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Role of Education and Economic Benefits of Energy Conservation in India

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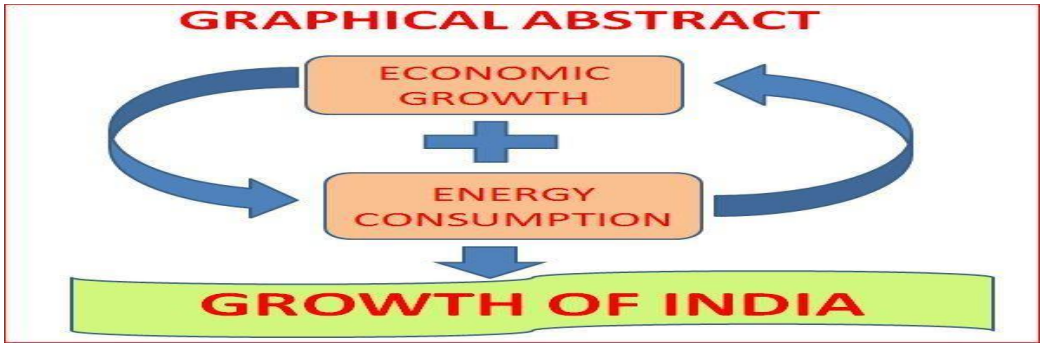
Keywords

Oil Consumption, Energy Consumption, Economic Growth, Economic Activities, Impact, India

ABSTRACT

Abstract: The oil price shock of the 1970s and its disruptive impact on the economic activities all over the world prompts researchers to study the nexus between energy and economic growth. The role of energy in the modern economic scenario has occupied a central space to give fillip to economic growth. However, no conclusive result could be derived about the kind of relationship that exists between the two. The present study is an attempt to understand this relationship in the context of India. The paper has used the data from 1971 to 2020 and has concluded that this relationship between energy use and real output is stable. The study also reveals that in the short run, there is unidirectional relationship between the two more consumption of energy stimulates economic activities in India. In the long run, we find that bidirectional relationship exists between energy and economic prosperity of India. Strengthening of energy sector is of paramount importance in India to achieve phenomenal economic growth."



Introduction

The level of energy consumption is closely linked to the rate of economic growth; in other words there is a close nexus between the two. It is true in the global context and has been amply and frequently demonstrated since 1973 oil shock. Researchers are now keenly interested in ascertaining the link between energy use and economic growth of a country. But the studies conducted by various researchers have yielded conflicting results. Some studies as [1,2] have discovered positive relationship between the level of energy consumption and the rate of GDP growth, while such studies as [3,4] point out that negative causal nexus exists between the energy consumption and economic progress. There are a few studies which reveals that no link exist between energy consumption and economic growth [5,6] there are a few other studies which disclose the existence of bidirectional causal relationship between the two [7- 9] Thus, there is no

uniformity in the findings of empirical researches with regard to the causal link between energy

consumption and economic growth in a country. These diverse findings could be attributed to diversity in economic conditions of difference countries and different in the periods of the studies [10-16,] conflicting versions about the relationship between energy consumption and economic growth of a country induces the researches to explore the issue further to arrive at some definitive link between the two both in the short term and long term especially in the context of developing countries like India. The findings of such studies are very important in designing energy related policies and monetary policies of a country. The present study is a modest attempt to explore the nexus between the level of energy consumption and the rate of economic growth in India. Some researchers maintain that different variables included in the models might have led to different results about the association between energy use and output growth [17-21].
Format of the paper is designed as follows 1 Introduction 2 Review of the existing literature 3 Empirical analysis 4 Conclusion and policy implications.

