The Empirical Relationship between Energy Consumption, Foreign Direct Investment and Economic Growth in India

Dr. A. Lakshmi
Assistant Professor
Department of Economics,
University College for Women, Koti

Abstract

This study investigated the impact of energy consumption and foreign direct investment on economic growth in India. The time series model was used in this study from 1990 to 2014. The results showed that energy consumption and foreign direct investment had played an important role to boost economic growth in India. The study found that there is a unidirectional causality runs from foreign direct investment to energy consumption.

Keywords: Energy Consumption, Foreign Direct Investment, Economic Growth

1. Introduction

There is a continuing debate among the economist and policy makers on the impact of energy consumption and economic growth in the world. Over the last decades, energy consumption has significantly increased in the world due to higher population and industrialization. Policy makers should concentrate on renewable sources rather than non-renewable energy sources, because non renewable sources damage the environment.

The previous studies suggest that four types of hypothesis in the renewable energy consumption and economic growth nexus; growth, conservation, feedback and neutrality. The growth hypothesis suggests that there is a unidirectional causality running from non-renewable energy consumption to economic growth, it would imply that increase or decrease of economic growth is depends on the consumption of energy. The conservation hypothesis tells us that unidirectional causality running from economic growth to energy consumption. It indicates that reduction in energy consumption does not negative impact on economic growth. The feedback hypothesis

shows that bidirectional causality between energy consumption and economic growth. This relationship suggests that reduction in consumption of energy has a negative impact on economic growth and vice versa. Finally, the neutrality hypothesis shows that there is no causal relationship between non-renewable energy consumption and economic growth, it would imply that reduction in energy consumption may not weakened the economic growth (Apergis and Payne, 2010a; Paramati et al, 2018; Jalle and Gujjunuri, 2018b).

2. Literature review

A number of studies have empirically examined the relationship between renewable energy consumption and economic growth in the world.

Banday and Aneja (2019) investigate the causal relationship between energy consumption, gross domestic product and CO2 emission for BRICS (Brazil, China, India, Russia and South Africa) countries. They employed Panel unit root test, Panel causality test and Bootstrap panel causality test. The estimated results reveal that a unidirectional causality from GDP to CO2 emissions for Brazil, China, India and South Africa, and no causality for Russia.

Baranzini et al. (2013) have examined the causal relationship between energy consumption and economic growth in Switzerland. The sample is yearly data from 1950 to 2010. The popular unit root tests, such as ADF and PP tests are employed to identify the order of integration of time series. They employed cointegration test and error correction model. The empirical results found that there exists long-run equilibrium relationship from real GDP, oil and electricity consumption. The study confirms bidirectional causality running from oil consumption to GDP.

Bilgili (2015) has examined the relationship between the renewable energy consumption and industrial production on the U.S economy. The empirical analysis of the study uses monthly data for the period of January 1981 to November 2013. He employed Wavelet Coherence methodology for identifying the possible influences of renewable energy consumption on U.S

economy. The estimated results reveal that the renewable energy consumption statistically significant and positive effect on industrial production in the United States.

Hondroyiannis et al. (2002) investigated the predictability of energy consumption and economic growth in Greece. They have undertaken sample period from 1960 to 1996. In order to estimate models, they employed Error Correction Model (ECM) and Granger Causality model. The estimated result seems that there is a long-run equilibrium relationship among the variables and supported the endogeneity of energy consumption and economic growth.

Mallaiah and Karuna Sree (2018) have examines the empirical relationship between renewable and non renewable energy consumption and economic growth in India. Their study employed cointegration test and granger causality test and found that long-run equilibrium relationship among the variables.

Mallaiah and Santhosha (2018) also examined the relationship between economic growth, renewable energy consumption, CO_2 emissions and trade openness in India over the period 1990 to 2013. They found renewable energy consumption has negative impact on economic growth and CO_2 emissions and trade openness have positive impact on economic growth.

Singh and Vashistha (2020) have re-examined the empirical relationship between electricity consumption and economic growth in India. The study uses yearly observations for the period of 1971 to 2014. They employed unit root test (ADF), Johansen cointegration test, Vector Autoregression (VAR) and Granger causality test. Estimated results confirm that there is no long-run equilibrium relationship between electricity consumption and economic growth in India. The results indicate that a unidirectional causal relationship runs from economic growth to electricity consumption.

3. Data sources and methodology

Annual time series data for GDP per capita (constant 2010 US$), energy consumption (kg of oil equivalent per capita) and foreign direct investment (net inflows % GDP) are obtained from

World Bank's World Development Indicators (2019). Data is for the period 1990 to 2014. The data is defined as: EG is for GDP per capita (proxy for economic growth), EC is for energy consumption and FDI is for foreign direct investment inflows. All the data converted into natural logarithms to avoid data issues ((Paramati et al. 2016; Mallick et al. 2016; Paramati et al. 2017; Jalle and Gujjunuri 2018a; Jalle et al. 2018b).

Before going to estimate the model, the unit root test is necessary to obtain the maximum integration order of the variables. Therefore, the study uses conventional unit root tests- Augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests to obtain robust results. The ADF test with an optimal lag length determined by the Schwarz information criteria (SIC) is used. The study employed cointegration test to examine the long run equilibrium relationship among the variables. We can write equation as follows:

$$EG_t = \beta_0 + \beta_1 EC_t + \beta_2 FDI_t + \varepsilon_t$$

Where, EG is Economic growth, EC is Energy consumption, FDI foreign direct investment. β_0, β_1 and β_2 are parameters and ε_t is error term.

