CHAPTER - 5

SUMMARY AND CONCLUSION

As the two major emerging economies, China and India are presently at the forefront of economic growth and development. Determined steps to combat climate change have been taken by these future global leaders. The economic strategies and policies that these governments announce have never been without a greater concern for the environment. As a consequence, they are showcasing a new way of growth to the onlookers. Though both the economies have unique developmental challenges still are trying to switch on to the renewable sources to achieve more energy efficiency and keep up the promises made in the international agreements.

5.1 Research Problem

India and China are the two major transitional and emerging economies of Asia which are in the two distinct stages of structural change, technological innovation, trade, energy use and economic growth (Fan&Hossain, 2018). Sustainable economic growth and development is very much desirable to get better social wellbeing. Every economy has the objective to achieve the desired stage of economic growth and development for a long term without harming environment quality. Both the countries selected for the study have achieved noteworthy economic development in the last few decades. GDP of both collectively account for 25 percent of the global GDP (World Bank databank, 2020). Trade openness is no doubt a primary driving force behind country's development and it is true for India and China too. Faster Economic growth of both the countries has led to the consumption of energy which is projected to be 32 percent of world energy consumption in 2035 (Energy Information Administration, 2015). This increase in energy consumption drastically increases the pollution levels. India's and China's contribution to the world's emission increased to 33 percent in 2018(World Bank databank, 2018). In the process of industrialization, these two countries give priority to secondary industry which is high in energy consumption resulting in high carbon dioxide emissions. Further development requires considerably more energy than the countries currently consume. India and China will naturally speed up environmental degradation due

to their large amount of carbon dioxide emission. It is inequitable to ask developing countries to sacrifice growth for the sake of reducing emissions (Truong, 2010). These issues and challenges have led to widespread and intense debates all over the world and so, many countries are engaged in the mitigation of greenhouse gas emissions.

Thus this study is an attempt to understand the relationship between greenhouse gas emissions per capita, trade openness and gross domestic product per capita in these two economies for 49 years (1970 to 2018).

5.2 Objectives of the study

The present study is an attempt to investigate the relationship between greenhouse gas emissions per capita, trade openness and gross domestic product per capita in India and China, the world's fastest growing economies. To understand the linkages, the study was carried out with the following objectives.

1. To analyse the trend and growth of greenhouse gas emissions per capita, trade openness and gross domestic product per capita in India and China.
2. To assess the decoupling status of greenhouse gas emissions per capita and gross domestic product per capita, greenhouse gas emissions per capita and energy consumption per capita, greenhouse gas emissions per capita and trade openness.
3. To test the stationarity of greenhouse gas emissions per capita, gross domestic product per capita, trade openness and their determinants.
4. To study the cointegrating relationship among greenhouse gas emission per capita, gross domestic product per capita, trade openness and their determinants.
5. To test the causal relationship among the greenhouse gas emissions per capita, gross domestic product per capita and trade openness

5.3 Hypotheses of the study

1. The variables chosen in the study are stationary
2. There exists long run relationship among the greenhouse gas emissions per capita and its determinants
3. There exists long run relationship between gross domestic product per capita and its determinants
4. There exists long run relationship between trade openness and its determinants
5. Decoupling effects exist between greenhouse gas emissions per capita and gross domestic product per capita, greenhouse gas emissions per capita and energy consumption per capita, greenhouse gas emissions per capita and trade openness

The present study is based on the Environment Kuznets curve hypothesis which says about the decoupling between environmental degradation and economic growth. The study used data for the period 1970 to 2018 from World Bank, Our World in data, World Resources Institute and Emissions database for global atmospheric research websites. Suitable econometric techniques like cointegration approach, vector error correction approach, Granger causality approach, decoupling analysis, variance decomposition analysis, impulse response function, CUSUM tests and CUSUM square tests were applied to fulfill the objectives of the study. The findings are summarized as following.

