Does Globalization Impede Environmental Quality in India?

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Abstract: Using annual data for the period 1970-2012, the study explores the relationship between globalization and CO_2 emissions by incorporating energy consumption, financial development and economic growth in CO_2 emission function for India. It applies Lee and Strazicich (2013) unit root test for examining the stationary properties of variables in presence of structural breaks and employs the cointegration method proposed by Bayer-Hanck (2013) to test the long-run relationships in the model. The robustness s of cointegration result from the latter model was further verified with the application of the ARDL bounds testing approach to cointegration proposed by Pesaran, Shin and Smith (2001). After confirming the existence of cointegration, the overall long run estimates of the estimation of carbon emission model points out that acceleration in the process of globalization (measured in its three dimensions - economic, social and political globalizations) and energy consumption result in increasing CO_2 emissions, along with the contribution of economic development and financial development towards the deterioration of the environmental quality by raising CO_2 emissions over the long-run. This finding validates holding of environmental Kuznets Curve (EKC) hypothesis for the Indian context.

Keywords: Globalization, Economic growth, Energy consumption, CO_2 Emissions
JEL Classification: F00, Q54

I. Introduction

Globalization being a worldwide phenomenon has been affecting each human being in every part of the world in their socio-economic-political aspects of the life. Globalization mostly links all the economies through trade in goods and services and foreign direct investment (FDI) and its consequences are numerous. This has got implications for the degree of openness, financial development, growth of real per capita income and environmental quality across the economies. While each economy desires to achieve higher rate of per capita income growth through trade and investment, the process of achieving growth through industrialization and urbanization fortuitously gives rise to undesirable or unintended externalities such as pollution and thereby degradation of environmental quality, owing to intensification in the consumption of conventional forms of energy in major economic activities including industrial production activity. While energy consumption serves as a vital input into the production and economic growth, it has its side effects, by causing environmental pollutions in terms of release of carbon dioxide (CO_2) and sulphur dioxide (SO_2). The emissions of these pollutions have implications for global climate change and ecological imbalances and thereby can cause enormous economic damages and direct and indirect welfare losses for the civilizations on the earth. The effects of these emissions may result in dragging economic growth through their welfare retarding effects. Hence, the effects of intensification in the use of energy for consumption and production activities, depend on its net impact on an economy whether its good outcomes dominate over the bad outcomes or *vice-versa*.

Higher the degree of openness (a measure of globalization) of an economy means increased external competitiveness and strong linkage of an economy in trade and investment (domestic and foreign) with rest of the world, which indirectly implies for higher economic growth. But while engaging in trade and investment activities, this also requires consumption of huge quantum of energy which releases more carbon dioxide. An effort towards reduction of carbon dioxide without exploration of substitutive clean energy implies the economy has to sustain with lesser degree of industrialization, lesser openness and lesser economic growth. Thus, the effect of globalization depends on the net effects of openness on economic growth as there could be a net effect of energy consumption on economic growth and also the effect of openness on energy consumption. This is because of their inherent dynamic relationships with each other. Since economic growth is associated with higher energy consumption and its qualitative impact on environment, unless one controls the openness variable in energy demand model, it is difficult to disentangle the effects of energy consumption on economic growth and similarly unless one controls for the energy consumption, along with openness and financial development, one can't disentangle the effect of economic growth on carbon emissions in carbon estimating model. There is more likelihood of obtaining biased prediction about their dynamic relationships between these variables. Further, the degree of openness itself also depends on liberalization measures adopted by the concerned economies with regard to their trade and investments and ultimately also their degree of financial development.

Considerable studies have attempted to address how increased trade is directly or indirectly responsible for the environmental degradation and how all the dimensions of globalization affect the natural environments. Globalization contributes to economic growth through expansion of trade and investment flows between the countries and thereby affects the environmental quality in many ways that can adversely affect the economies when they persistently rely on export led growth strategies. Globalization accelerates the structural change by altering the industrial structure of countries as industries orient towards satisfying foreign demand for their products and this gives rise to increased resource use and atmospheric pollution levels. This in turn intensifies the market failures and policy distortions that may spread and exacerbate environmental damage. Globalization intensifies trade liberalization and trade related activities and those in turn affect the environment when all goods and services produced in the economy are directly and indirectly associated with uses of power and energy (oil products, natural gas), which are common to all the countries. According to the types of fuels utilized, correspondingly emissions levels are obvious.

The environmental degradation also further depends on the types of technology used in production. With technological sophistications, nations are putting efforts to extract energy from various renewable sources such as solar and wind powers and through cost effective ways. There remains to establish the link between technological innovations on the one hand and environmental quality and resource use on the other. A significant attention has been paid to the economic benefits of globalization but reasonable attention has not been paid to the social and environmental implications. Therefore, the paper attempts to address a crucial issue for a developing economy context - whether globalization as a result of international trade and investments has been always bettering for economies' growth and environment. We find that the energy consumption is a major contributing factor of CO_2 emissions. The economic growth along with financial development degrades the environmental quality. Globalization (especially the measure of political globalization and social globalization) impedes environmental quality. While economic growth Granger causes CO_2 emissions, the opposite also holds true. Energy consumption and CO_2 emissions are interdependent and same relationship holds true for economic growth and energy consumption. The relationship between globalization and CO_2 emissions is bidirectional. Financial development Granger causes economic growth, energy consumption, globalization and CO_2 emissions.

I.I Indian Experience

India has undergone significant transformations during its phase of the post - liberalization period, 1990-91. The economy initiated a number of liberalization policies mainly owing to imbalances in its fiscal performance and current account performances of the BOP faced during the period of 1990s. India since independence has been importing oil and natural gas massively from the oil producing rich countries in the gulf to fulfill its huge increasing demand mainly on account of rising population, urbanization and industrialization. The sharp international demand pressures and frequent oil crises in the world economy mainly owing to international embargoes among the oil rich countries in the past, it has resulted in the increasing price of oil and its volatility which have economically dragged the economy to produce deficits in its current account performances of BOP.

India being a poor developing economy is believed to mostly compromises with its environmental standards in an effort to maintain its international competitiveness position at a high level and thus might have induced the economy to relatively engage in exporting more of pollution-intensive goods, or might have inwardly attracted more pollution-intensive foreign capital investments from other countries. There are theories which also widely believes that the developing economies might have developed comparative advantage in pollution-intensive industries and become ‘havens’ for the world’s polluting industries (Siebert, 1977, McGuire, 1982, Copeland and Taylor, 1995). However, the empirical evidences are not so strong in support of the ‘pollution haven hypothesis’. This may be because India is one of the lowest greenhouse gas emitters in the world on a per-capita basis. It was emitting to the tune of 1.13 tons of carbon equivalents per capita in 2000 which is roughly one-fourth of the corresponding global average and now it has marginally gone up to 1.67 tons in 2010 on per capita basis. On the other hand, given the large size of the Indian economy, there has been faster growth of carbon emissions over the last decade from 69 percentage from 2000 to 2010, while its gross domestic output has grown at the rate of 110 percentage over the same time period. India is highly vulnerable to climate change, as large population are dependent on agriculture and natural resources and any adverse impact on these and related sectors due to environmental degradation and climate change will negate government's efforts to eradicate poverty and ensure sustainable livelihood for the population (Boutabba, 2014).

One possible theoretical explanation in support of low carbon emitting developing economy is based on the factor endowments hypothesis. This asserts that factor endowment (or technology) determines a countries’ comparative advantage and the polluting industries are typically capital intensive. Therefore, the polluting industries are more likely to be concentrated in capital abundant developed economies regardless of their differences in the environmental policy (Copeland and Taylor, 2004). Nevertheless, the empirical evidence relating to this is also very scant. The previous empirical literature on this issue provides interesting and conflicting evidences; and the consensus is yet to reemerge. This motivates us to relate the energy consumption, openness, economic growth and carbon emissions for an emerging developing economy, India. This is one of the populous countries with lower per capita incomes, is currently pursuing to promote industrialization simultaneously along with the presence of flourishing service sector. The economy is highly relying on all the traditional sources of energy along with engaging rapidly with the world in trade, finance and foreign investments.

Given the above background, the main objective of this paper is to investigate a country specific dynamic relationship between globalization, CO_2 emissions, energy consumption, financial development and economic growth. This is mainly because of the empirical analysis at the aggregate level using multiple countries is unable to capture the complexities of the economic environment of each individual country. Therefore, we recommend that a country specific analysis will provide many inferences on the issue we are investigating. Furthermore, our choice of India as an empirical attempt is motivated by the fact that India is one of the fastest growing Asian economies and second most populous countries in the world with more than one billion population, which implies that its energy consumption and CO_2 emissions will continue to rise in the face of globalization in the future. The choice of the country is further motivated by the fact that India has been the world's fourth largest energy consumer (EIA, 2011), and world's third biggest emitter of CO_2 that accounts for more than 5% of global emissions (EIA, 2011). It is expected to believe that India's primary energy supply will increase by at least 3 to 4 times by 2031 with respect to the base financial year 2003 (Ghosh, 2010), and the most carbon-intensive of non-renewable fossil fuel energy-coal is projected to continue to remain its dominating position in order to make energy price affordable. Hence, exploring the dynamic relationships between globalization, CO_2 emissions, energy consumption, economic growth and financial development in India enables the policymakers to design effective energy and environmental policies.

The remainder of the paper is structured as follows. Section II describes both theoretical and empirical literatures. Section III describes the data and model construction used in the analysis. Section IV briefly describes the empirical methodological framework employed. Section V analyzes the empirical findings and their discussions. Finally, the concluding remarks and policy recommendations of our findings are outlined in Section VI.

II. Literature Review

Although existing empirical literature in this area provides many interesting insights, a consensus is yet to be reached. Grossman and Krueger (1991) started the debate on Environmental Kuznets Curve (EKC) which explained the relationship between environmental pollution and economic growth through an inverted U-shape curve.[1] With reference to the consequences of international trade on environmental quality, Grossman and Krueger (1991) further argued that the environmental effects of international trade depend on the policies implemented in an economy. In this context, two contrasting schools of thought became prominent about the impact of international trade on CO_2 emissions. The first school of thought postulated that trade openness provides an opportunity to each and every country for accessing the benefits of international trade which in turn enhances the market share of respective countries those are participating in the international trade. This result in competition among countries and at the same time it continues to increase the efficiency by utilizing the scarce resources through better management and by importing standard technology in order to lower CO_2 emissions (Runge (1994) and Helpman (1998). The second strand argues that the natural resources are depleted due to the presence of international trade. As a result, the depletion of natural resources raises CO_2 emissions and causes a decrease in the environmental quality (Shahbaz et al. (2012); Schmalensee et al. (1998), Copeland and Taylor (2001), and Chaudhuri and Pfaff (2002).