Literature review:
The link between energy consumption and economic growth has always elicited keen interest among policy makers and researchers [22]. That is why copious literature is available on the topic. For example, [23] has explored the nexus between energy consumption and output growth in relation to India, using the data from 1952 to 1995, and finds that no causal link exists between the two.[24] investigated the link between energy use and economic growth in Newzealand taking annual data from 1960 to 2004, and found that unidirectional relationship exists between the two-growth leads to rise in energy consumption. A similar study pertaining to G-7 countries with the application of cointegration FMOLS estimators, dynamic OLS, [25] detected bi-directional causal relationship between the two in the selected countries [26]. Examined the relationship between energy and economic growth and found different results for different countries. This study finds unidirectional relationship-rise the level of energy consumption promotes GDP growth in the case of three countries, but in the case of six other countries it is found that economic growth causes spurt in energy consumption, and the Virtuous circles, i.e. both promoting each other, in the case of three African countries but no causal relationship in seen in the case of one country. The study [27] conducted to examine the link between energy consumption and economic growth in the context of India, Indonesia Philippines and Thailand reveals mixed results. In the case of India and Indonesia, unidirectional casual relationship more energy consumption leads to higher economic growth is observed, but bidirectional relationship, i.e. both push up the growth of each other, in the case of Philippines and Thailand is seen. [28] concludes the existence of bidirectional relation in the case of China. Bidirectional relationship is found in the long run in the case of Korea by a study titled [29,30] reveals that in the case of Pakistan unidirectional relationship the more energy consumption, the more economic growth is seen between energy consumption and economic growth. [31] Covered 119 countries belonging to different income groups to study the causal relationship between energy consumption and income growth. This study reveals different results for different countries. No long term relationship is seen during sample period in the case of low income countries. Unidirectional relationship from upswing in growth to spurt in energy consumption - is detected in the case of upper middle income group, and thus the conservation hypothesis for these countries stands vindicated. In the case of higher middle and higher income group countries bidirectional causal relationship is found between energy use and GDP, thus a feedback hypothesis stands reinforced.
Another study Stern and Cleveland also finds the positive association between energy and economic growth and also reveals that more energy use promotes economic growth but additional factors like energy price or other inputs should also be taken into account. [32] Finds unidirectional causal relationship more output - more energy consumption in the case of BRICS countries, which means that Energy Conservation Policy should be followed and will not hamper economic growth. [33] Reveals a close nexus between energy use and growth. Two datasets are

observed: One data set comprises 99 countries, covering the period from 1970 to 2010, another data includes the period from 1800 for US and some other Northern European countries but in the case of a few other countries some later dates are in the nineteenth and early 20th century are covered. The study reveals stable relationship between GDP per capita and energy consumption per capita over the last 40 years, but poor countries have more energy intensity than richer countries. Very conflicting results are found in the study [34] which examines the cause and effect relationship between electricity use and output growth for seven South American countries. Unidirectional relationship from electricity to growth is found in the case of 5 countries while in the case of one country bi-directional relationship and in the case of one another country no causal relationship are observed.

Non linear method is also applied by some researchers to examine the relationship between energy use and economic growth. For instance [35] examine the relationship in the case of US and newly industrialized economies and the use of linear method reveals unidirectional relationship in two countries, bidirectional relationship in two countries and no relationship in three countries. But the use of non-linear method yields different findings- bidirectional relationship in five countries, unidirectional relationship in two countries. The study (2012) conducted by France, Amiri and Zibaei finds causal relationship more energy consumption promotes growth from linear as well as non linear methods. All these studies reveals that conflicting versions prevail about the relationship between energy consumption and economic growth, and the issue cannot be clinched in a single acceptable way. It differs from country to country, from time to time and also depends apon the economic status of the country to be examined. In the case of India also, varied findings are observed. The results vary from no causal link to unidirectional link. Since different results are observed at different times, the present study is based upon the data until the recent one, covering from first oil embargo to achieve more reliable results.

