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The Environmental Kuznets Curve and Trade Openness: The Case of South Asian Countries

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In the recent decades, the relationship between environmental problems and trade remains the most controversial topics for the economic literature. When trade increases, the consumption of fuels also increases which are heavily used in generation of energy, transport and industry. A large amount of population uses the small area of arable land to cut down trees for energy, as a result, carbon emissions increases. So, the aim of this paper is to examine the relationship between trade openness, GDP growth, population and carbon emissions in case of South Asian countries (Bangladesh, India, Pakistan and Sri Lanka) by using panel data over the period of 1980-2014. Panel unit root test, panel co integration, panel granger non-causality test, panel VECM test and DOLS estimator has been used to analyze the association between carbon emissions and selected macro-economic variables. The result of panel unit root test shows that variables are stationary at the first difference. The Johansen co-integration test reveals that all variables are co-integrated in the long run. In Panel Granger non-causality test, the unidirectional causality exists running from GDP growth and population to carbon emissions, whereas, trade openness does not cause carbon emissions in the long run. On the other hand, panel VECM results reveal that trade openness and population has no causal link with carbon emissions, but GDP causes carbon emissions in the short run. The result obtain from DOLS estimator shows the negative impact of trade openness and GDP growth on carbon emissions, however, population has positive impact on carbon emissions. Lastly, overall results do not show the presence of U-shaped Environmental Kuznets Curve (EKC) in Bangladesh, India, Pakistan and Sri Lanka. The proper policies should be taken to reduce the carbon emissions and improve trade situation.

JEL Codes: F18, Q54, Q56.

Keywords: Free Trade, carbon emissions, environment and trade, environment and growth, Environmental Kuznets Curve.

Field of Research: Economics

1. Introduction

The idea of the relationship between carbon emissions and trade openness has widely acknowledged. Many people believe that economic growth will lead to environment degradation unavoidably and at some extent, environment protection will hamper economic growth. As a result, environmental protectionists were against the economic growth for the sake of environmental protection. On the other hand, others believed that

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there is a correlation between environmental conditions and economic growth which is known as Environmental Kuznets Curve (EKC) Hypothesis. It describes that economic growth will lead to gradual environmental degradation at the initial stage. But as economic development and income per capita reach and exceed a certain level, namely the peak of EKC, economic growth will go hand in hand with environmental improvement, making an inverted U-shaped curve (Grossman and Krueger,1995; Bandyopadhyay and Shafik, 1992; Selden, 1994, 1995).

International trade is the most important engine of economic growth. Trade openness is considered as an increase in the size of the country's traded sectors with respect to total output. It has become the similar idea of "free trade" where all trade distortions are eradicated. Pritchett (1996) defines "openness" as the economy's trade intensity. On the other hand, according to Stenses (2006), he precisely defines openness in relation to barriers to international trade imposed by governments. International trade openness defines as a low international trade cost which is an abstraction of transport cost, tariffs, subsidy taxes and non tariff barriers. Additionally, trade openness earns foreign exchange by exporting and saves foreign exchange through import substitution, gives entrance in a broader way for marketable goods and services, easy access to foreign technologies which create opportunities for local firms to boost up their efficiency level in terms of production and resource allocation.

Groosman and Krueger (1991) is the first who study on the trade, growth and environment where they divided into various channel. A first channel is the scale effect which is causing harm to the environment. As trade increases, the more industrial output produced which can have undesirable effect on environment. Second channel is the technique effect where domestic plant can have advanced technology to produce more output. So trade openness can enhance the quality of the environment. Lastly, the income effect can create more jobs in the host country and local income can rise, so they will demand environmental improvement.

The main global concern started to appear in the 1970's, in the context of the impact of trade and economic growth on the environmental quality deterioration. It became more noticeable when half of the population of today started to use and consume more environmental resources compared to what environment can produce. The remarkable economic boom and fastest development of world trade occur after the "golden 60's", and the main goal was to achieved sustainable development in a greater extent, but the sudden changes of the higher resource prices and the alarming environmental deterioration leads to incorporate some environmental regulations. The policy of environmental quality is the most debatable issue till today and many opponents opposing or questioning against the results of such policies. As a result, there are two opposing groups over the discussion of the link between trade and environment.

According to the advocates of trade openness, only free trade can ensure the fair or equal and sustainable economic growth which leads to improve the environment, on the other side, they argue that trade barriers could be harmful as well as highly inefficient for the economy. The link between higher amount of income and improving of environmental quality were observed in some developed countries. In the group of

mainstream economists, they accepted trade as a key engine to improve the environment quality by assuming that free trade will increase the income where the level of environmental quality is low and improving the living standards, the household will demand higher and better environmental quality, at the end environment degradation will decrease. The critics of trade openness think that trade can have negative impact on environment and natural resources and in some point there is no recovery. Even if, there is higher living standard and income, but it is impossible task to calculate the actual value of the reduction of economic loss in the invaluable biodiversity.