5.4 Summary of findings

5.4.1 Growth and trend pattern of selected macroeconomic variables

Gross domestic product per capita in India and China

- For India, GDP per capita grew at an average of 0.3 percent in 1970s and improved to 3.3 percent in the 1980s. It accelerated to 3.7 percent during the 1990s and to 4.6 percent in the decade of 2000, and further to 6.8 percent in the past one decade. This increase can be attributed to the liberalisation of Industry and trade and borrowings from abroad. China's average gross domestic product per capita was 4.1 percent in 1970s, 8.2 percent in 1980s, 8.8 percent in 1990s and increased to 9.7 percent in the decade of 2000. But the last decade showed a decline in the gross

domestic product per capita to 7.3 percent. The global slowdown of 2008 had an impact on Indian Economy and Chinese economy reflecting in the annual growth rate which stood at 2 percent for India and dropped down from 14 percent to 9 percent for China. After this period, the real GDP of China has slowed down significantly reflecting in the per capita gross domestic product, making China's economy matured. Its growth has slowed significantly and dropped to 6 percent in 2018. International Monetary Fund (IMF) has projected a further fall to 5.5 percent by 2024.

- For India, the average pace of per capita growth was 5.8 percent a year in the last decade which is stable and steady compared to China. The compound annual growth rate of GDP per capita for India is 3.39 percent and China is 7.29 percent during the study period.

Greenhouse gas emissions per capita in India and China

- The compound annual growth rate of greenhouse gas emissions in India is 3.35 percent and China is 4.41 percent. Though comparatively India emits low still it is not far behind in emissions, the country being the third largest emitter in the world. India too faces the big challenge of curbing greenhouse gas emissions as the economy grows and population increases.

Gross Fixed Capital Formation in India and China

- During 1970s, average annual growth rate of gross fixed capital formation (investment) of China was 7.6 percent, while India's investment growth rate was 2.7 percent only. Similarly in the decades of 90s, 2000, and 2010, China showed higher growth rate of 6 percent, 15.3 percent and 7 percent respectively in comparison to India.

Trade openness in India and China

- The trade openness growth rate in the five decades was fluctuating for India. The country had higher growth rate of 5.1 percent in 1990s and 6.9 percent in the decade of 2000. During 70s and 80s, China showed tremendous increase in the trade openness with10.5 percent and 9.5 percent respectively. The compound annual growth during 1970-2018 was 3.52 percent for India and 4.17 percent for China.

Energy consumption per capita in India and China

- The annual growth rate of energy consumption per capita has been the highest in the 1970s and 2000 to 2009 for China with 6.1 percent and 8.5 percent respectively. The compound annual growth rate for India was 2.07 percent and for China, it was 3.79 percent. But China's energy consumption per capita had slowed down after 2010 showing signs of maturing economy which moves away from heavy industry to less energy-intensive service.

Population in India and China

- There has been decline in population growth 1970 to 2018 in both India and China. The compound annual growth was negative with -1.49 percent for India and -3.53 percent for China.

Exchange rate in India and China

- The exchange rate of India in the first year of the study period 1970 was Rs.7.50 which increased to Rs 68.38 in 2018 bringing down the value of Indian Rupee against US Dollars. China's Yuan was valued at 2.46 in 1970 which increased to 6.61 Yuan only in 2018 showing more stability.

Inflation rate in India and China

- The inflation rate in India increased steadily to 8.47 percent in the 1970s and 8.7 percent in the 1980s. Widening of fiscal balances created demand pressures and became the reason for inflationary pressures in the 1980s. After the structural adjustment policies of 1991, inflation rate had increased drastically. The second half of the 1990s was marked by a significant spin in the inflation effect reflecting the improved monetary-fiscal interface. Inflation in India has declined steadily from an average of 8.7 percent in the 1990s to 5.7 percent during the decade of 2000. From 2010 to 2018, inflation fell to 5 percent.
- On the other hand, inflation in China has been comparatively low with 1.06 percent in 1970s, 4.7 percent in 1980s, 3.5 percent in the decade of 2000 and 2.8 percent in the last decade. Given the fact that Indian economy is

severely marred by inflation, it seems unlikely that they will be able to compete against China in the long run.