Period 0f Study, Variables Description And Econometric Techniques

The paper is based on examining the annual data from 1971 to 2020 as the data on energy used was available till 2020 only. The variables used in the study are real GDP, real gross capital formation (GCF) and total energy consumed each year. The data on GDP and GCF were measured in Indian currency at current prices which has been deflated by GDP deflator to change these nominal values into real values. The energy use here refers to use of primary energy before altering to other end-use fuels. This is measured as sum of domestic production, imports and stock changes net of exports and fuels supplied to ships and aircrafts engaged in international transport. The energy used is calculated as kilograms of oil equivalent. The data was available on kilogram of oil equivalent per capita which has been multiplied by population of the country to get total energy use by a country. All these data have been taken from World Development Indicators (2010; 2019).[36,37]

Energy is an important factor of production which plays important role in determining the growth rate of an economy. But many development theories did not use energy as a separate variable of production. However, the kind of relation varies with time and economic status of the country. Hence, any kind of relationship, positive or negative, may be expected about the energy consumption and economic growth measured in terms of real GDP in the case of India. Another factor included in the model is real GCF which is expected to have positive relation with GDP. Based on this formulation following model has been developed to estimate the relationship between energy consumption and economic growth.

lGDPt = f(lGCFt, lenergyt) (1) Where,

l designates log of variables

GDP indicates real gross domestic product GCF is real gross capital formation Energy refers to total energy used

t represents time period.

The study will use time series data. It is normally observed that macroeconomic variables reveals a sort trend over a period of time, we will apply Augmented Dicky-Fuller (ADF) test and Philips-

Perron (PP) test to ensure stationary nature of the variables. If variables are found stationary, we may estimate long run relation through regression equation. If the data reveals the presence of unit root at level but its absence at first difference, we may apply Johansen co integration method to understand long run association among the variables. This will be followed by estimation of vector error correction model (VECM) to measure short run and long run dynamics of the relationship.

Empirical Results

The results of unit root tests are given in Tables 1a and b. ADF results are given in Table 1a and PP results are given in Table 1b. It is evident from both the tables that the variables included in the model are non stationary when checked at level but stationary at first difference. Thus we may infer that all the variables are of same order of integration.

Hence, we may apply Johansen's method for estimating cointegration relationship among the variables. Since the result is influenced by lag order, appropriate lag order has been selected using Schwarz information criterion, the result of which is given in Table 2.

The Schwartz information criterion in Table 2 suggests that 1 time period lag would be appropriate for Johansen co integration test. Hence, Johansen co integration test has been conducted to predict long run relationship between GDP, gross investment and energy used the result of which is shown in Table 3a and b. The null hypothesis of no co integration relationship is tested against the alternative hypothesis that the variables are co integrated using trace value and maximum Eigen value. Table 3a shows that the trace statistics 45.89425 is greater than the critical limit of 35.19275. Thus, the null hypothesis of no co integration relationship is rejected in favour of alternative hypothesis of at least one co integration relationship among the variables. Again, since the trace value for at most one co integration is less than its critical value at 5% significance level, we may accept the null hypothesis and conclude that there is one co integration relationship among the variables. Maximum Eigen value shown in Table 3b also reveals the same result. The Maximum Eigen statistics of 26.96961 is more than the critical value of 22.29962 when the null hypothesis is no co integration relationship among the variables. However, at most one co integration relationship is accepted as maximum Eigen statistics is less than the critical value. Thus, both trace statistics and maximum Eigen statistics confirm that there is long run stable relationship between economic growth, gross investment and energy used in India.

Once finding co integration relationship among the variables, VECM has been estimated to know long run causal nexus between energy use and economic growth and then Granger causality/block exogeneity Wald test has been estimated to find short run causality between the variables. The results are given in Table 4. The table reveals that lagged error correction term in both the cases, when GDP is taken as dependent variable and also when energy consumption is taken as dependent variable, is negative and significant implying that there is bidirectional causal relationship between growth and energy consumption in India in the long run.