Furthermore, climate change is one of the greatest environmental issues in the South Asian region (Bangladesh, India, Pakistan and Sri Lanka). Climate change is suffering under the intensity of environmental degradation, CO_2 emission, and the greenhouse gas problem. According to Guttikunda et al. (2015), South Asian cities (Dhaka, New Delhi, Karachi and Colombo) hold only 2% of the total land mass in the world, but due to high growth in the urbanization, these cities are emitting nearly 30% sulfur dioxide to the world. Recently in the South Asian region, the effect of air pollution and CO_2 emission has been noticeable through the brown cloud phenomenon. The brown cloud effect has negative impact which is found in the South Asian region (Bangladesh, India, Pakistan and Sri Lanka) where the monsoonal pattern and rainfall has been frequently swung. (Behera and Das, 2017) Mostly in developing countries do not take the environmental issues seriously. Lenient environmental policies can have negative effect on environment; they change the policy which is focus more on open market and trade barriers reduced which encourage more polluting companies to pollute environment with lenient environmental policy.

In South Asian countries for last five years the carbon emissions is increased drastically. The portions of export, import and GDP are raised gradually in South Asian countries (Bangladesh, India, Pakistan and Sri Lanka). On the other hand, carbon emissions have fluctuated quite a bit throughout the year. The population has been multiplied from 2014 to 2018. It is known that South Asian countries are the fastest growing countries and they expanding their economics through trade. Therefore, one of the main reasons behind the carbon emissions is industrialization. The number of industries are increasing in South Asian countries, as a result, more industries means more negative externalities and toxic waste which causes the carbon emissions to rise and damages the environment. When trade increases it increases the use of fuels which used for energy, industry and transport sector. People cut down the small portions of arable land to generate energy, on the other hand, make more scope to create urbanization and industrialization. As a result, carbon emission rises, food production decreases which leads to decline in food availability.

The association ship between trade openness and environmental quality has been considered the most significant issues in recent years. One of the most trade possible channel that can affect the environmental quality which is industrialization, use of energy, urbanization. Through industrialization, it generates negative environment externalities in the host country. Most of the investments are invested in host country; as a result, it pollutes the environment. The increase of trade openness leads to an increase in deforestation. Additionally, capital-labor and environmental regulations are

negatively related to deforestation in developing countries like south region. But it is positively associated with developed countries.

Many authors studied the relationship between trade openness and environment quality. Maji (2015) analyzed the relation between trade openness and environmental quality in the context of Nigeria. He collected Nigerian data from World Development Indicators (WDI) for the period of 1981-2011 and the economic method applied in the study is Autoregressive Distributed Lag bounds (ARDL). The result found that trade openness and economic growth improves environmental quality and reduces deforestation in the long run. However, population increases deforestation which leads to decline the environmental quality.

Naranpanawa (2011) has examined the link between trade openness and carbon emissions for the South Asian country which is Sri Lanka. He used Sri Lanka data from 1960-2006 by using Autoregressive Distributed Lag bounds (ARDL) approach and the result confirmed the relationship between trade openness and carbon emissions in the short run, but not in the long run. Another study is examined by Rehman et al. (2007) where they concluded that trade and environmental quality are positively associated, nevertheless the positive effect is conditional in terms of corruption. According to them the linkage between corruption and trade openness is considered as a compliment for environmental policy distortions.

A number of studies such as: Bernard and Mandal (2016), Copland and Taylor (1994, 1995) and Yang et al (2013) have focused on the impact of trade on environment qualityin the terms of developed and developing countries. This paper is gone further than the previous studies by exploring the relationship between carbon emissions, trade openness and GDP in case of South Asian countries (Bangladesh, India, Pakistan and Sri Lanka) by using panel data over the period of 1980-2014. Panel unit root test, panel co integration, DOLS estimator, VECM test and panel granger causality test has been used to analyze the association between carbon emissions and selected macro-economic variables. By adding that, the following research questions are specifically addressed in this study:

- Is there any relationship between carbon emissions, trade openness, GDP and population in the four South Asian countries?
- What are the directions of short and long run causalities between the variables?

On the other hand, the results of the long run and short run causality reveals that trade has no causal relation with carbon emissions and the overall result of these economic methods do not show the presence of U-shaped Environmental Kuznets Curve (EKC) in Bangladesh, India, Pakistan and Sri Lanka. Also, the rest of the paper is organized as follows: in the next section, it explains the review of the literature followed by the description of methodology and data which is used in the paper. In section three it describes current situation of environmental and trade openness in a context of South Asian countries (Bangladesh, India, Pakistan and Sri Lanka). Section four gives an explanation about the economic methods and data which is used in this study. The results of the economic models cover the section five. Lastly, it concludes and

discusses about the policy recommendations of the relationship between carbon emissions and trade openness for South Asian countries with the direction of future research for more comprehensive analysis.

2. Literature Review

The impact of trade openness on environmental quality has been the most intense research topic for the few last decades. Many studies have been found which explained the linkage between carbon emissions and trade openness.

The EKC hypothesis argues that the pollution increases when the country starts to develop its industries and after reaching the certain level of economic progress, the pollution declines. At the early stage of industrialization, pollution level increases and it begin to polluting the industries. The main turning point is the result of growing communities by approving the institutional and non-institutional measures because they support the cleaner environment. Fewer polluting service industries will be noticeable in terms of prominence when industrialization is advanced. When the inverted U shaped develops certain level of income and environmental pollution revert leads to a positively generating n-shape curve.

