from economic growth to CO_2 emissions, electricity consumption in agriculture, commercial and industrial sectors and CO_2 emissions. Again, Rajkumari et al. [15] while investigating the causality between electricity consumption and economic growth for the state Karnataka found unidirectional causality from economic growth to electricity.

Thus from the extensive review of literature it is found that the causal relationship between economic growth and energy consumption (in particular electricity consumption) is mixed and conflicting for various countries of the world. These results can be summarized into the types of: (i) unidirectional causality from economic growth to energy consumption (ii) unidirectional causality from energy consumption to economic growth (iii) bidirectional causality between economic growth and energy consumption and (iv) no causality between the economic growth and energy consumption.

Though many works have been done for India to study the relationship between these two variables yet to our knowledge this topic is not yet covered for Assam. So in this paper we aim to

study the causal relationship between the economic growth in terms of Gross State Domestic Product and Total Electricity consumption in Assam by considering the time period 1980-81 to 2018-2019 with the help of Granger Causality Test.

3. DATA AND METHODOLOGY

Here secondary data on total electricity consumption (in M.U) is collected from economic survey of Assam and Statistical Handbook Assam (Source: Assam State Electricity Board) and data on Gross State Domestic Product (GSDP) in lakhs at constant price is collected from economic survey of Assam and the publications of Reserve Bank of India (Source: Central Statistics Office, Ministry of Statistics and Programme Implementation, Government of India) considering the period 1980-81 to 2018-19. Since GSDP data is available at different base year, different series are spliced at 2004-05 base year to get a comparable series.

The Granger causality between electricity consumption and economic growth in terms of GSDP are examined with the help of following methodology:

In order to test the causality between the two variables, the first step is to check the stationarity of the data series. For this purpose Augmented Dickey Fuller (ADF) and Phillips Perron (PP) tests are applied after natural log transformation of the original series. Here the null hypothesis to be tested is that there is a unit root against the alternative that the time series is stationary. To investigate the cointegration between the two variables, in the second step Johansen cointegration test is used. If two series say X and Y are individually integrated of order one i.e. I (1) and cointegrated then Engle and Granger proved that there would be a causal relationship at least in one direction [5]. Granger (1969) [3] defined causality as follows:

"A variable Y is causal for another variable X if knowledge of the past history of Y is useful for predicting the future state of X over and above knowledge of the past history of X itself. So if the prediction of X is improved by including Y as a predictor, then Y is said to be Granger causal for X". The equations for Granger Causality with two variables X and Y are as follows:

$$X_t = \alpha + \sum_{i=1}^{m} \beta i \; X_{t-i} + \sum_{j=1}^{n} \gamma j \; Y_{t-j} + u_t \; \ldots (1)$$

$$Y_t = a + \sum_{i=1}^{q} bi \; Y_{t-i} + \sum_{j=1}^{r} cj \; X_{t-j} + v_t \quad \ldots (2)$$

Where u_t and v_t are zero mean, serially uncorrelated random disturbances. The null hypothesis to be tested here is lagged x-values do not explain the variation in y i.e. X(t) doesn't Granger cause Y(t) against the alternative that lagged x-values explain the variation in y or X(t) Granger cause Y(t).

4. FINDINGS

The growth of Total Electricity Consumption in M.U and Gross State Domestic Product in lakhs are shown in fig. 1 and 2.