4. Results

Unit root test is pre requisite of testing long run relationship between two or more time series data. The results of the ADF and PP test are shown in table-1 below. The two tests suggest that all the variables are non-stationary at level. When the data converted into first difference all the variable become stationary. From the table it is clear that all the variables (economic growth, energy consumption and FDI) are stationary in their first difference. Here the first difference of all the variables is taken to satisfy the stationary condition as they are not stationary at their level.

Table 1: Unit root test results

Variable	ADF				PP			
	Level		First Difference		Level		First Difference	
	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.
EG	1.967	0.999	-5.088	0.002*	2.280	0.999	-9.479	0.000*
EC	2.225	0.999	-4.594	0.006*	2.258	0.999	-4.594	0.006*
FDI	-1.712	0.412	-5.442	0.001*	-1.658	0.438	-5.442	0.001*

Note: *** indicates the rejection of null hypothesis of unit root at the 1% significance levels.

The study applied the Johanson cointegration test and results are displayed in Table 2. The results from table none indicates that the null hypothesis of no cointegration is not rejected but at most 1 the null hypothesis of no cointegration relationship among the variables is rejected against the alternative hypothesis of cointegration relationship between the variables. The results confirm long-run equilibrium relationship between the energy consumption, FDI and economic growth in India.

Table 2: Johanson Cointegration test results

Hypothesized No. of CE(s)	Trace Statistic	Critical Value	Prob.	Max-Eigen Statistic	Critical Value	Prob.
None*	45.657	29.797	0.000	40.737	21.131	0.000
At most 1	4.880	15.494	0.821	4.757	14.264	0.772
At most 2	0.122	3.841	0.726	0.122	3.841	0.726

Note: * indicate rejection of the null hypothesis at 1 and 5 level of significance, respectively.

We apply OLS method to study the impact of energy consumption, foreign direct investment on economic growth. The OLS results reported in Table 3. The results found that energy consumption and economic FDI have positive impact on economic growth in India. A one percent change in energy consumption leads to increase economic growth by 1.65 percent and a 1% change in foreign direct investment leads to increase economic growth by 0.03 per cent. These findings suggest that energy consumption and FDI is enhancing the economic growth in India during the study period.

Table 3: (OLS) results Dependent variable (Economic Growth)

Variable	Coefficient	t-Statistic	Prob.
EC	1.657	17.866	0.000***
FDI	0.037	1.968	0.061**
C	-3.323	-6.035	0.000***

Note: *** and ** indicates the significance at 1% and 10% level.

Finally, the study conducts a pair-wise Granger causality test to analyse the causal direction between the variables. The granger causality test results reported in Table 4. The estimated results provide sufficient evidence of a unidirectional causality runs from foreign direct investment to energy consumption.

Table 4: Granger Causality test results

Null Hypothesis:	F-Statistic	Prob.
EC does not Granger Cause EG	0.313	0.735
EG does not Granger Cause EC	1.231	0.315
FDI does not Granger Cause EG	0.119	0.888
EG does not Granger Cause FDI	2.561	0.104
FDI does not Granger Cause EC	6.126	0.003**
EC does not Granger Cause FDI	0.332	0.721

Note: ** indicate rejection of the null hypothesis at 1 % level of significance, respectively.

5. Conclusion

This study investigated the impact of energy consumption and foreign direct investment on economic growth in India. The time series model was used in this study from 1990 to 2014. The study employed cointegration technique, granger causality test and ordinary least square. The estimated results found long-run equilibrium relationship among the variables. The results also confirmed that energy consumption and foreign direct investment had played an important role to boost economic growth in India. The study found that there is a unidirectional causality runs from foreign direct investment to energy consumption.

References

Baranzini, A., Weber, S., Bareit, M. and Mathys, N.A., 2013. The causal relationship between energy use and economic growthin Switzerland. Energy Economics, 36, pp.464-470.

Bilgili, F., 2015. Business cycle co-movements between renewables consumption and industrial production: A continuous wavelet coherence approach. Renewable and sustainable energy reviews, 52, pp.325-332.

Hondroyiannis, G., Lolos, S. and Papapetrou, E., 2002. Energy consumption and economic growth: assessing the evidence from Greece. Energy economics, 24(4), pp.319-336.

Jalle, M & Gujjunuri, S., 2018a. Nexus between economic growth, renewable energy consumption, CO2 emissions and trade openness in India: An empirical investigation. International Journal of Research in Engineering, IT and Social Sciences, 8(7). 155-159.

Jalle, M & Gujjunuri, S., 2018b. Does tourism impact on income inequality? Evidence from India. International Journal of Research in Engineering, IT and Social Sciences 8(7), 97-101.

Jalle, M., Maheshwaram, K. S & Gujjunuri, S., 2018. Renewable and non-renewable energy consumption and economic growth in India. International Journal of Research in Economics and Social Sciences,8 (2), 818-827.

Mallick, L., & Ummalla, M. B., Jaganath. (2016). Does tourism affect economic growth in Indian states? Evidence from panel ARDL model. Theoretical and Applied Economics, 23(1), 183-194.

Paramati, S. R., Apergis, N., & Ummalla, M. (2018). Dynamics of renewable energy consumption and economic activities across the agriculture, industry, and service sectors: evidence in the perspective of sustainable development. Environmental Science and Pollution Research, 25(2), 1375-1387.

Paramati, S. R., Ummalla, M., & Apergis, N. (2016). The effect of foreign direct investment and stock market growth on clean energy use across a panel of emerging market economies. Energy Economics, 56, 29–41.