On the other hand, globalization leads to the greater integration of economies and societies (Agenor, 2003). According to Hecksher (1919) and Ohlin (1933) model, trade is the main engine that provides an innovative opportunity to enhance the process of production as well as the productivity of abundant natural resources. Further, international trade in the face of globalization mobilizes the factors of production freely among countries. In this context, Antweiler et al. (2001) examined the effect of trade on environmental quality. They introduced composition, scale and technological effects by decomposing the trade model. Their study concluded that trade openness is beneficial to the environment if the technological effect is greater than both the composition effect and scale effect. This finding shows that international trade will improve the income level of developing nations and induce them importing less polluted techniques to enhance the production. Copeland and Taylor (2005) supported that international trade is beneficial to environmental quality through environmental regulations and capital-labor channels. They documented that free trade reduces CO_2 emissions because

[1] The Environmental Kuznets Curve (EKC) theory suggests that the income inequality first rises and then falls with economic growth. The basic idea is very simple and more intuitive. It is in the sense that in the early stages of economic growth, environmental degradation and pollution tend to increase. After a certain level of income is achieved, economic growth declines along with environmental degradation and pollution (Kuznets, 1995).

international trade will shift the production of pollution-intensive goods from developing countries to the developed nations. Managi et al. (2008) found that the quality of the environment is improved if the environmental regulation effect is stronger than the capital-labor effect. Similarly, McCarney and Adamowicz (2006) suggested that trade openness improves the environmental quality depending on government policies. The local governments can reduce CO_2 emissions through their environmental policies.

Later on, a series of debate has started by investigating the relationship between environmental pollution and economic development. Johansson and Kriström (2007) noted that the literature on the EKC is not enough and this topic needs more indepth empirical investigation. But, Stern (2004) argued that the issues of the EKC should be revisited by using new models and new decompositions with different panels and time series data. Similarly, Wagner (2008) pointed out that the data on per capita CO_2 emissions and per capita GDP are not stationary in time series framework and this problem has to be sufficiently addressed in the literature. Therefore, many dimensions of the EKC are available for further empirical investigation. Akbostanci et al. (2009) using PM10 and SO_2 measures of environmental degradation tested the direction of causality between income and environmental degradation for various stages of economic development. Using the data for 58 provinces of Turkey over the period 1968–2003, their empirical results unveiled that CO_2 emissions and income have long run relationship but inverted U-shaped relationship is observed when SO2 and PM10 are used as measures of environmental degradation. The results do not support EKC hypothesis based on income and environmental degradation nexus. Soytas and Sari (2009) reexamined the relationship between economic growth, CO_2 emissions and energy by incorporating capital formation and labor as potential determinants of economic growth and CO_2 emissions. Their results exposed that CO_2 emissions Granger cause energy consumption and vice versa which implies that by reducing CO_2 emissions, Turkey may retard economic growth. This shows that Turkey is achieving economic growth at the cost environment. Kaygusuz (2009) investigated the electricity and energy demand functions and their empirical exercise found that rapid energy consumption and energy production are linked with environmental issues at the national level as a rise in energy consumption (electricity consumption) increases CO_2 emissions.

Ozturk and Acaravci (2010) reinvestigated the cointegration and causality relationships between economic growth, CO_2 emissions and energy consumption by incorporating employment using time series data over the period 1968–2005. After finding the existence of cointegration, further they observed that income elasticity of CO_2 emissions is inelastic but income elasticity of energy consumption is more elastic. This implies they could not empirically validate the EKC hypothesis. The causality analysis found neutral effect between energy consumption and economic growth, economic growth and CO_2 emissions and, energy consumption and CO_2 emissions. This implies that the adoption of energy conservation has no adverse effect on growth[2]. Shahbaz et al. (2012) empirically investigated the relationships between CO_2 emissions, energy consumption, economic growth and trade openness for Pakistan over the period of 1971-2009. By employing both the cointegration and causality tests, the findings supported the existence of environmental Kuznets curve (EKC) and showed the long run relationships between them. Their findings further showed that energy consumption increases CO_2 emissions both in the short and long runs, while trade openness reduces CO_2 emissions in the long run only. Furthermore, they also found a one causal relationship running from economic growth to CO_2 emissions. Shahbaz et al. (2013a) examined the linkages among economic growth, energy consumption, financial development, trade openness and CO_2 emissions over the period of 1975Q1–2011Q4 for Indonesia. Their findings confirmed the long run relationships among them in the in the presence of structural breaks. The empirical findings further indicated that economic growth and energy consumption increase CO_2 emissions, while financial development and trade openness compacts it. The VECM causality analysis has further shown the feedback between energy consumption and CO_2 emissions. Economic growth and CO_2 emissions are also interrelated i.e. bidirectional causality. Financial development Granger causes CO_2 emissions. The study opens up new policy insights to control the environment from degradation by using energy efficient technologies. Financial development and trade openness can also play their role in improving the environmental quality. In case of Romania, Shahbaz et al. (2013b) confirmed the long run relationship between economic growth, energy consumption and energy pollutants. Their empirical evidence validates holding of Environmental Kuznets Curve (EKC) hypothesis both in long-and-short runs.

[2] Joberta and Karanfil (2007) and, Kaplan et al. (2011) have also investigated the validation of EKC for Turkey.

There have been some studies which examine the EKC hypothesis for India. The findings of these studies are mixed. The studies by Bhattacharyya and Ghoshal (2009), Khanna and Zilberman (2001) support the EKC hypothesis; whereas Dietzenbacher and Mukhopadhyay (2007), Mukhopadhyay and Chakraborty (2005) have rejected the EKC hypothesis. All these studies have used input–output approach to estimate the emissions. Furthermore, Alam et al. (2011) investigated the dynamic causal relationships between energy consumption, carbon dioxide (CO_2) emissions and income for India during 1971-2006. Their empirical results provide the evidence of bi-directional Granger causality between energy consumption and CO_2 emissions in the long run but neither CO_2 emissions nor energy consumption causes movements in real income. This indicates that there is no causality relationship between energy consumption and income in any direction in the long-run implying that India could follow energy consumption and efficiency improvement policies without impeding economic growth. Hence this will allow India to reduce CO_2 emissions without affecting its growth and contribute significantly towards combating global warming. Tiwari (2011) has also made similar attempt to examine the causal dynamic relationships between energy consumption, CO_2 emissions and economic growth for India covering the period 1971-2007. He observed that energy consumption, capital and population Granger cause economic growth but not vice-versa. The results from using both IRFs and VDCs techniques further indicated that CO_2 emissions have positive impact on energy use and capital but negative impact on population and GDP. On the other hand, energy consumption has positive impact on CO_2 emissions and GDP but its impact is negative on capital and population.

Tiwari (2012) empirically examined the dynamic relationships between energy consumption, CO_2 emissions and economic growth for India covering the period from 1970-2005. His empirical results indicate that CO_2 emissions Granger cause GDP, while energy consumption does not Granger cause GDP. Further there exists bidirectional causality between CO_2 emissions and energy consumption in India. The variance decomposition shows that GDP is explained by CO_2 emissions compared to energy consumption, while CO_2 emissions are explained by energy consumption compared to GDP. Tiwari et al. (2013) reinvestigated the dynamic causal relationship between coal consumption, economic growth, trade openness, and CO_2 emissions over the study period 1966-2011. Their study confirmed the existence of cointegration and noted the presence of Environmental Kuznets Curve in the short and long runs. Their empirical evidence also found that both coal consumption and trade openness significantly contribute to CO_2 emissions. Kanzilal and Ghosh (2013) revisited the cointegrating relationship between carbon emission, energy use, economic activity and trade openness for India using threshold cointegration tests with a view to testing the environmental Kuznets curve (EKC) hypothesis in the presence of possible regime shift during the period 1971 to 2008. Their findings confirmed the existence of threshold cointegration among the variables and the EKC hypothesis for India. The empirical results also found that the carbon emission is highly elastic with respect to real per capita income and energy use in India. In another attempt, Boutabba (2014) examined the linkage between globalization, energy consumption and economic growth and financial development with carbon emissions for India during 1971 to 2008. They highlighted a positive relationship between financial development and carbon emissions without emphasizing on the relationship between trade openness and carbon emissions.

Mallick and Mahalik (2014) empirically explored the relationships among energy use, economic growth and financial development for India and China covering the period 1971-2011. The results from using ARDL to cointegration procedure found a positive impact of urban population and adverse effects of financial development and growth on energy consumption for both India and China. Yang and Zhao (2014) also investigated the temporal linkages among economic growth, energy consumption, and carbon emissions for India during the period 1970-2008 using recently developed methods such as out- of-sample Granger causality tests and directed acyclic graphs (DAG). Their empirical evidence reveals that energy consumption unidirectionally Granger causes carbon emissions and economic growth, while there is bidirectional causality between carbon emissions and economic growth. Further, the results show that trade openness plays a significant role in the dynamics of energy consumption and carbon emissions.

Although a great deal of studies has investigated the relationship between trade liberalization and the environment drawing the work of Grossman and Krueger (1991) and Cole and Elliot (2003) but a very few researchers have used various indictors of globalization to examine its impact on environmental degradation. Using the theoretical framework provided by Antweiler et al. (2001), Cole (2006) have investigated the impact of trade liberalization (an indicator of globalization) on per capita energy use for 32 developed and developing countries for the period 1975-1995. The empirical evidence indicated that the trade liberalization is likely to increase per capita energy use for the mean countries in the presence of scale, technique and composition effects. In a similar way, Chang (2012) examined the relationship between trade openness and environmental degradation for China during 1981-2008. The results from using vector autoregressive (VAR) model showed that the long run impact of trade openness and foreign direct investment on environmental pollution is ambiguous depending upon the types of pollutants. The short run impact is predictable where China's exports expansion leads to an increase in sulphur dioxide (SO2) emissions, while imports and FDI enlargement enhance the growth of solid waste generation. This finding supports the conclusion of Cole et al. (2011) that the environmental effect of openness depends upon the pollutants concerned.

In other countries contexts, Machado (2000) indicated a positive link between foreign trade and CO_2 emissions in Brazil. Mongelli et al. (2006) concluded that the pollution haven hypothesis existed for Italy.[3] Halicioglu (2009) augmented CO_2 emissions function by incorporating trade in order to investigate the causal relationship between income, CO_2 emissions and energy consumption for Turkey during the period 1960–2005. He found cointegration by applying the ARDL bounds testing approach to cointegration. The results showed that GDP is highly significant among other variables in explaining CO_2 emissions. Chen (2009) explored this issue in Chinese provinces and documented that industrial development is linked with an increase of CO_2 emissions due to energy consumption.[4] Pao and Tsai (2010) confirmed the presence of the EKC hypothesis for Brazil, Russia, India and China. Ozturk and Acaravci (2010) validated the EKC for Turkey while Acaravci and Ozturk (2010) validated it for Denmark and Italy. Nasir and Rehman (2011) also supported the EKC for Pakistan.