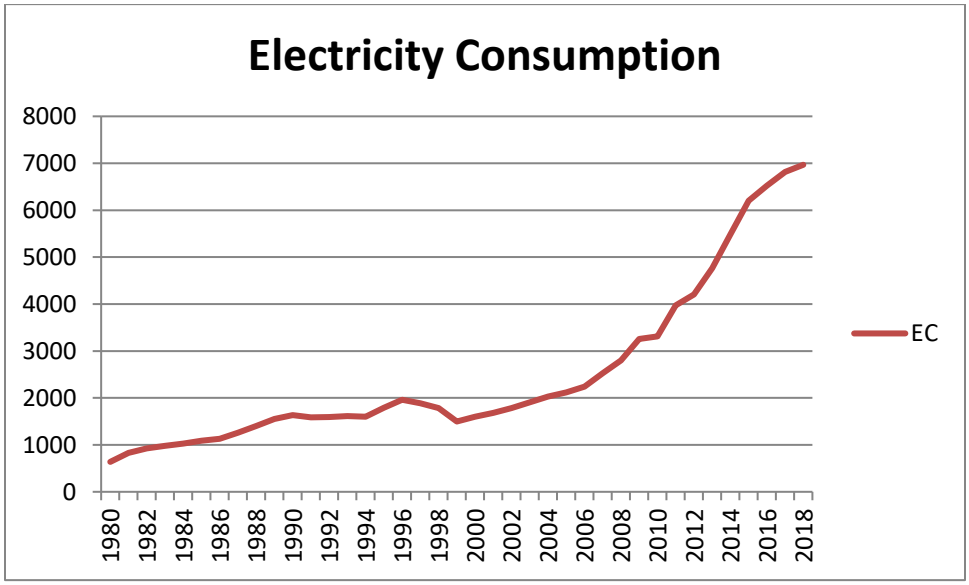

Figure 1: Total Electricity Consumption in Assam

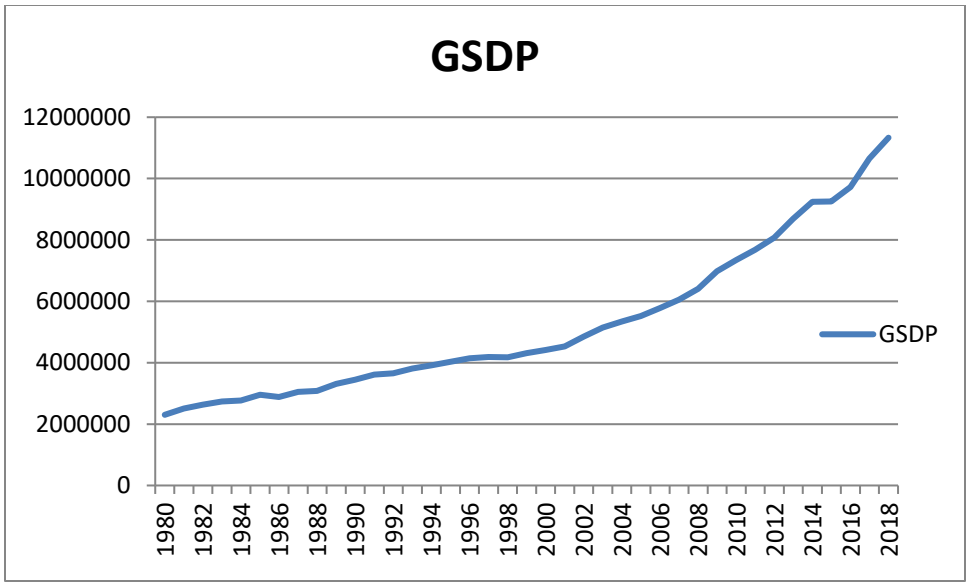

Figure 2: Gross State Domestic Product in Assam

The results of Augmented Dickey Fuller and Phillips-Perron test done with the help of Eviews 11 software are shown in table 1.

Table 1: Results of Unit Root Tests for lnEC and lnGSDP

Variables	ADF Test		Phillips-Perron Test	
	Level	First difference	Level	First difference
lnEC	-1.021258(0.9289)	-4.803516(0.0023)	-1.449367(0.8293)	-4.809821(0.0022)
lnGSDP	-0.113170(0.9928)	-6.675803(0.0000)	-0.069335(0.9936)	-6.753228(0.0000)

Note: The figures given in the brackets denote the p-values corresponding to the test statistics and lnEC and lnGSDP denote the natural logarithm of total electricity consumption and Gross State Domestic Product respectively.