5.4.2 Decoupling status

Decoupling status of Greenhouse gas emissions per capita and gross domestic product per capita in India and China

- In India during the period 1970-2018, majority of the years had weak decoupling status which means that as GDP increases, greenhouse gas emissions increase less than GDP. During the study period in China, it can be seen that weak decoupling was mostly found in about 27 years spread out. Strong decoupling can be seen in 12 years in the country. Expansive coupling was observed in 7years over the period. Expansive Negative decoupling was found in 1975 and Weak Negative decoupling in 1976.

Decoupling status of Greenhouse gas emissions per capita and energy consumption per capita in India and China

- In India among the 49 years of the study period, 29 years showed weak decoupling implying that as the energy consumption increases as result of economic growth of the country, there is an accompanied emission which also increases at a rate lesser than GDP. Weak decoupling was the status in about 32 years in China from 1970 to 2018.For both India and China, weak decoupling in majority of the years shows that pollution emissions growth is slower than the economic growth. This may be a welcome sign showing the shift to energy efficient and low polluting fuels used in the various spheres for the country's development. This energy efficiency shift has been due to the policy action of both the countries.

Decoupling status of Greenhouse gas emissions per capita and trade openness in India and China

- The decoupling status of greenhouse gas emissions per capita and trade openness in India showed that for 23 years the country had weak decoupling status. The relationship between trade openness and greenhouse gas emissions per capita was found to be strong negative decoupling in China for 13 year and weak decoupling for 15 years. Weak

decoupling occurred between greenhouse gas emissions per capita and trade openness in majority of the years in India whereas in China both Weak and strong decoupling happened to be equally seen.

5.4.3. Long run relationship between GDP and its determinants using cointegration analysis

The ADF test

- The ADF unit root test of stationarity for GDP per capita, GFCF per capita, trade openness, inflation, population, energy consumption per capita and GHG per capita revealed the following. Using the Intercept criteria the results showed the variables GDP per capita, GFCF per capita, trade openness, inflation energy consumption per capita, population and GHG emissions per capita became stationary only in their first differences for both India and China.
- The results of the unit root with trend and intercept pointed out clearly that the null hypothesis of a unit root can be rejected at the level for inflation for India and GHG emissions per capita and inflation for China. However, the hypothesis of unit root was rejected in the first difference at 5 percent level of significance, meaning that GDP per capita, GFCF per capita, energy consumption per capita, trade openness, population and GHG emissions per capita were found to be stationary at their first differences for India and the variables GDP per capita, GFCF per capita, trade openness, energy consumption per capita, population and were found to be stationary at first differences for China.

Long run relationship- Cointegration test

- The Johansen and Juselius (1990) test of cointegration revealed that there were 6 cointegrating equations for India and China showing presence of long run relationship in the greenhouse gas emissions equation.
- The coefficients obtained revealed that trade openness and energy consumption per capita have positive impact on the GDP per capita in India during the study period. It denotes that an increase in the values of the above variables will lead to an increase in GDP per capita. The remaining variables such as GFCF per capita, inflation, population and GHG

emissions per capita have a negative effect on GDP per capita in India and GFCF per capita, trade openness, inflation, population and energy consumption per capita have negative impact on GDP per capita in China. The coefficient of energy consumption per capita is highest (0.28) in India implying that a one percent increase in energy consumption per capita will lead to 28 percent increase in GDP per capita. For China, energy consumption per capita and GHG emissions per capita have positive effects on GDP per capita in China. GFCF per capita, trade openness, inflation and population have negative impact on GDP per capita. The coefficient of GHG emission per capita has higher coefficient (0.58) in China implying that a one percent increase in GHG emissions per capita will lead to 58 percent increase in GDP per capita. The coefficients obtained from the cointegration equation clearly shows that GDP per capita during the study period for India is impacted by GFCF per capita, trade openness, population, inflation GHG emissions per capita and energy consumption per capita.

