Causality relationship between CO_2 emission, energy intensity and economic growth in Sri Lanka

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1. Introduction

With continuous industrialization and increasing population pressure with significant change in lifestyle, the threat of global warming and climate change is rapidly increasing in recent time period. The carbon emission level is expected to be increased for many of the economies, resulting further towards global warming. As World Bank data shows, for the decade ended from 2015, CO_2 (Carbon Dioxide) emission in Sri Lanka has risen 0.608mt per capita to 1.14mt per capita. This continuous pace of growth has been caused by fast industrialization, accelerated growth of the service sector and has resulted in a high consumption of fossil fuel, massive destruction of natural resources, and rapidly increasing level of pollution of air and water. In addition to these factors, now Sri Lankan economy has been increasingly integrated to the outside world with active involvements of labour migration, tourism, and export of goods and services, these activities are expected to contribute significantly towards a high economic growth.

The main objective of this study was to evaluate the relationship between economic growth, energy consumption and carbon emission (which is considered as a proxy variable for environmental quality). The study mainly focused on the effect of the economic growth when carbon emission and energy consumption changes.

According to Uddin et.al., 2016 it has found the relationship between carbon emission, energy consumption and economic growth in Sri Lanka in between the time period of 1971 – 2006, and thereafter there were no any literature on this field found and therefore it is timely important to conduct with updated data for the current scenario of the country by following the same statistical tools.

2. Materials and Methods

Data source of the study was World Development Indicator 2019, published by the World Bank. The variables under consideration for the study are, carbon emission (C), energy consumption (E), real income (Y), and trade openness (T). For further analysis, these variables have been converted to logarithmic form. The relationship between variables can be shown in the following manner:

$$Ct = \alpha + \beta\ 1Et + \beta\ 2Yt + \beta\ 3Ot + \varepsilon t$$

where, εt is error term. Logarithmic transformation of the above equation and inclusion of a trend variable would leave the equation as follows:

$$LCt = \alpha 0 + \alpha t + \beta\ 1LEt + \beta\ 2LYt + \beta\ 3LOt + \varepsilon t$$

where, T is the trend variable, LC is the log of carbon emission; LE is the log of energy consumption; LY is the log of real GDP per capita; and LO is the log of trade openness ratio as a proxy for foreign trade. In the analysis, we applied multivariate Granger methodology to identify direction of causation among the variables of interest using Granger (1969) method. The estimation procedure begins with testing the time series properties of data.

3. Results and Discussion

Stationarity of the time series data were checked by using augmented Dickey–Fuller (ADF) in all the Differenced variables, the P value is lesser than the 5% and 10% critical values, and null hypothesis is rejected. Therefore, there is no unit root in those variables; then we stated that the series is stationary.

The co-integration test is warranted for checking whether the variables are co-integrated. If the variables in the present case are found to be co-integrated, they are said to have maintained a long-term relationship. Johansen co-integration test was used, and the null hypothesis was "there is no co-integration" and the alternative hypothesis was "there is co-integration among variables". In this case in the zero rank or the null hypothesis, the trace statistic (83.7965) is higher than the critical value (47.21), so the author had to reject the null hypothesis. Only in the maximum rank 3 is having trace statistic (2.0030) lower than critical value (3.76), so the author stated that there were three co-integrating equations. This state that the four variables were co-integrated. By further calculations using Vector Error Correction model (VECM), the error term in the variables was able to remove and made them non co-integrated.

It's mostly accepted that many of the macro variables are related in a way that sometimes it is difficult to understand the nature of such relationship between those variables. Therefore, we applied Granger causality test, which is widely used to understand the direction of causality between variables. Null hypothesis was "there is causality between variables", and the alternate hypothesis was "there is no causality between variables".

Table 01. Granger / Wald test for the variables

Variables	Carbon emission	Energy consumption	Real GDP	Trade openness
Carbon emission	-	0.6553	0.3331	0.4371
Energy consumption	0.4323	-	0.6624	0.7460
Real GDP	0.0052	0.0069	-	0.7156
Trade openness	0.8897	0.6548	0.9919	-

As shown in above table, the results for Sri Lanka reveal that there are existing unidirectional causality running from economic growth to the change in carbon emission, energy consumption and trade openness in the short run, which is found to be significant at 5% and 10% significance levels. Carbon emission shows higher P values than the significant levels in other variables after testing for causality, therefor null hypothesis cannot be rejected which showed there is causality between carbon emission and the rest of the variables. There are only two times the null hypothesis got rejected in the table and it stated that there is unidirectional causality between all the variables. Causality analysis exposed that Real GDP and Energy consumption are interdependent with each variable. There was bidirectional causality found between Energy Consumption and Carbon emission variables. The joint long-and-short runs causality analysis also supports the empirical findings for long run as well as short run.

4. Conclusions

This study investigated the dynamic relationship between Carbon emission, energy intensity and economic growth in Sri Lanka. For this purpose, author applied, the VECM Granger causality to test the direction of causal relationship between the variables. The results indicated that the variables are co-integrated for long run relationship. The empirical evidence showed that energy intensity increases carbon emissions and economic growth is a major contributor

for that situation. The causality analysis exposed the bidirectional causality between energy intensity and carbon emissions. The unidirectional causal relation is found running from economic growth and energy intensity to Carbon emissions. This suggests that carbon emissions can be reduced at the cost of economic growth or energy efficient technologies should be encouraged to enhance domestic production. Sri Lankan policy makers, should use supplementary policies when using the carbon emission reduction policies, since carbon emission and economic growth have positive relationship between them, if those policies were made to decrease carbon emission that can create negative impact on economic growth. Future research can be conducted by investigating the relationship between renewable energy consumption, non-renewable energy consumption.

5. References

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