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[3] The pollution haven hypothesis reveals that in order to attract foreign investment, the governments of developing countries have a tendency to undermine environment concerns through relaxed or non-enforced regulation reported by Hoffmann et al. (2005).

[4] Zhang and Cheng (2009) concluded that GDP growth causes energy consumption while energy consumption causes CO2 emissions.

III. The Data and Model Construction

We have used the data on CO_2 emissions per capita, real GDP per capita, energy consumption per capita, financial development and three dimensions of globalization (economic globalization, political globalization, and social globalization) to probe the existence of environmental Kuznets curve (EKC) for India during an era of intensified globalization where all the economies including India are taking part. The data on total energy consumption (million tons), CO_2 emissions (metric tons) and real GDP (Indian currency), real domestic credit to private sector measure of financial development have been drawn from the world development indicators (CD-OM, 2013). The series population is used to express all the series in per capita terms. The data on KOF globalization index is borrowed from Dreher (2006). The globalization index is constructed from three sub-indices (social, economic and political globalization).[5] Govindaraju and Tang, (2013) incorporated coal consumption in CO_2 emissions and reported its positive impact on environmental degradation. Shahbaz et al. (2013c) augmented CO_2 emissions function by incorporating the measures of globalization for Turkish data. So, drawing from the previous works, such as Govindaraju and Tang (2013) and Shahbaz et al. (2013c), we have incorporated alternative globalization measures along with total energy consumption and economic growth in CO_2 emissions function as additional determinants of CO_2 emissions. The study covers the period of 1970-2012. The general functional form of our model is given in the following equation:

$$C_t = f(EC_t, Y_t, Y_t^2, G_t) \qquad (1)$$

We have transformed all the variables into their natural logarithms following (Shahbaz et al. [2013c]). The empirical version of our model is constructed as follows:

$$\ln C_t = \alpha_1 + \alpha_C \ln EC_t + \alpha_Y \ln Y_t + \alpha_{Y^2} \ln Y_t^2 + \alpha_{FD} \ln FD_t + \alpha_G \ln G_t + \xi_t \qquad (2)$$

where, $\ln C_t$ is natural log of CO_2 emissions per capita, natural log of total energy consumption intensity per capita is indicated by $\ln EC_t$, $\ln Y_t$ ($\ln Y_t^2$) is natural log of real GDP per capita (square of real GDP per capita) and $\ln G_t$ is for natural log of KOF index of globalization (economic globalization i.e. $\ln EG_t$, social globalization i.e. $\ln SG_t$ and political globalization

[5] See in details http://globalization.kof.ethz.ch/

i.e. $\ln PG_t$). The latter measure is considered in three important dimensions such as EG, SG, and PG in our empirical models. ξ_t is the random error term which is assumed to have a normal distribution with zero mean and predictable variance. We expect that the impact of coal consumption on CO_2 emissions to be positive and hence $\alpha_C > 0$. The relationship between economic growth and CO_2 emissions is expected to have an inverted U-shape if $\alpha_Y > 0$ and $\alpha_{Y^2} < 0$ otherwise it would have a U-shape if $\alpha_Y < 0$ and $\alpha_{Y^2} > 0$. We expect $\alpha_{FD} < 0$ if financial sector allocates funds to environmental friendly projects (Tamazian et al. 2009). Financial development impedes environmental quality if financial sector does not monitor the projects after allocating the funds (Zhang, 2011) then we expect $\alpha_{FD} > 0$.

Globalization impacts CO_2 emissions via income effect, scale effect and composition effect. Under the ceteris paribus condition, pollution would increase with an expansion of gross national output due to foreign trade and investment (FDI), and vice-versa. This is the scale effect of globalization on the environment. This means that all other things holding the same, pollution would change as a result of the structural changes in the economy specifically owing to foreign trade and investments. This means a move towards pollution intensive production would generate more pollution and vice-versa. This is the composition effect. This implies that the scale and structure of economic output remaining the same, new technology or production methods introduced due to foreign trade or FDI will alter the amount of pollutant emitted per unit of output. This is the technique effect of globalization. The decomposition analysis suggests that foreign trade and investment liberalization are double-edged swords, offering both disadvantages and advantages for a country. Since these factors interact simultaneously and can work in different directions, the net environmental effect of globalization can only be assessed empirically. So, $\alpha_G < 0$ if energy-efficient technology via foreign direct investment and trade is encouraged for domestic production otherwise $\alpha_G > 0$.

IV. Methodological framework

IV.I The Bayer-Hanck Cointegration Approach

The robustness of cointegration relationship is investigated in this study by employing the recently introduced cointegration test developed by Bayer and Hanck, (2013). Initially; Engle and Granger, (1987) developed the residual based cointegration test, which was based on a three step procedure. The main drawback of Engle-Granger cointegration test is that if there is an error in the first step then it runs into third step and provides misleading empirical estimates. Further, long run static regression provides reliable empirical evidence but results may be inefficient if the estimate of cointegrating vector is not normally distributed. In such a situation, we can't make any sensible decision regarding the cointegration between the variables. These issues regarding Engle-Granger cointegration test were solved by Engle and Yoo, (1991). Although, Engle and Yoo, (1991) cointegration test provides better and efficient empirical results due to its power and size, and this test can also be applicable if distribution of estimators of cointegrating vector is not normally distributed. The Engle-Granger and Engle-Yoo cointegration tests provide baised results due to their low explanatory powers. The test by Philips and Hansen, (1990) was also used to eliminate the biasedness of OLS estimates. The results of Philips and Hansen, (1990) cointegration test do not take into account whether trend is included or not in the data. But, Inder, (1993) criticized the Philips and Hansen, (1990) test and preferred to apply fully-modified OLS (FMOLS) for long run estimates compared to estimate of unrestricted error correction model (UECM). Latter on; Stock and Watson (1993) developed dynamic OLS i.e. leads and lags dynamics test to examine cointegration once all the series are cointegrated at I(1).

Once we have unique order of integration then we can apply Johansen and Juselius, (1990) maximum likelihood cointegration approach to examine cointegration between the variables. This is single-equation based cointegration technique which provides long run relationship between the variables by showing number of cointegrating vectors in the model. The empirical exercise to investigate cointegration between the variables becomes invalid if any variable is integrated at I(0) in the VAR system or mixed order of integration of the variables. The Johansen and Juselius, (1990) maximum likelihood cointegration results are sensitive if variables are exogenous and endogenous in the model. This test only indicates the presence of cointegration between the variables for long run but leaves short run dynamics to be questionable. Then, Pesaran et al. (2001) suggested a bounds testing approach for cointegration or autoregressive distributive lag model (ARDL) to scrutinize the long run relationship between the series. This cointegration approach is applicable if series are integrated at I(1) or I(0) or I(1)/I(0) by taking account of endogeneity and exogeneity issue in the estimation. The ARDL bounds testing approach provides empirical evidence on long run as well as short run relationship between the variables simultaneously. The major problem with the ARDL bounds testing is that this approach provides efficient and reliable results once single equation cointegration relationship exists between the variables otherwise it misleads the results. This approach is unable to provide any empirical results if any of the variables is integrated at I(2).

This implies that all these cointegration approaches have different theoretical backgrounds and produce conflicting results. In such circumstances, it is difficult to obtain uniform results because one cointegration test rejects the null hypothesis while other test accepts the same. We observe that, Engle-Granger, (1987) residual based test, Johansen, (1991) system based test and, Boswijik, (1994) and Banerjee et al. (1998) suggested lagged error correction based approaches to cointegration. It is pointed by Pesavento, (2004) that the power of ranking cointegration approaches is sensitive with the value of nuisance estimators. To overcome this issue, Bayer and Hanck, (2012) developed a new cointegration technique by combining all non-cointegrating tests to obtain uniform and reliable cointegration results. This cointegration test provides efficient estimates by ignoring the nature of multiple testing procedures. So, Bayer and Hanck, (2012) followed Fisher, (1932) formula to combine the statistical significance level i.e. p-values of single cointegration test and formula is given below:

$$EG-JOH=-2[\ln(P_{EG})+\ln(P_{JOH})] \quad (3)$$

$$EG-JOH-BO-BDM=-2[\ln(P_{EG})+\ln(P_{JOH})+\ln(P_{BO})+\ln(P_{BDM})] \quad (4)$$

The probability values of different individual cointegration tests such as Engle-Granger, (1987); Johansen, (1995); Boswijik, (1994) and, Banerjee, Dolado and Mestre, (1998) are shown by P_{EG}, P_{JOH}, P_{BO} and P_{BDM} respectively. To take decision whether cointegration exists or not between the variables, we follow Fisher statistic. We may conclude in favor of cointegration by rejecting null hypothesis of no cointegration once the critical values generated by Bayer and Hanck are found to be less than calculated Fisher statistics and vice-versa.

III.IV. The VECM Granger Causality

After examining the long run relationship in the model, we use the Granger causality test to determine the causality relationships among the variables from the application of vector error correction method (VECM). In case of cointegration between the series, the VECM can be written as follows:

$$\begin{bmatrix} \Delta \ln C_t \\ \Delta \ln Y_t \\ \Delta \ln EC_t \\ \Delta \ln FD_t \\ \Delta \ln G_t \end{bmatrix} = \begin{bmatrix} b_1 \\ b_2 \\ b_3 \\ b_4 \end{bmatrix} + \begin{bmatrix} B_{11,1} & B_{12,1} & B_{13,1} & B_{14,1} & B_{12,1} \\ B_{21,1} & B_{22,1} & B_{23,1} & B_{24,1} & B_{25,1} \\ B_{31,1} & B_{32,1} & B_{33,1} & B_{34,1} & B_{35,1} \\ B_{41,1} & B_{42,1} & B_{43,1} & B_{44,1} & B_{45,1} \\ B_{51,1} & B_{52,1} & B_{53,1} & B_{54,1} & B_{55,1} \end{bmatrix} \times \begin{bmatrix} \Delta \ln C_{t-1} \\ \Delta \ln Y_{t-1} \\ \Delta \ln EC_{t-1} \\ \Delta \ln FD_t \\ \Delta \ln G_{t-1} \end{bmatrix} + \ldots + \begin{bmatrix} B_{11,m} & B_{12,m} & B_{13,m} & B_{14,m} & B_{15,m} \\ B_{21,m} & B_{22,m} & B_{23,m} & B_{24,m} & B_{25,m} \\ B_{31,m} & B_{32,m} & B_{33,m} & B_{34,m} & B_{35,m} \\ B_{41,m} & B_{42,m} & B_{43,m} & B_{44,m} & B_{45,m} \\ B_{51,m} & B_{52,m} & B_{53,m} & B_{54,m} & B_{55,m} \end{bmatrix}$$

$$\times \begin{bmatrix} \Delta \ln C_{t-1} \\ \Delta \ln Y_{t-1} \\ \Delta \ln EC_{t-1} \\ \Delta \ln FD_t \\ \Delta \ln G_{t-1} \end{bmatrix} + \begin{bmatrix} \zeta_1 \\ \zeta_2 \\ \zeta_3 \\ \zeta_4 \\ \zeta_5 \end{bmatrix} \times (ECM_{t-1}) + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ \mu_{5t} \end{bmatrix} \quad (5)$$

where difference operator is $(1-L)$ and ECM_{t-1} is the lagged error correction term, generated from the long run association. The long run causality is found by the significance of coefficient of lagged error correction term using t-test statistic. The existence of a significant relationship in first differences of the variables provides the evidence on the direction of short run causality. The joint χ^2 statistic for the first differenced lagged independent variables is used to test the direction of short-run causality between the variables. For example, $B_{12,i} \neq 0 \forall_i$ shows that economic growth Granger causes CO_2 emissions and economic growth is Granger cause of CO_2 emissions if $B_{21,i} \neq 0 \forall_i$.