Table 1a: Stationary test results: (ADF)

Variables	Level		First difference		Inferences
	C	C and T	C	C and T	
$LENERGY_1$	2.161900	-1.157111	−5.714010*	-6.182212*	I (1)
$LGDP_t$	3.342427	-1.920284	−6.601260*	−8.151217*	I (1)
$LGCF_t$	-0.099993	-2.557858	−8.200880*	−8.099122*	I (1)
McKinnon critical values					
1%	-3.592462	−4.186481			
5%	-2.931404	−3.518090			
10%	-2.603944	−3.189732			
***shows significant at 1%. Schwarz information based lag order. ADF: Augmented Dickey-Fuller**					

Table 1b: Stationary test results: (PP)

Variables	Level		First difference		Inferences
	C	C and T	C	C and T	
$LENERGY_1$	2.161900	−1.414998	−5.815657*	−6.228557*	I (1)
$LGDP_t$	3.342427	−1.957966	−6.597087*	−9.606079*	I (1)
$LGCF_t$	-0.099993	−2.618754	-8.200880*	−8.099122*	I (1)
McKinnon critical values					

1%	-3.592462	-4.186481			
5%	-2.931404	-3.518090			
10%	-2.603944	-3.189732			
***shows significant at 1%. Schwarz information based lag order. ADF: Augmented Dickey-Fuller**					

Table 2: Results of various criteria for lag order selection

Lag period	Final prediction error	Akaike information criterion	Schwarz information criterion	Haman Quin information criterion
0	5.30e-06	−3.634999	−3.509616	−3.589341
1	6.71e-10	−12.61096	−12.10943*	−12.42833*
2	6.62e-10*	−12.63154*	−11.75385	−12.31193
3	7.62e-10	−12.51089	−11.25706	−12.05432
***indicates selection of lag period.**				

Table 3a: Unrestricted cointegration rank test (trace)

Hypothesized number of CE (s)	Eigen value	Trace value	5% critical value	Probability**
r=0*	0.473831	45.89428	35.19275	0.0025
r=1	0.252109	18.92467	20.26184	0.0755
r=2	0.147933	6.723766	9.164546	0.1418
***indicates refusal to accept the hypothesis at 5% significance level. MacKinnon-Haug-Michelis (1999) probability values.**				

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Table 3b: Unrestricted cointegration rank test (maximum eigenvalue)

Hypothesized number of CE (s)	Eigen value	Max eigen statistic	0.05% critical value	Probability**
r=0*	0.473831	26.96961	22.29962	0.0103
r=1	0.252109	12.20091	15.89210	0.1746
r=2	0.147933	6.723766	9.164546	0.1418
Max Eigen test indicates 1 co integrating equation at 5% significance level. * indicates refusal to accept the hypothesis at 0.05 the level. MacKinnon-Haug-Michelis (1999) probability values.				

Table 4: Results of short run and long run causality test

Dependent variable	DLGDP	DLGCF	DENERGYT	ECT(-1)
	Chi square (P-values)			
DLGDP	____	0.0403	0.0448	−0.071734
				(−2.08101)
DENERGYT	0.2119	0.0490	____	−0.093125
				(−5.20728)

5. Conclusion and policy implication:

There is no denying "that energy plays a vital and very critical role in accelerating the process of economic growth of a country. The present paper intends to ascertains the kind of link that exists between energy use and economic progress in the context of India. The period covered under this study runs from 1971 to 2020. The study release long run cointegration relation between energy consumption, gross investment and economic development. There is bidirectional relationship between energy consumption and the economic growth of India as is evidenced by the VECM. The result of block erogeneity Wald test lends credence to the belief that unidirectional relationship exists between energy consumption and output from the former to the latter. In other words, more energy consumption strengthens the process of economic growth. Hence this study provides an important insight into designing the economic policy. India has to develop its energy sector to cope with the violent volatility in the international price and supply of energy to ensure its accelerated and high rate of growth. Only then can India emerge as one of the economic superpowers of the world and can succeed in elevating the economic woes of the depressed and deprived sections of the society."

Highlights:

- Role of energy in the modern economic scenario
- Kinds of relationships that exists between the energy consumption and economic growth

- Strengthening of energy sector is of paramount importance in India to achieve phenomenal economic growth
- More energy consumption strengthens the process of economic growth.

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