5.4.4Short run relationship-Vector Error Correction Model (VECM)

- The error correction coefficient for GDP per capita as dependent variable for India was negative (-0.1476) indicating that the series for GHG emissions per capita will converge in the long run. The magnitude shows that GDP per capita will adjust for about 0.15 percent of its total deviations from the long run equilibrium during the short run. A percentage change in two year lagged energy consumption per capita is associated with a 0.68 percent increase in GDP and is significant at 10 percent level
- For China the error correction coefficient of GDP per capita was negative (-0.29) showing the ability to go back to equilibrium in the long run. The variable inflation impacted positively on GDP per capita and was statistically significant at 5 percent level.
- The estimated error correction model has the minimum goodness of fit with R^2 value being 0.59 and adjusted R^2 of 0.35 for India. The R^2 indicated that for India 59 percentage of variations in the dependent variable was due to the variations in the explanatory variables used in the model. For China,

the R^2 was 0.43 and adjusted R^2 was 0.29 which indicated that 43 percentages of variations in the dependent variable was due to the variations in the explanatory variables used in the model.

5.4.5 Variance Decomposition Analysis

- In the short run, 100 percent variance is explained by the variable itself meaning strongly endogenous. The remaining variables do not have any influence. From second period onwards, Inflation has an influence on GDP per capita both in the short run and in the long run. Variance contribution of GDP per capita in the long run is 82.6 percent, the variance contribution of GFCF per capita is about 0.58 percent, variance contribution of trade openness, population, energy consumption per capita and greenhouse gas emissions per capita is 1.34 percent, 10.20 percent, 0.48 percent, 1.76percent and 3 percent respectively.
- For China, 100 percent forecast error variance of GDP per capita is explained by itself in the short run. Population has a strong influence on GDP per capita from second period onwards, variance contribution of GDP per capita itself is 58 percent and population is 21.4 percent in the long run.

5.4.6 Impulse response Function

- For India, SD shock on GDP per capita will cause positive impact on GFCF per capita, energy consumption per capita and greenhouse gas emissions per capita in the short and long run. The innovation given on GDP per capita will cause an asymmetric impact on trade openness and inflation and a negative impact on population.
- For China, an SD shock on GDP per capita will cause an asymmetric impact on GFCF per capita, inflation and population. The shock on GDP per capita will cause positive impact on trade openness, energy consumption per capita and greenhouse gas emissions per capita.

5.4.7 Test of Stability- CUSUM and CUSUMSQ plot

The CUSUM and CUSUMSQ plot of the residuals generated from the vector error correction model for gross domestic product per capita was used to test its stability and the results revealed that the CUSUM plot for GDP per capita was within the 5 percent critical bound levels, indicating that the gross domestic product was found to be stable throughout the study period for both India and China. The CUSUMSQ plot revealed that there was evidence of instability for India from 1980s till 1995 and for China after 1995.

5.4.8 Long run relationship between Trade openness and its determinants (Gross domestic product per capita, gross fixed capital formation per capita, exchange rate and population)using cointegration analysis

The ADF test

- The ADF unit root test of stationarity results are as follows. Using the "Intercept" and "Trend and intercept" criteria the results indicated that the variables GDP per capita, GFCF per capita, exchange rate, population and trade openness became stationary only in their first differences for India and China.

Long run relationship- Cointegration tests

- The Johansen and Juselius (1990) test of cointegration revealed that there were 1 cointegrating equation for India and 2 for China showing presence of long run relationship in the trade openness equation
- The coefficients obtained revealed that GFCF per capita and exchange rate have negative impact on trade openness in India during the study period. It denotes that an increase in the values of the GFCF per capita and exchange rate will lead to decline in trade openness. GDP per capita and population have a positive effect on trade openness in India. The coefficient of GDP is highest with 31.7 percent implying that one percent increase in the GDP leads to 31.7 percent increase in trade openness. The coefficients obtained for China revealed that GFCF per capita and population have negative impact on trade openness during the study period. It denotes that an increase in the values of the GFCF per capita

and population will lead to decline in trade openness. GDP per capita and population have positive impact on trade openness in China. The co-efficient of GDP is the highest with 0.32 percent implying that one percent increase in GDP leads to 0.32 percent increase in trade openness.