V. Empirical Findings and their Discussions

For investigating the cointegration among the variables in the carbon emission model, testing of stationarity of the variables is carried out as a prelude testing exercise. For this purpose, we apply the Augmented Dicky-Fuller (ADF) and Philip Perron (PP) unit root tests with presence of intercept and trend terms in unit root estimating equation. The results reported in Table-1 finds that although all of the variables under consideration such as CO_2 per capita ($\ln C_t$), real GDP per capita ($\ln Y_t$), energy consumption per capita ($\ln EC_t$), financial development ($\ln FD_t$), overall globalization ($\ln G_t$), economic globalization ($\ln EG_t$), political globalization ($\ln PG_t$) and social globalization ($\ln SG_t$) are non-stationary at their levels, all are becoming stationary at their first differences implying all the variables are integrated of I(1).

Table-1: Unit Root Analysis

Variable	ADF Unit Root Test		P-P Unit Root Test	
	T. statistic	Prob. Value	T. statistic	Prob. value
$\ln C_t$	-2.2513 (1)	0.4498	-3.1637 (3)	0.1062
$\ln Y_t$	-1.5828 (1)	0.8159	-0.6491 (3)	0.9701
$\ln EC_t$	-0.8153 (3)	0.9505	-2.6203 (6)	0.3010
$\ln FD_t$	-0.4825 (1)	0.9805	-2.7807 (3)	0.2124
$\ln PG_t$	-2.5814 (2)	0.2903	-2.6115 (6)	0.2571
$\ln SG_t$	-2.1210 (2)	0.5182	2.6020 (3)	0.2815
$\ln EG_t$	-2.1875 (3)	0.4836	-2.2053 (3)	0.4741
$\ln G_t$	-1.9188 (2)	0.6267	-1.9205 (6)	0.6257
$\Delta \ln C_t$	-6.8372 (2)*	0.0000	-4.5881 (3)*	0.0058
$\Delta \ln Y_t$	-7.4697 (1)*	0.0000	-3.4989 (3)**	0.0479
$\Delta \ln EC_t$	-6.0885 (1)*	0.0001	-4.9221 (3)*	0.0015
$\Delta \ln F_t$	-5.0146 (1)*	0.0011	-4.7242 (3)*	0.0026
$\Delta \ln F_t$	-5.0742 (1)*	0.0011	-4.7703(3)*	0.0023
$\Delta \ln PG_t$	-8.4474 (1)*	0.0000	-4.6768 (3)*	0.0030
$\Delta \ln SG_t$	-4.1181 (1)**	0.0124	-4.4112 (3)*	0.0060
$\Delta \ln EG_t$	-5.2543 (2)*	0.0006	-5.2524 (3)*	0.0006
$\Delta \ln G_t$	-6.5296 (3)*	0.0000	-6.4980 (3)*	0.0000
Note: * and ** represents significance at 1 and 5 percent level. () show lags and bandwidths for ADF and PP unit root tests respectively.				

In the presence of structural breaks, ADF and PP unit root test are known to provide biased results in view of their low explanatory power to reject the null hypothesis of unit root. This is because; these unit root tests do not account the information about the unknown structural break dates stemming from the series which weakens the stationarity properties. To overcome such problem, we have further applied Lee and Strazicich, (2013)'s unit root test which accommodates the information about single unknown structural break present in the series. The results presented in Table-2 find that all of the variables have unit root problem at their levels along with the presence of structural breaks in their respective series. The structural breaks i.e. 2000, 1998, 1978, 1991, 1999, 1990 and 1995 are found in the series of CO_2 per capita, real GDP per capita, energy consumption, financial development, political globalization, social globalization, economic globalization and overall globalization respectively. These results give the indication that the structural breaks occurring in variables to capture the political globalization and economic globalization are associated with the liberalization initiatives undertaken around the period 1991, following India's twin crises problem. The social globalization took some time to adapt with the new globalization regime as a result the break event occurs towards the late of twentieth century. The break date for carbon emissions (2000) in India almost follows the break date of India's higher growth around the period (1998) and the latter period is also consistent with break date for higher overall energy demand. All the break points show some sort of consistency in the pattern of economic events occurring in the Indian economy. However, this is to note that since all the variables are found to be stationary in their first differenced form, this implies that all the series are integrated of order one i.e. I(1).

Table-2: Results of Lee and Strazicich Unit Root Test

Variables	**TB**	**K**	**S_{t-1}**	**B_t**
$\ln C_t$	2000	0	-0.3469 (-2.7213)	-0.0465* (-1.6184)
$\ln Y_t$	1998	3	-0.0888 (-1.1969)	0.0229 (0.7571)
$\ln EC_t$	1998	3	-0.2578 (-2.8987)	0.0239* (1.5714)
$\ln FD_t$	1978	3	-0.0873 (-1.8095)	-0.1043** (-1.7993)
$\ln PG_t$	1991	0	-0.3791 (-2.8048)	0.0433* (1.3233)
$\ln SG_t$	1999	4	-0.1354 (-2.3969)	-0.8371*** (-2.5316)
$\ln EG_t$	1990	3	-0.1138 (-2.3457)	0.1771*** (6.6574)
$\ln G_t$	1995	4	-0.1232 (-1.7598)	0.0744*** (2.7842)

Notes: Critical values for the LM test at 10%, 5% and 1% significance levels = -3.211, -3.566 and -4.239 respectively. Critical values for the dummy variable denoting the break date follows the standard asymptotic distribution. TB is the break date; K is the lag length; S_{t-1} is the LM test statistic; B_t is the coefficient on the break in the intercept. * Significance at 10% level. **

Significance at 5% level. *** Significance at 1% level.

The results from all of the above unit root tests show that all the variables are stationary at first differences i.e. $I(1)$. In such circumstance, the combined cointegration test developed by Bayer and Hanck, (2013) is a suitable empirical method to investigate whether there exists cointegration among the variables. Table-3 presents the combined cointegration test results including the EG-JOH, and EG-JOH-BO-BDM. We find that Fisher-statistics for both EG-JOH and EG-JOH-BO-BDM tests exceed the critical values at 5% level of significance when we use CO_2 per capita emissions, per capita real income, energy consumption per capita, and overall measure of globalization as dependent variables for respective models. The test rejects the null hypothesis of no cointegration among the variables in these models. The similar results are also obtained when one replaces the overall measure of globalization indicator $\ln G_t$ with $\ln SG_t$ and $\ln EG_t$ and $\ln PG_t$ as three different measures of globalization. However, when financial development is considered to be a dependent variable, the cointegration test is not consistently able to reject the null hypothesis of no cointegration. This confirms the presence of cointegration among all the variables in different models with inclusion of overall globalization indicator and by substituting the later with three different measures of globalization. However, this does not find cointegration in the model where financial development appears as a dependent variable. Thus, in overall, one can conclude that there is a long run relationship between CO_2 emissions, economic growth, financial development, energy consumption, and the overall index of globalization (including its three components, such as economic globalization, political globalization and social globalization) in India.

Table-3: The Results of Bayer and Hanck Cointegration Analysis

Estimated Models	EG-JOH	EG-JOH-BO-BDM	Lag Order	Cointegration
$C_t = f(Y_t, EC_t, FD_t, PG_t)$	55.491*	125.290*	2	Yes
$Y_t = f(C_t, EC_t, FD_t, PG_t)$	55.473*	70.469*	2	Yes
$EC_t = f(C_t, Y_t, FD_t, PG_t)$	55.866*	166.391*	2	Yes
$FD_t = f(C_t, Y_t, EC_t, PG_t)$	9.533	15.598	2	No
$PG_t = f(C_t, Y_t, EC_t, FD_t)$	55.875*	57.448*	2	Yes
$C_t = f(Y_t, EC_t, FD_t, SG_t)$	55.427*	119.802*	2	Yes

$Y_t = f(C_t, EC_t, FD_t, SG_t)$	57.431*	118.927*	2	Yes
$EC_t = f(C_t, Y_t, FD_t, SG_t)$	59.099*	169.623*	2	Yes
$FD_t = f(C_t, Y_t, EC_t, SG_t)$	5.397	11.296	2	No
$SG_t = f(C_t, Y_t, EC_t, FD_t)$	55.649*	56.882*	2	Yes
$C_t = f(Y_t, EC_t, FD_t, EG_t)$	55.455*	120.399	2	Yes
$Y_t = f(C_t, EC_t, FD_t, EG_t)$	57.015*	123.371*	2	Yes
$EC_t = f(C_t, Y_t, FD_t, EG_t)$	56.490*	127.975*	2	Yes
$FD_t = f(C_t, Y_t, EC_t, EG_t)$	7.674	10.786	2	No
$EG_t = f(C_t, Y_t, EC_t, FD_t)$	57.244*	69.830*	2	Yes
$C_t = f(Y_t, EC_t, FD_t, G_t)$	55.583*	121.697*	2	Yes
$Y_t = f(C_t, EC_t, FD_t, G_t)$	61.442*	127.003*	2	Yes
$EC_t = f(C_t, Y_t, FD_t, G_t)$	58.292*	129.777*	2	Yes
$FD_t = f(C_t, Y_t, EC_t, G_t)$	11.285	14.570	2	No
$G_t = f(C_t, Y_t, EC_t, FD_t)$	56.761*	57.678*	2	Yes
Note: ** represents significant at 5 per cent level. Critical values at 5% level are 10.576 (EG-JOH) and 20.143 (EG-JOH-BO-BDM) respectively. Lag length is based on minimum value of AIC.				