By observing the values of p for both the test, it is found that the series lnEC and lnGSDP become stationary at first order differences which indicates that both the series are integrated of order one.

The results of Johansen cointegration test for detecting cointegration of the given series are shown in table 2.

Table 2: Johansen Cointegration Test

Null	Test Statistic	5% critical value
Trace Test		
r=0	10.19743	15.49471
r≤1	2.989611	3.841465
Maximum eigenvalue test		
r=0	7.207815	14.26460
r≤1	2.989611	3.841465

The null hypothesis to be tested here is no cointegration between the variables i.e. r=0. Observing the values of both the test statistics viz. Trace test and Maximum Eigen value test with corresponding critical values indicate that the null hypothesis of r=0 cannot be rejected and therefore it can be concluded that there is no cointegration between the variables lnEC and lnGSDP. Thus we have found that though the variables lnEC and lnGSDP are I (1) but not co-integrated. Therefore, the equations of Granger Causality test to make them I (0) become [5]

$$\Delta X_t = \alpha + \sum_{i=1}^{m} \beta i \, \Delta X_{t-i} + \sum_{j=1}^{n} \gamma j \, \Delta Y_{t-j} + u_t \quad \ldots (3)$$

$$\Delta Y_t = a + \sum_{i=1}^{q} bi \, \Delta Y_{t-i} + \sum_{j=1}^{r} cj \, \Delta X_{t-j} + v_t \quad \ldots (4)$$

The next step is to choose the optimal lag length and on the basis of the results obtained from LR (sequential modified likelihood ratio test statistic) and SC (Schwarz information criterion), it is chosen as 1.

Table 3: Granger Causality Test Result between Electricity Consumption and Gross State Domestic Product

Null Hypothesis	F-statistic	p-value
Δlngdp does not Granger Cause Δlnec	0.17455	0.6808
Δlnec does not Granger Cause Δlngdp	0.60417	0.4466

From table 3, it is seen that the null hypotheses GSDP does not cause Electricity Consumption and Electricity Consumption does not cause GSDP cannot be rejected. Therefore, it can be concluded that no causal relationship between EC and GSDP exist in either direction for Assam for the considered period which implies the evidence of the neutrality hypothesis.

5. CONCLUSION

Through this paper, attempt is made to study the relationship between total electricity consumption and economic growth in terms of GSDP in Assam for the period 1980-2018. Following the results of ADF and PP tests it is found that both the series become stationary in first order differences. But the result of Johansen Cointegration Test indicates that they are not cointegrated. After that applying Granger Causality Test at lag 1 (selected by considering the criterion of optimal lag length viz. sequential modified likelihood ratio test statistic and Schwarz information criterion) found no causal relationship in either direction for Assam which supports the neutrality hypothesis that there is no causal relationship between electricity consumption and economic growth in Assam. This result also confirms with some previous studies like Zahid [19] for India, Yu and Choi [18] for the United States, the United Kingdom and Poland etc. So it can be concluded that energy conservation policies would not impact the economic growth in Assam and vice versa. Though the power supply position in Assam is improving and the economic growth rate also accelerates than before yet the disparity against the per capita electricity consumption and also per capita income with respect to national average have been still

widening. The per capita electricity consumption in Assam for 2018-19 is 341kWh against the national average of 1181kwh and similarly Assam is among the top 5 poorest states of India in terms of National State Domestic Product in spite of its abundant natural resources. This may be one of the reasons for non-existence of significant causal relationship between these two variables.

In Assam, there are immense potentialities for the development in the electricity sector based on Hydel, Natural gas, Oil and Coal resources. Since, so far no causal relationship exists between EC and GDP for Assam, adequate steps should be taken by the Government for maximum exploration of its energy resources in order to become a self-sufficient State. Future attempts will be made to study the causal relationship between electricity consumption and factors like agricultural growth, industrial growth separately and also considering environmental degradation factors to get a more comprehensible picture of the relationship between electricity consumption and economic growth.

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CONFLICT OF INTERESTS

The author(s) declare that there is no conflict of interests.

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