5.4.9 Short run relationship-Vector Error Correction Model (VECM)

- The error correction coefficient for trade openness as dependent variable for India was negative (-0.0081) indicating that the trade openness emissions series will converge in the long run. An increase in exchange rate by one percent will cause a decline of 0.68 percent in trade openness. An increase in population by one percent will lead to an increase in trade openness by 0.76 percent.
- For China, the error correction coefficient for trade openness was negative (-0.0546) indicating that GHG Emissions series will converge in the long run. The results also reveal that a percent change in lagged trade openness causes 0.35 percent increase in trade openness and is statistically significant at 10 percent level.
- The estimated error correction model has the minimum goodness of fit with R^2 value being 0.25 and adjusted R^2 of -0.06 for India. The R^2 indicated that for India, 25 percentages of variations in the dependent variable was accounted for by the variations in the explanatory variables used in the model. For China, the R^2 was 0.32 and adjusted R^2 was 0.04 which indicated that 32 percent of variations in the dependent variable were accounted for by the variations in the explanatory variables used in the model.

5.4.10. Variance Decomposition Analysis

- In the short run, 100 percent variance is explained by the variable itself meaning strongly endogenous. The remaining variables do not have any influence. From second period onwards, GDP per capita and GFCF per capita have strong influence on trade openness both in the short run and in the long run. Variance contribution of trade openness in the long run is 50 percent, the variance contribution of GFCF per capita is about 0.58 percent, variance contribution of GDP per capita, GFCF per capita,

population and exchange rate is 24 percent 16 percent,8 percent and 1 percent respectively.

- For China, 100 percent forecast error variance of trade openness is explained by itself in the short run. GFCF per capita has a strong influence on GDP per capita from second period onwards. Variance contribution of trade openness itself is 67 percent and population is 23 percent in the long run.

5.4.11 Impulse Response Function

- The IRF of GDP is negative both in the short run and long run for India implying that GDP per capita has negative influence on trade openness. For China the response is positive both in the short run and long run supporting the view that trade openness is one of the important reasons for its faster growth.
- The GFCF per capita is negative both in the short run and long run for India and China. The population variable is positive throughout the period in both India and China.
- The response of exchange rate (ER) is stable initially and stays in the positive region in the long run for India. For China, the exchange rate response was positive in both short run and long run.
- It can be inferred that a standard deviation shock on trade openness will cause a positive impact on population and exchange rate in India. The innovation given to trade openness will cause a negative impact on GDP per capita and GFCF per capita. For China, an SD shock on trade openness will cause positive impact on GDP per capita, population and exchange rate and a negative impact on GFCF per capita.

5.4.12Test of Stability- CUSUM and CUSUMSQ plot

The CUSUM and CUSUMSQ plot of the residuals generated from the vector error correction model for trade openness was used to test its stability and the results revealed that the CUSUM plot and CUSUM square plot for trade openness was within the 5 percent critical bound levels, indicating that the trade openness was found to be stable throughout the study period for both India and China.

5.4.13 Long run relationship between Greenhouse gas emissions and its determinants using cointegration analysis

The ADF test

- The ADF test of stationarity for the selected determinants of greenhouse gas emissions such as GDP per capita, GDP per capita square, GHG per capita, energy consumption per capita and trade openness was carried out. In the intercept criteria of Unit root test, the results indicated that all the variables GDP per capita, GDP per capita square, GHG per capita, EN per capita and trade openness became stationary only in their first differences for India and China.
- The results of the unit root with trend and intercept revealed that the null hypothesis of unit root was rejected in the first difference at 5 percent level of significance for all the variables such that that GDP per capita, GDP per capita square, GHG emissions per capita, energy consumption per capita and trade openness were found to be stationary at their first differences for India and China.

Long run relationship-Cointegration Test

- The Johansen and Juselius (1990) test of cointegration revealed that there were 3 cointegrating equations for India and China showing presence of long run relationship in the greenhouse gas emissions equation.

  The coefficients obtained revealed that GDP per capita and GDP per capita square have positive impact on the GHG emissions per capita in India and GDP per capita, energy consumption per capita and trade openness have positive impact on GHG emissions per capita for China in the long run. It

denotes that an increase in the values of the above variables will lead to increase in GHG emissions per capita. Energy consumption per capita and trade openness have a negative effect on GHG emissions per capita for India and for China. GDP per capita square has negative effect on GHG emissions per capita. .