The Bayer and Hanck (2013) combined cointegration approach is known to provide efficient parameter estimates but fails to accommodate the structural breaks in series, while investigating the cointegration among the variables in the model. This issue is further overcome by applying the ARDL bounds testing approach to cointegration in the presence of structural breaks following Shahbaz et al. (2013, 2014). Since the ARDL bounds test is known to be sensitive to lag length selection and we have used the AIC criteria to select the appropriate lag order of the variables. It is reported by Lütkepohl, (2006) that the dynamic link between the series can be well captured with an appropriate selection of lag length of the model (Lütkepohl, 2006). The optimal lag length results are reported in Column-2 of Table-5. We use critical bounds from Narayan, (2005) to make the decision about the existence of cointegration in different models. The results show that the calculated F-statistic is found to be greater than the upper bounds critical values when CO_2 emissions (C_t), energy consumption (EC_t), economic growth (Y_t) and overall globalization (G_t) were used as dependent variables. Similar results are also obtained when we alternatively used other measures of globalization (economic globalization i.e. EG_t, political globalization i.e. PG_t and social globalization i.e. SG_t) for the same models. This shows that the ARDL bounds test at least confirms the long run relationship among the variables as obtained earlier. It entails that a long run relationship between CO_2 emissions, energy consumption, economic growth, financial development and globalization in the case of India over the period from 1971-2012.

Table-5: The Results of ARDL Cointegration Test

Bounds Testing Approach to Cointegration				Diagnostic tests			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Estimated Models	Optimal lag length	Structural Break	F-statistics	χ^2_{NORMAL}	χ^2_{ARCH}	χ^2_{RESET}	χ^2_{SERIAL}
$C_t = f(Y_t, EC_t, FD_t, EG_t)$	2, 1, 2, 1, 2	2000	8.078*	0.0903	[1]: 0.8996	[1]: 2.4114	[1]: 5.4079
$Y_t = f(C_t, EC_t, FD_t, EG_t)$	2, 2, 2, 1, 2	1998	8.040*	0.6891	[2]: 0.0065	[1]: 0.4345	[2]: 1.9668
$EC_t = f(C_t, Y_t, FD_t, EG_t)$	2, 2, 2, 2, 2	1998	6.899**	0.5901	[1]: 0.1503	[3]: 2.5606	[1]: 1.6824
$FD_t = f(C_t, Y_t, EC_t, EG_t)$	2, 2, 2, 2, 2	1978	1.549	1.5755	[1]: 0.5541	[2]: 0.0861	[1]: 2.4461
$EG_t = f(C_t, Y_t, EC_t, FD_t)$	2, 1, 2, 2, 1	1990	10.930*	1.3219	[1]: 2.7756	[1]: 0.0756	[1]: 1.0681
$C_t = f(Y_t, EC_t, FD_t, PG_t)$	2, 2, 1, 1, 2,	2000	7.650*	0.4905	[1]: 2.1397	[1]: 2.7127	[1]: 2.0860
$Y_t = f(C_t, EC_t, FD_t, PG_t)$	2, 1, 2, 2, 2	1998	6.642**	1.3237	[1]: 0.0339	[1]: 2.3118	[1]: 1.6221
$EC_t = f(C_t, Y_t, FD_t, PG_t)$	2, 2, 2, 1, 1	1998	5.784**	0.3500	[1]: 0.5749	[1]: 2.6114	[3]: 0.0032
$FD_t = f(C_t, Y_t, EC_t, PG_t)$	2, 2, 1, 2, 1	1978	3.877	2.3778	[2]: 2.0272	[3]: 0.1918	[3]: 1.7267
$PG_t = f(C_t, Y_t, EC_t, FD_t)$	2, 2, 2, 2, 1,	1991	6.186**	0.6790	[1]: 2.4772	1]: 1.1100	[1]: 1.5688
$C_t = f(Y_t, EC_t, FD_t, SG_t)$	2, 2, 2, 2, 2	2000	7.597*	2.0115	[1]: 2.8692	[1]: 1.4041	[3]: 1.8889
$Y_t = f(C_t, EC_t, FD_t, SG_t)$	2, 2, 1, 2, 2	1998	6.623**	1.7774	[1]: 0.9740	[1]: 1.5260	[2]: 2.7868
$EC_t = f(C_t, Y_t, FD_t, SG_t)$	2, 2, 1, 2, 1	1998	5.098***	0.0538	[1]: 0.8575	[2]: 2.5057	[1]: 2.6387
$FD_t = f(C_t, Y_t, EC_t, SG_t)$	2, 2, 2, 1, 1	1978	3.519	1.9076	[1]: 3.4089	[4]: 0.0401	[1]: 0.9456
$SG_t = f(C_t, Y_t, EC_t, FD_t)$	2, 1, 2, 2, 1	1999	11.903*	2.3711	[2]: 2.5970	[4]: 1.4899	[1]: 0.9204
$C_t = f(Y_t, EC_t, FD_t, G_t)$	2, 1, 2, 2, 2	2000	6.729**	2.9586	[1] 1.2936	[2]: 0.1390	[1]: 0.7810
$Y_t = f(C_t, EC_t, FD_t, G_t)$	2, 2, 2, 2, 2	1998	6.764**	1.1050	[2]: 0.1391	[2]: 0.2508	[1]: 2.7896
$EC_t = f(C_t, Y_t, FD_t, G_t)$	2, 2, 2, 2, 2	1998	6.813**	0.2912	[1]: 0.1889	[4]: 2.7157	[1]: 2.4516
$FD_t = f(C_t, Y_t, EC_t, G_t)$	2, 1, 1, 2, 1	1978	2.227	2.6036	[2]: 3.7661	[1]: 0.0023	[1]: 3.4558
$G_t = f(C_t, Y_t, EC_t, FD_t)$	2, 2, 2, 1, 2	1995	6.912**	0.1653	[2]: 2.3343	[1]: 1.6513	[2]: 1.2110
	Critical values (T= 42)#						
	Lower bounds $I(0)$	Upper bounds $I(1)$					
	6.053	7.458					
	4.450	5.560					
	3.740	4.780					

Note: The asterisks * and ** denote the significant at 1 and 5 per cent levels, respectively. The optimal lag length is determined by AIC. [ ] is the order of diagnostic tests. # Critical values are collected from Narayan, (2005).

After finding the existence of cointegration relationships among the variables, we have gone in for estimating the long run and short run impact of economic growth, financial development, energy consumption and globalization indices on CO_2 emissions. The long run results reported in Table-4 finds that there is a negative relationship between real GDP per capita and CO_2 emissions in all the models in general. But the relationship changes once the squared per capita GDP is introduced into our model. It finds positive and negative relationships of real GDP per capita and squared real GDP per capita respectively with CO_2 emissions. The latter results indicate that a 1% rise in real GDP will raise CO_2 emissions approximately by 8 to 9 per cent while the negative sign of squared term suggests linking of reduced CO_2 emissions and real GDP at the higher levels of per capita incomes. This implies that per capita income once it crosses some threshold level, thereafter for each one percent rise in per capita incomes results in reduced emissions of carbon dioxide by almost 0.50 percentages. This confirms to holding of EKC hypothesis for India. This finding is consistent with the findings of Shahbaz et al. (2012) for Pakistan, Shahbaz et al. (2013a, b) for Turkey and Indonesia, Tiwari et al. (2013) for India and Shahbaz et al. (2014) for Bangladesh. Rising energy consumption consistently and positively affects CO_2 emissions. Almost 0.31 per cent increase in CO_2 emissions could be linked with 1 percent rise in energy consumption, all else remaining the same. This finding is also consistent with a previous study by Tiwari et al. (2013) for India. Energy consumption as expected is found to be positively associated with CO_2 emissions. A one per cent increase in energy consumption gives rise to 2 to 3.50 percent rise in carbon emissions. Financial development significantly adds in CO_2 emissions. This empirical evidence is contradictory with Tazamian et al. (2009); Jalil and Feridun (2011) and Shahbaz et al. (2013c) who reported that financial development is negatively linked with CO_2 emissions for the BRIC economies, China and South Africa. In contrast, Ozturk and Acaravci (2013) noted insignificant impact of financial development on environmental degradation. The relationship between the overall globalization (social and political globalization) and CO_2 emissions is found to be strongly positive, while economic globalization is negatively related with CO_2 emissions. Keeping other things constant, a 1 per cent increase in globalization (as a result of economic, social and political globalizations) results in more than one per cent increase in CO_2 emissions in India. This overall outcome does not confirm to the findings of Shahbaz et al. (2013a) who noted that globalization improves environmental quality in Turkey via income, scale and technique effects.

The short run results reported in the lower segment of Table-5 which shows that CO_2 emission is significantly and positively related with energy consumption. Economic growth is positively and insignificantly linked with CO_2 emissions. Financial development although negatively associated with the decline in CO_2 emissions but the relationship is insignificant. The overall measure of globalization (including its three components such as economic globalization, political globalization and social globalization) adds in CO_2 emissions insignificantly. The lagged terms of ECM have relevant and correct signs. The short run deviations from the long run equilibrium are corrected by 14 to 30 percentages each year. The diagnostic tests show that error terms of short run models are normally distributed; and free from serial correlation, heteroskedasticity, and ARCH problems in all the four models. The Ramsey reset test also shows that the functional forms are well specified.

Table-5: Long and Short Runs Result Estimates

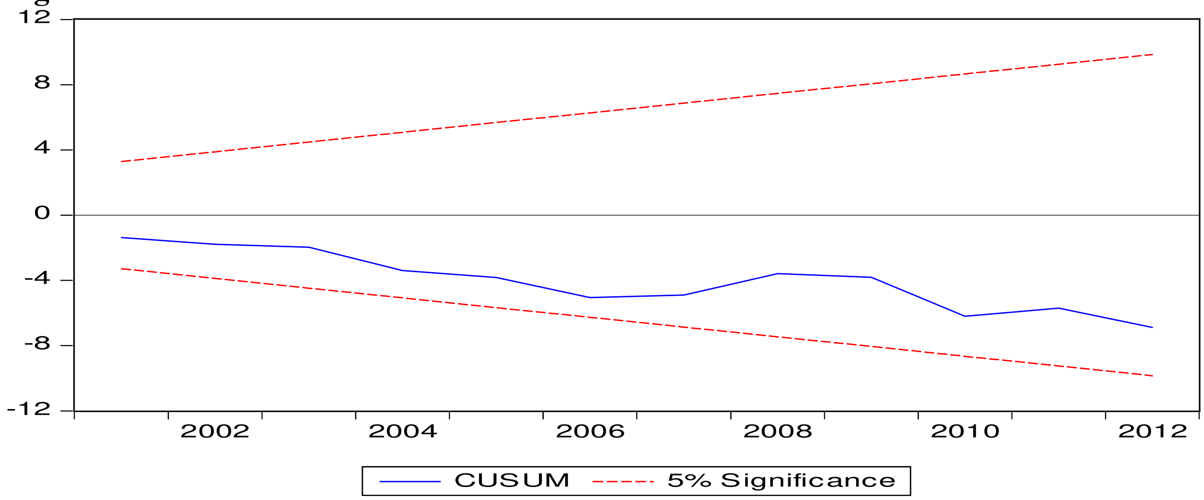
Dependent variable = $\ln C_t$								
Long Run Analysis								
Variables	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Constant	-8.9079*	-58.7117*	-7.7915*	-55.1956	-10.4225*	-52.9955*	-6.3294*	-56.5281*
$\ln Y_t$	-1.5758*	9.3915*	-2.0013*	8.5790*	-1.0629*	8.1300*	-2.2218*	8.8913*
$\ln Y_t^2$	…	-0.4834*	…	-0.4573*	…	-0.4328*	…	-0.4680*
$\ln EC_t$	3.5647*	2.0308*	4.0260*	2.2224*	2.1214*	2.1069	3.4690*	2.1429*
$\ln FD_t$	0.2432**	0.1601	0.3315*	0.2202*	0.3033*	0.2003	0.4169*	0.1847*
$\ln EG_t$	0.3082	-0.1352***	…	…	…	…	…	…
$\ln SL_t$	…	…	0.2152*	0.0171	…	…	…	…
$\ln PG_t$	…	…	…	…	1.2702*	0.1306	…	…
$\ln G_t$							1.0876*	-0.0158
R^2	0.9747	0.9769	0.9778	0.9799	0.9891	0.9899	0.9861	0.9888
Short Run Analysis								
Variables	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic	Coefficient	T-statistic
Constant	0.0236*	2.7738	0.0223*	2.8338	0.0230*	3.0239	0.0233*	2.9829
$\Delta \ln Y_t$	0.0934	0.5384	-0.0005	-0.0029	0.0294	0.1760	-0.1363	-0.7174
$\Delta \ln EC_t$	0.6915**	2.4483	0.8338*	2.9073	0.7164**	2.7068	0.8858*	3.1775
$\Delta \ln FD_t$	-0.0236	-0.2940	-0.0264	-0.3420	-0.0091	-0.1221	-0.0189	-0.2515
$\Delta \ln PG_t$	0.0275	0.2274	…	…	…	…	…	…
$\Delta \ln SL_t$	…	…	0.0876	1.6326	…	…	…	…
$\Delta \ln EG_t$	…	…	…	…	0.1632	1.1899	…	…
$\Delta \ln G_t$	…	…	…	…	…	…	0.2608	1.4946
ECM_{t-1}	-0.1494**	-2.2940	-0.1892**	-2.7098	-0.3020*	-3.3285	-0.2959*	-3.3068
R^2	0.2745		0.3076		0.3573		0.3552	

F-statistic	2.6490**		3.1111**		3.8928**		3.8568*	
D. W	2.2531		2.1454		1.7237		2.1463	
Short Run Diagnostic Tests								
Test	F-statistic	Prob. value	F-statistic	Prob. Value	F-statistic	Prob. value	F-statistic	Prob. Value
$\chi^2 SERIAL$	0.3539	0.1544	0.1373	0.8742	0.1143	0.8923	0.1207	0.8866
$\chi^2 ARCH$	0.0581	0.8142	0.0940	0.7607	0.0179	0.8953	0.1094	0.7426
$\chi^2 WHITE$	1.8930	0.0811	2.4138	0.0277	1.1933	0.3366	1.7989	0.340
$\chi^2 REMSAY$	2.1443	0.1523	1.5860	0.2165	2.1316	0.1022	0.0905	0.7653
Note: *, ** and *** show significant at 1%, 5% and 10% level of significance respectively.								

The stability of ARDL parameters is tested by applying cumulative sum of recursive residuals (CUSUM) and the CUSUM of square ($CUSUM_{SQ}$) suggested by Brown et al. (1975). Hansen argued that misspecification of model may provide biased results that influence the explaining power of the results. The CUSUM and CUSUMsq tests are employed to test the parameters constancy. Further, Brown et al. (1975) pointed out that these test help in testing the gradual changes in parameters. The expected value of recursive residual is zero leads to accept that null hypothesis of parameter constancy. The plots of both CUSUM and CUSUMsq are shown by Figure-1 and Figure 8 at 5 per cent level of significance. Results indicate that plots of both tests are within critical bounds at 5 per cent levels of significance.

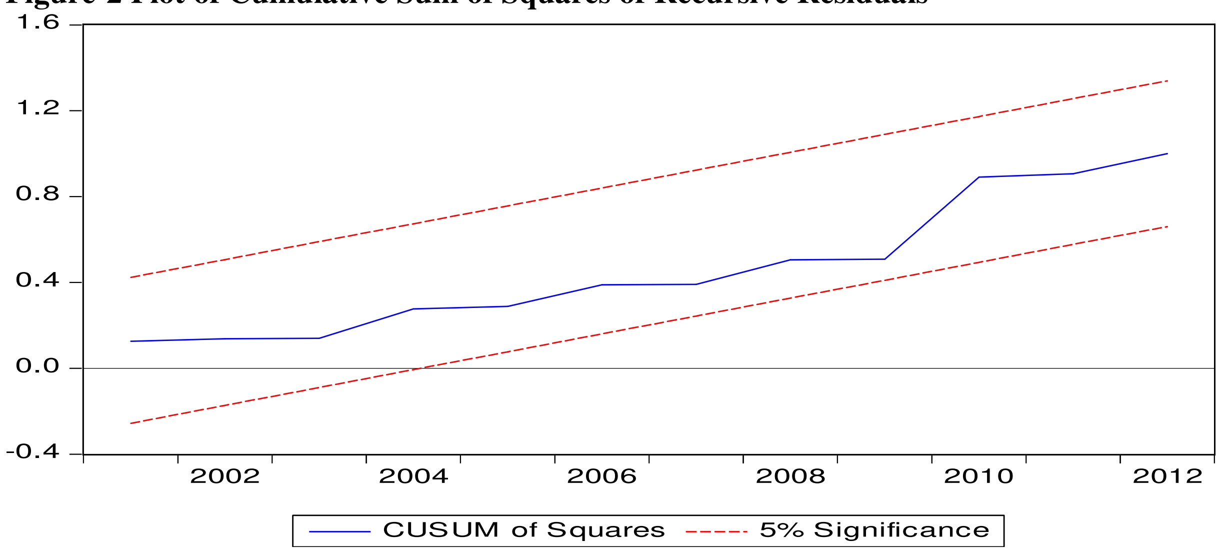
Economic Globalization

Figure-1 Plot of Cumulative Sum of Recursive Residuals



Straight lines represent critical bounds at 5% significance level

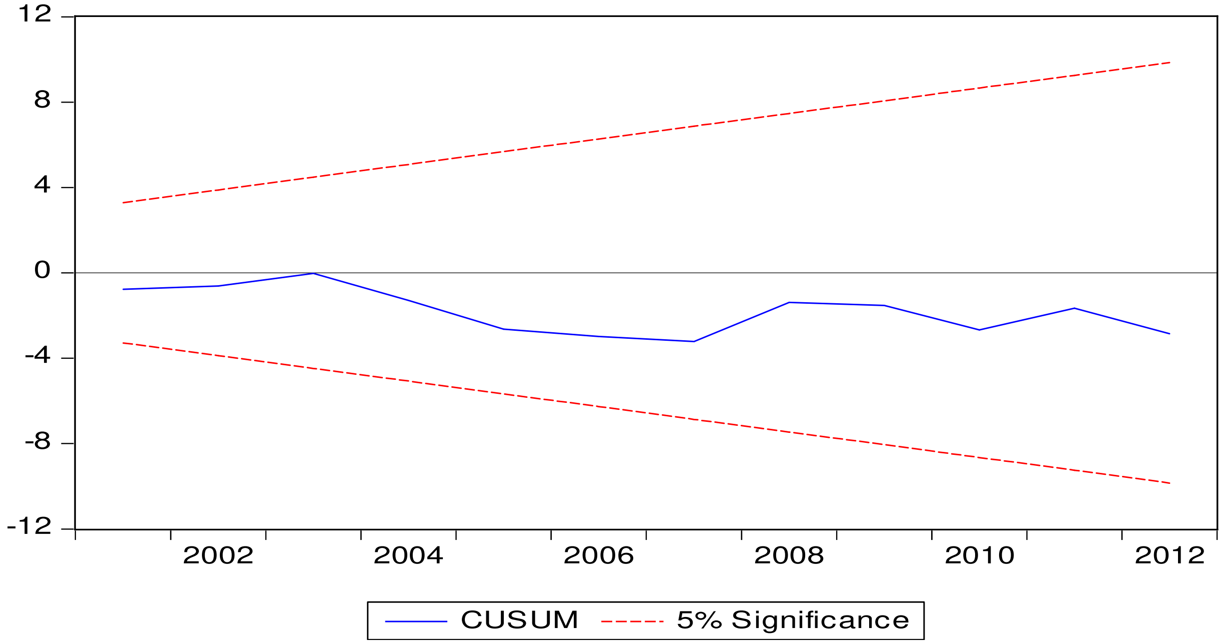
Figure-2 Plot of Cumulative Sum of Squares of Recursive Residuals