- The study found that for China, the effects of GDP per capita and GDP per capita square on greenhouse gas emissions per capita are positive and negative respectively thus confirming the inverted U shape for the study period in accordance with EKC theory But for India there is no evidence of such a relationship between greenhouse gas emissions per capita and gross domestic product.

Short run relationship-Vector Error Correction Model (VECM)

- The error correction coefficient for GHG emissions per capita as dependent variable for India was negative (-0.4860) as in the theory indicating that the series for GHG emissions per capita will converge in the long run. The variable one year lagged trade openness is associated with 0.001 percent increase in GHG emissions per capita in India and is statistically significant at 5 percent level.
- For China It was found that the error correction coefficient for GHG emissions per capita was negative (-0.2917) indicating that the series for GHG emissions per capita will converge in the long run. The adjustment coefficient which corrects the previous period deviation and the magnitude shows that GHG emissions per capita will adjust for about 0.29 percent of its total deviations from the long run equilibrium during the short run. A percent change in two year lagged GHG per capita by itself will lead to 0.30 percent decrease in GHG per capita and is statistically significant at 10 percent level.
- The estimated error correction model has the minimum goodness of fit with R^2 value being 0.48 and adjusted R^2 of 0.39 for India. The R^2 indicated that for India 48 percentage of variations in the dependent variable was due to the variations in the explanatory variables used in the model. For China, the R^2 was 0.66 and adjusted R^2 was 0.51 which indicated that 66 percent

of variations in the dependent variable were due to the variations in the explanatory variables used in the model.

5.4.14 Variance Decomposition Analysis

- The variance decomposition results showed that in the short run 100 percent variance is explained by the variable itself meaning strongly endogenous. The remaining variables do not have any influence. From second period onwards, GDP per capita square have strong influence on GHG emissions per capita both in the short run and in the long run. Variance contribution of GHG emissions per capita is 57.3 percent, the variance contribution of GDP per capita is about 9.18 percent, variance contribution of GDP per capita square, energy consumption per capita and trade openness is 30.75 percent, 0.58 percent and 2.18 percent respectively.
- For China, 100% forecast error variance of GHG emissions per capita is explained by itself in the short run. Energy consumption per capita has a strong influence on GHG emissions per capita from second period onwards. Variance contribution of GHG per capita itself is 56.13% and of energy consumption per capita is 15.63%

5.4.15 Impulse Response Function

- The impulse response function of GDP pc in both India and China is almost the same. In India, it initially increases in the short run, then declines in the 2^{nd} period, becomes stable while nearing the 5^{th} period attains negative region after that. In China the response of GDP pc is positive and increasing till 2^{nd} period, declines in the third period, becomes stable in the short run and attains negative in the long run. The response of GDP pc^2 initially is positive but gradually falls till period 9 and becomes negative in the 10^{th} period for India. In the case of China, the IRF of GDP pc^2 is same as the response of GDP pc, first it is positive and stable and then becomes negative in the long run. It can be inferred that in India any shock on greenhouse gas emissions will cause a positive impact on gross domestic product per capita square and energy consumption per capita and negative effect on trade openness. An innovation on greenhouse gas emissions will

cause an asymmetric impact on gross domestic product per capita in India. For China an innovation on greenhouse gas emissions per capita will cause an asymmetric impact on GDP per capita, GDP per capita square, energy consumption per capita and trade openness. The figure clearly shows how the economic growth inhibits greenhouse emissions in the long run especially for China supporting the EKC hypothesis but the decoupling happened to be slower in India comparatively. GDP pc ^{2} in India and China shows the same effects as their GDP pc responses.

5.4.16 Test of Stability- CUSUM and CUSUMSQ plot

- The CUSUM and CUSUMSQ plot of the residuals generated from the vector error correction model for greenhouse gas emissions per capita were used to test its stability and the results revealed that the CUSUM plot for GHG per capita was within the 5 percent critical bound levels, indicating that the greenhouse gas emissions was found to be stable throughout the study period for both India and China. The CUSUMSQ plot revealed that there was evidence of stability for India and China, some period in 80s showed instability.