Straight lines represent critical bounds at 5% significance level

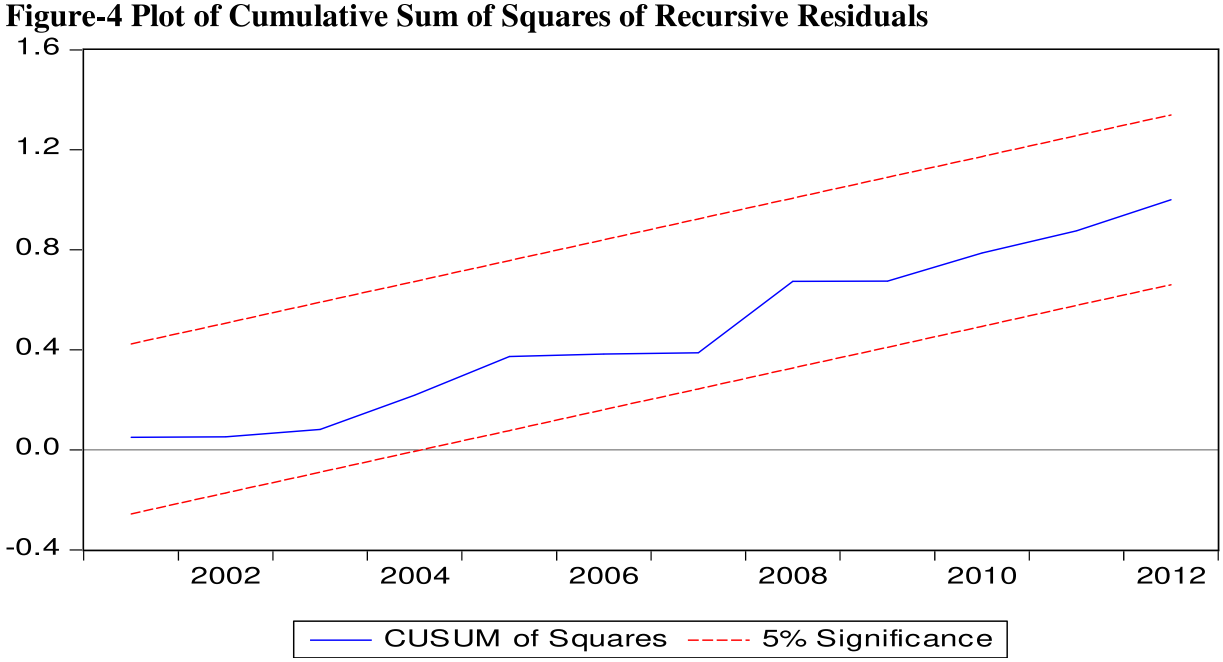
Political Globalization

Figure-3 Plot of Cumulative Sum of Recursive Residuals



Straight lines represent critical bounds at 5% significance level

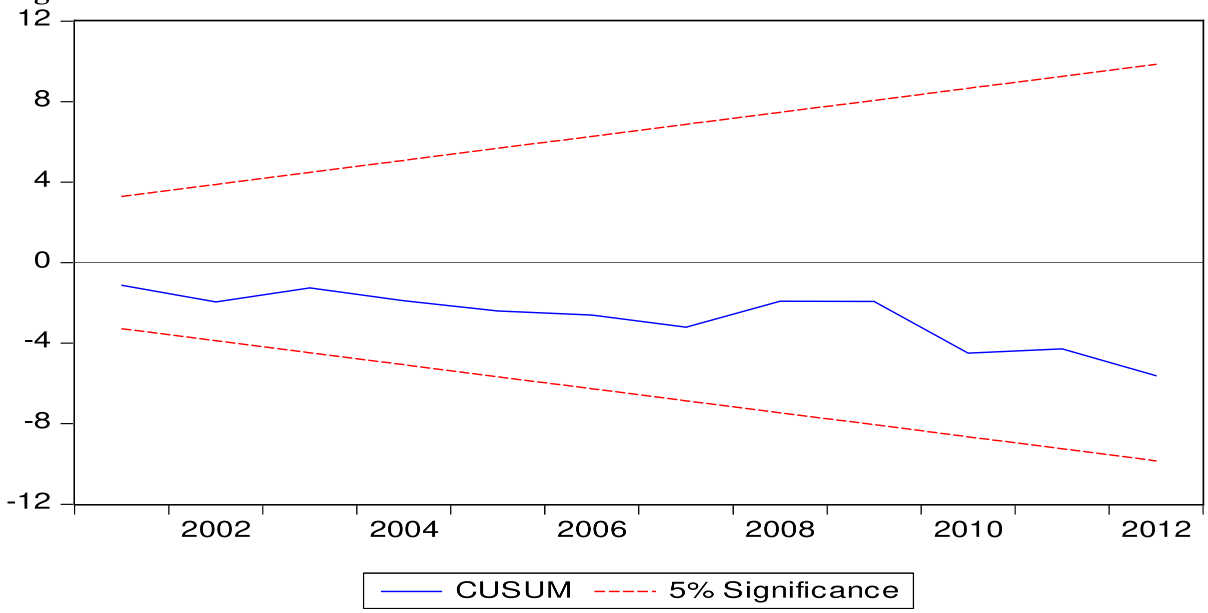
Figure-4 Plot of Cumulative Sum of Squares of Recursive Residuals



Straight lines represent critical bounds at 5% significance level

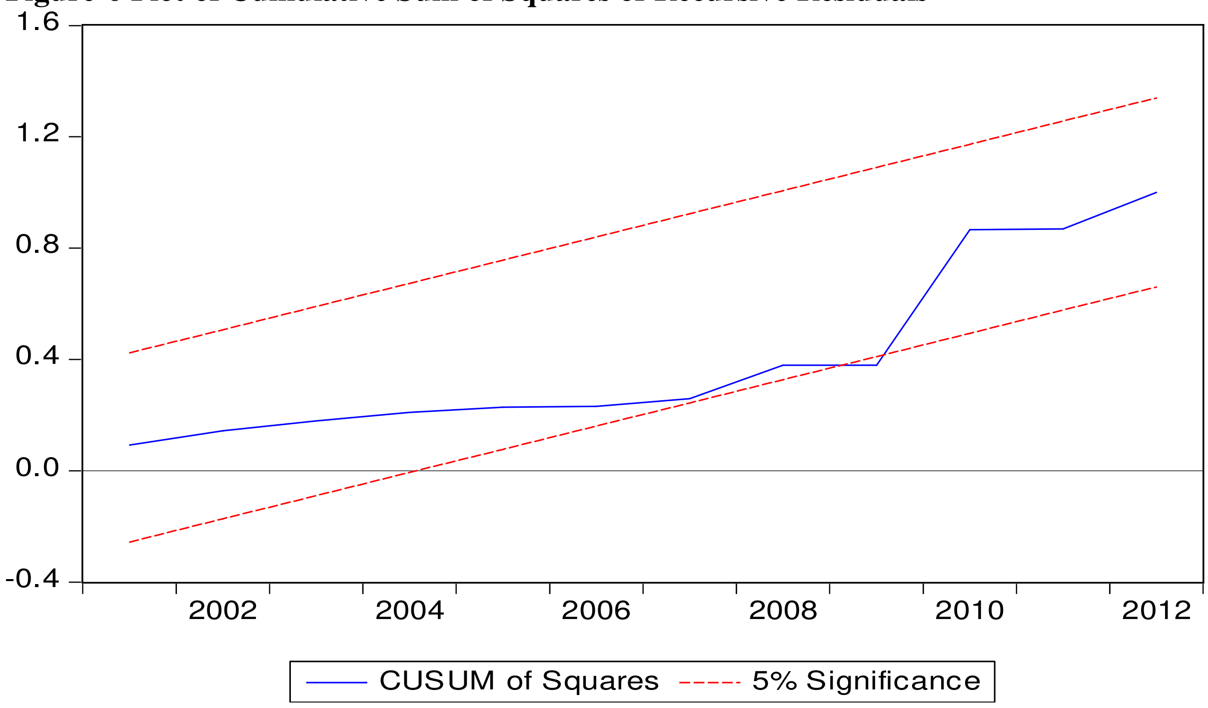
Social Globalization

Figure-5 Plot of Cumulative Sum of Recursive Residuals



Straight lines represent critical bounds at 5% significance level

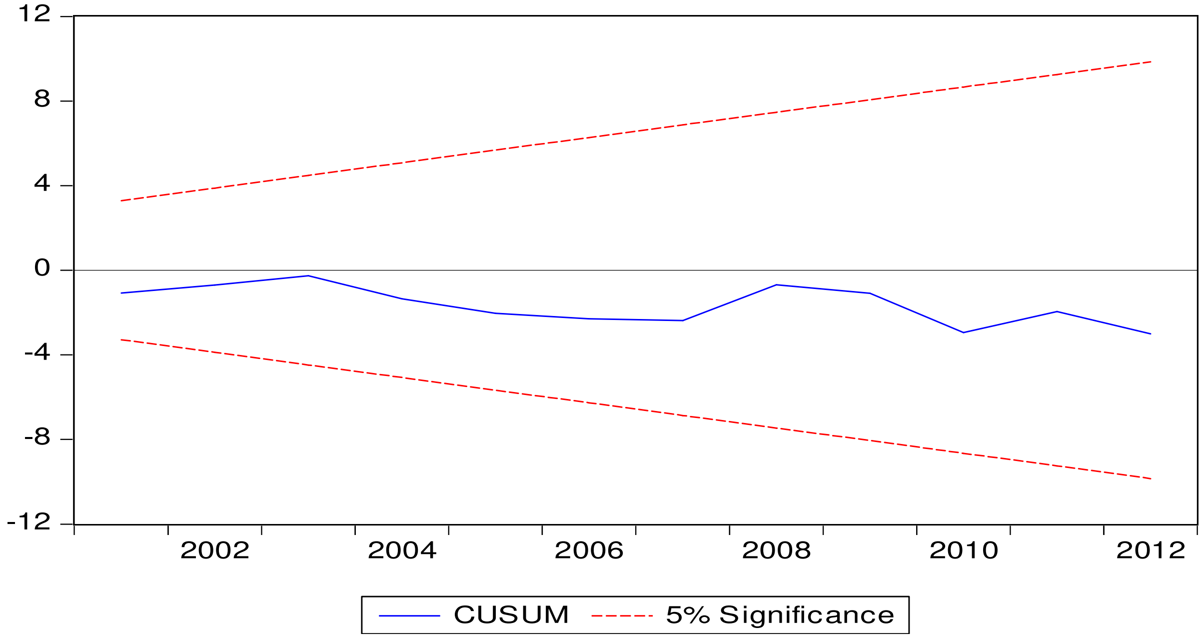
Figure-6 Plot of Cumulative Sum of Squares of Recursive Residuals



Straight lines represent critical bounds at 5% significance level

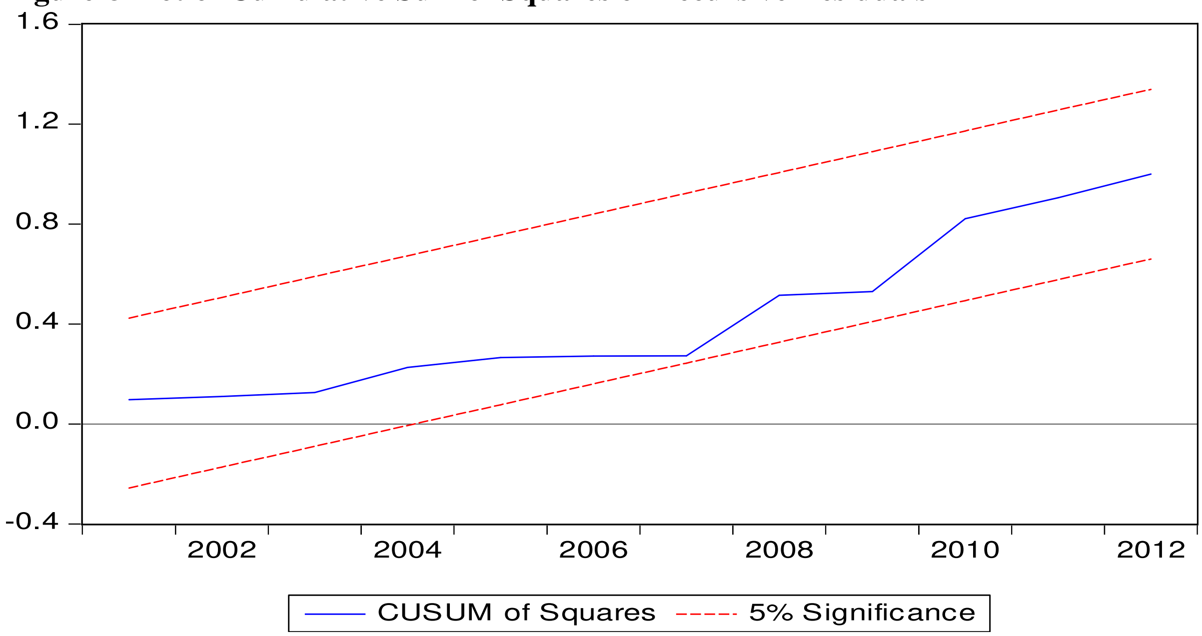
Overall Globalization

Figure-7 Plot of Cumulative Sum of Recursive Residuals



Straight lines represent critical bounds at 5% significance level

Figure-8 Plot of Cumulative Sum of Squares of Recursive Residuals



Straight lines represent critical bounds at 5% significance level

The VECM Granger Causality Analysis

When cointegration is confirmed, there must be a uni or bidirectional causality among the series. We examine this relationship within the VECM framework with inclusion of three different measures of globalization. Such knowledge is essential for formulating appropriate energy policies for sustainable economic growth. Table-6 reports the results on the direction of short run causality. We find that the feedback effect is evidenced between economic growth and energy consumption. In short run, the relationship between globalization and environmental pollution is independent in India. CO_2 emissions Granger cause energy consumption. Financial development Granger causes economic growth and economic growth in turn also Granger causes financial development. Economic growth Granger causes only the overall globalization and the components overall globalization measure are unrelated with economic growth.

Table-6: VECM Granger Causality Analysis

Dependent Variable	Direction of causality					
	Short Run Coefficients					Long Run
	$\sum \Delta \ln C_{t-1}$	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln EC_{t-1}$	$\sum \Delta \ln FD_{t-1}$	$\sum \Delta \ln EG_{t-1}$	ECM_{t-1}
$\Delta \ln C_t$	…	0.3582 [0.7020]	2.2594 [0.1225]	0.7281 [0.4914]	0.4033 [0.6718]	-0.1402*** [-1.7426]
$\Delta \ln Y_t$	0.0736 [0.9291]	…	2.6225*** [0.0898]	7.8708* [0.0036]	1.4256 [0.2567]	-0.6091** [-2.7505]
$\Delta \ln EC_t$	3.3469** [0.0492]	2.9476** [0.0683]	…	2.0280 [0.1498]	0.8428 [0.4466]	-0.5766* [-2.8034]
$\Delta \ln FD_t$	0.1428 [0.8675]	4.8430** [0.0150]	0.3158 [0.7316]	…	1.6283 [0.2131]	…
$\Delta \ln EG_t$	0.9630 [0.3936]	0.6714 [0.5187]	0.6411 [0.4340]	0.9611 [0.3943]	…	-0.3045** [-2.0516]
	$\sum \Delta \ln C_{t-1}$	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln EC_{t-1}$	$\sum \Delta \ln FD_{t-1}$	$\sum \Delta \ln SG_{t-1}$	
$\Delta \ln C_t$	…	0.1804 [0.8358]	3.3414** [0.0494]	0.7078 [0.5010]	1.4702 [0.2465]	-0.1635*** [-1.7917]
$\Delta \ln Y_t$	0.2522 [0.7788]	…	4.7925 [0.0159]	4.3941** [0.0215]	2.0853 [0.1425]	-0.7070** [-2.6917]

$\Delta \ln EC_t$	3.9243* [0.0030]	3.2845*** [0.0518]	…	1.0025 [0.3793]	1.6248 [0.2144]	-0.7698* [-3.5751]
$\Delta \ln FD_t$	0.0133 [0.9868]	5.2759** [0.0109]	0.4386 [0.6490]	…	0.5271 [0.5956]	…
$\Delta \ln SG_t$	1.3344 [0.2665]	1.6534 [0.2098]	1.4678 [0.2470]	0.3274 [0.7432]	…	-0.3967* [-3.1525]
	$\sum \Delta \ln C_{t-1}$	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln EC_{t-1}$	$\sum \Delta \ln FD_{t-1}$	$\sum \Delta \ln PG_{t-1}$	
$\Delta \ln C_t$	…	0.2431 [0.7857]	3.0693*** [0.0618]	0.3021 [0.7415]	0.5434 [0.5865]	-0.2546** [-2.1685]
$\Delta \ln Y_t$	0.0570 [0.9446]	…	3.5989** [0.0402]	4.1957** [0.0251]	0.4728 [0.6279]	-0.4927*** [-1.9767]
$\Delta \ln EC_t$	2.9830*** [0.0664]	2.2309 [0.1255]	…	0.5391 [0.5890]	0.2048 [0.8160]	-0.7662* [-3.1305]
$\Delta \ln FD_t$	0.0307 [0.9697]	4.7713** [0.0159]	0.3001 [0.7429]	…	0.0175 [0.9826]	…
$\Delta \ln PG_t$	0.5498 [0.5630]	1.5185 [0.2359]	0.3492 [0.7081]	0.0818 [0.9216]	…	-0.6356* [-2.9297]
	$\sum \Delta \ln C_{t-1}$	$\sum \Delta \ln Y_{t-1}$	$\sum \Delta \ln EC_{t-1}$	$\sum \Delta \ln FD_{t-1}$	$\sum \Delta \ln G_{t-1}$	
$\Delta \ln C_t$	…	0.0681 [0.9343]	3.9065** [0.0315]	0.2127 [0.8096]	1.4583 [0.2483]	-0.3038** [-2.3259]
$\Delta \ln Y_t$	1.1438 [0.3325]	…	5.5820* [0.0089]	5.9225* [0.0070]	5.9367* [0.0069]	-1.1890* [-4.3538]
$\Delta \ln EC_t$	4.9830** [0.0130]	4.2442** [0.0242]	…	1.1495 [0.2384]	1.1409 [0.2602]	-0.8457** [2.5301]
$\Delta \ln FD_t$	0.0266 [0.9736]	5.0512** [0.0129]	0.3716 [0.6916]	…	0.2360 [0.7912]	…
$\Delta \ln G_t$	1.0338 [0.3666]	4.6500** [0.0177]	0.9329 [0.4049]	0.1560 [0.8562]	…	-0.6358* [-3.0454]

Note: *, ** and *** denote the significance at the 1, 5 and 10 per cent level, respectively.

VI. Concluding Remarks and Policy Recommendations

The study explored the relationships between globalization and CO_2 emissions by incorporating economic growth, energy consumption and financial development in CO_2 emissions function for the Indian economy during the period of 1971-2012. We employed the Bayer-Hanck (2013) cointegration approach to examine the long run relationship between the variables. The integrating properties of the variables is investigated by applying the Lee and Strazicich (2013) that accommodates single unknown structural break stemming from the series. The ARDL bounds testing cointegration procedure is further applied to test the robustness of our long run estimates. The long run estimates obtained from bounds test show that the result validates the environmental Kuznets curve (EKC) for the Indian economy.

Our empirical exercise indicated the presence of cointegration relationships among the variables in carbon emission model as well as economic growth and energy consumption models. The long run estimates show that economic growth is inversely linked with CO_2 emissions in presence of squared per capita real income growth variable. Otherwise there is a positive relationship between growth rate of per capita real income and carbon emissions. The study implied that this result could be in favor of the EKC hypothesis for India. Further, both energy consumption and financial development are found to be positively related with carbon emissions and hence environmental degradation. Both are considered to be the major contributors of CO_2 emissions. This finding reinforces the findings of Boutabba (2014) for the Indian context, where financial development strongly causes environmental pollutions. Although the long run estimates with respect to the relationship between economic measure of globalization on carbon emissions is observed to be negative as obtained from bounds test and non existence of short run relationship among them either with bounds test or VECM models, but in overall, the effect of overall globalization (which includes economic globalization, social globalization and political globalization) points out to environmental degradation for India.

The short run causality analysis also reveals that economic growth and CO_2 emissions are interdependent as there is a feedback effect relationship between the two. Energy consumption is Granger caused by CO_2 emissions and the reverse also holds true. The relationship between globalization (economic globalization, social globalization and political globalization) and CO_2 emissions is independent. However, economic growth is Granger caused by the financial development and financial development Granger causes economic growth. Economic growth Granger causes only the overall globalization and the components overall globalization measure are unrelated with economic growth.

Thus, the financial development which comes up with higher economic growth and higher economic growth which comes up along with openness of the economy, instead of discouraging more energy consumption and thereby reducing carbon emissions, it is resulting in increased emissions and more pollution by encouraging more energy consumption for a developing economy like India. Since India is on a progressive economic path and is highly likely to play leading role in the areas of global trade and investments, therefore, this finding call for a pro-active government policy strategy for a shift in energy consumption and reducing nation's greater reliance on the traditional forms of energies to using more clean and renewable forms of energy. Otherwise, given the high import intensive nature of these energy sources and their increasing demand to satisfy increasing population, India neither can have reasonable control over the emissions and thereby the environmental degradation and nor can immediately solve its current account imbalances and reduce the proportion of population trapped in poverty and malnutrition.

Considering the relationship between the overall measure of globalization (including its three component measures) with CO_2 emissions, the study arrived at some quite interesting results that the economic globalization is trying to put self controls on carbon emissions while the social and political globalization are still contributing to carbon emissions as a result that might be driving out the direct relationship between overall globalization and environmental degradation. The former result may be because of the dynamic relationships inherent between economic globalization and economic growth. As the economies progress towards higher stages of development by adopting various strategies including export led growth strategy, and after they attain certain threshold levels of per capita income growth or economic progress, they become self-conscious about the harmful consequences of the effects of globalization and try to limit on their carbon emissions. This finding for India could also be explained through Porter's Hypothesis. The hypothesis states that as income increases with trade openness, developing countries tend to impose stricter environmental regulations on themselves to adopt environmentally-friendly production patterns, resulting in reduction in pollution and improvement in competitiveness (Porter and Van der Linde 1995, Mani and Wheeler 1998). At the same time, as there are conflicts of interest among economies on account of political and social differences across different segments of population in different geography and society, there is no social and political consensus on how to limit and who should limit on the carbon emissions. These social and political responsibilities of controlling the carbon emissions seem to fall on no man's land despite significant debates and efforts to have a consensus agenda. This becomes the responsibility of global community to address and sort out the problems for a sustainable ecology for every future living being on the earth.

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