5.4.17 Granger's Causality

Granger's causality in Model I revealed unidirectional relationship between the following variable pairs for India such as

- Gross domestic product per capita & greenhouse gas emissions per capita,
- Gross domestic product per capita square and greenhouse gas emissions per capita
- Energy consumption per capita and greenhouse gas emissions per capita,
- Gross domestic product per capita square and trade openness

For China the following pairs had unidirectional relationship.

- Gross domestic product per capita and greenhouse gas emissions per capita
- Gross domestic product per capita square and greenhouse gas emissions per capita
- Trade openness and greenhouse gas emissions per capita

- Trade openness and gross domestic product per capita square
- Trade openness and energy consumption per capita.

The pairs which showed bidirectional causality were

- Gross domestic product per capita square &gross domestic product per capita.

The causality running from gross domestic product per capita to greenhouse gas emissions in both India and China revealed that all steps taken to improve growth will increase the emissions. When the countries grow the consumption of energy is more and therefore emissions increase as can be seen from the unidirectional causality between energy consumption per capita and green house gas emissions per capita in both India and China. The results for China clearly show how trade openness is the cause for increase in gross domestic product per capita, energy consumption per capita and green house gas emissions per capita similar to the finding by Jun et al,2020.

Conclusion

This study looked at the presence of long run relationships among greenhouse gas emissions per capita, trade openness and gross domestic product per capita in both India and China. Results from cointegration analysis using VECM indicate presence of long run relationship among the variables at all conventional levels of significance. The study confirmed the existence of inverted U shaped EKC hypothesis for the study period in China in accordance with EKC theory and empirical research by Jalil and Mahmu (2009), Halkos, G. and Tzeremes(2011), Xu et al. (2018), Hao et al. (2019). But for India there is no evidence of such a relationship between greenhouse gas emissions per capita and gross domestic product similar to the results of Makarrabbi et al. (2017).The existence of EKC in China guarantees the definitive improvement in the environment along the trade openness path.

Decoupling analysis shows that decoupling happens in both the countries but it is ‘weak decoupling’ for majority of the years indicating the need for stronger commitment to shift to energy efficient methods of production. Results based on granger causality show evidence of a Granger causality running from GDP per capita to greenhouse gas emissions per capita for both India and China cautioning

that environmental conservation policies should aim at reducing emissions of all the greenhouse gases including non carbon emissions too without sacrificing economic growth. This implies that both the economies should pursue energy conservation policies and greenhouse gas emission reduction policies in the long run without compromising economic growth. This calls for policy makers to consolidate the policy framework to ensure the economy is grown sustainably

Suggestions

The following are the suggestions of the study

- Economic activities are important for the development of a country. But emissions pose a serious threat to the survival of all living beings in the planet. China and India being fastest emerging economies have to take a serious look over them.
- Effective and timely actions could reduce the speed of emissions. Investment should be made on renewable resources so as to reduce the dependence on fossil fuels for sustainable growth. Emissions from short lived pollutants also have to be given considerable attention to reduce the dangerous permanent impact on the globe.
- Polluter should pay should be the rule which would bring a substantial reduction in the emissions.
- Realistic and sensible measures are the need of the hour. Adopting energy efficient building codes, improving appliance efficiency standards, encouraging public education and information programmes for conservation and recycling, energy research and development budget could be solutions if implemented properly by the administrators in both the economy.
- Pollution free technology such as emission control devices should be insisted in vehicles and machineries to meet the exhaust standards of the Clean Air Act for carbon monoxide and hydrocarbons.
- On the whole the results call for comprehensive economic, financial, institutional and energy policies for guaranteeing environmental sustainability

Scope for further research

- The present study focused on two emerging economies India and China for the period 1970 to 2018. An in-depth study of the states of India and provinces of China may help the policy makers to make state specific or province specific measures so as to control the emissions at a greater speed.
- The period of study may be extended to include the years affected by Pandemic (2019-21) which may give interesting insights.
- Novel methods of analysis of the long run relationships among the variables may be applied for the same period.
- The problem of endogenity may be addressed in the time series models with two stage and three stage models. It may give unique results showing the relationship between greenhouse gas per capita, trade openness and gross domestic product per capita.