During the last few decades, various theoretical models have been based on the effects of trade on environment. Table-1 presents the (See Appendix) key empirical work on carbon emissions, GDP growth and trade openness. The first empirical and most influential work has been carried by Grossman and Krueger (1993) where they analyzed trade- environment nexus by assuming negative impact of trade on environment. They divided the environmental outcome of NAFTA into scale, composition and technique effects. Results of various researches in this area have not been consistent by reason of variations of countries characteristics for example different indigenous energy supplies, political and economic histories, cultures & different institutional arrangements.

Effects of trade on environment have been analyzed by various theoretical models, Copland and Taylor's study is one of them. Copland and Taylor (1994, 1995) estimated North-South trade model and the results showed that free trade improve the developed countries environment as they import products from developing countries, yet it worsens the environment latter. Adamowicz and Carney (2005)found the similar results where they revealed that rich countries can protect their environment from pollution very effectively by damaging environment of the poorer countries.

Some authors detected that trade openness has positive impact on environment. For example, Taskin and Zaim (2000) discovered that trade liberalization pollutes the environment at the early stage of economic growth. When it starts to consume the environmental goods then the economic growth achieves its certain amount of development. Antweiler et al. (2001) discovered that trade openness provides the positive effect on environment and sulfur dioxide concentrations occur by trade openness. On the other hand, Frankel and Rose's (2005) study supports the Environmental Kuznets Curve (EKC) for trade's contribution where it generate carbon

emissions. On the contrary, the result of Stern's (2004) study did not support the Environmental Kuznets Curve (EKC) hypothesis for developing countries.

Choi et al (2010) examined the same topic for China, Japan and Korea. He found that Korea were more concern about the environmental protection because of trade openness. Higher trade openness resulting of higher economic growth which leads to raise the standard of living. At the early stage of economic growth, China is not concern about the pollution; it mainly focuses more on fastest growing capitalization through cheap labor, as a result, it worsens the environment. For Japan, the results revealed that there is a positive linkage between trade openness and carbon emissions. In case of China, Yunfeng and Laike (2010) noticed that, by considering the labor costs, marketing, environmental regulation and other factors, developed countries shift their pollution intensive industry to China.

Ulla (2010) analyzed that how does trade liberalization effect the environment in the developing countries? The results of panel data showed that the increase of carbon emissions leads to slow down the presence of Environmental Kuznets Curve (EKC). Similarly, Zhang and Gangopadhyay (2012) explored that how trade can affect the environment in a context of China. The paper used panel dataset of China's cities by using the composition, scale and technique effects. The results found that higher amount of income and trade has bad impact on environment. So, trade has nothing to do with environment degradation.

Yang et al (2013) analyzed the impact on Environment Kuznets Curve (EKC) of trade and foreign direct investment (FDI) in the context of China's 30 regions. They collected data of trade, FDI, economic development and environment conditions from China's Statistical yearbook for the period of 1990-2002. They used Fixed Effects Model and Random Effects Model. On the contrary, to modify the differential deviation they also used Maximum Likelihood Estimation. The result showed that, trade has no direct impact on Environment Kuznets Curve (EKC). However, trade contributes to the economic growth. On the other hand, FDI and pollution emissions are positively correlated but in some extent, FDI does have negative effect on China's environment.

Rahman (2013) estimated Vector Autoregressive (VAR) framework to test the interrelationship between trade openness and carbon dioxide emissions in the context of Bangladesh. He found that the Granger analysis has an inconclusive causal relation between these variables and VAR tested the stability where it has a significant impact of trade openness on carbon emissions but not in the reverse order.

Apergis and Oztruk (2014) examined the Environment Kuznets Curve (EKC) hypothesis in the 14 Asian countries, such as: Bangladesh, China, India, Indonesia, Iran, Japan, Republic of Korea, Malaysia, Nepal, Oman, Pakistan, Saudi Arabia, Singapore and United Arab Emi-rates for the period of 1990-2011. To test EKC, they applied GMM methodology in a multivariate framework by using panel data and the variable were: carbon emissions, GDP per capita, industry shares in GDP, population density, land and indicators which measure the quality of institutions. The result disclosed the presence of an inverted U shaped linkage between carbon emissions and per capita

income, as well as carbon emissions and population density. Additionally, it confirmed the existence of Environment Kuznets Curve (EKC) hypothesis in the 14 Asian countries. Similarly, the study of Ameer and Munir (2016) also focused on the data of Asian countries. They investigated the effect of trade openness, population and economic growth on environment. The result shows that carbon emissions model has significant impact of economic growth and technology on environment. While the result of sulfur dioxide emissions model finds the presence of inverted U-shaped EKC hypothesis.

The impact of trade openness on environmental quality of developing countries has been worked by Bernard and Mandal (2016), leading to the used of GMM estimation and Fixed Effect Model approach as a tool. The GMM estimation results disclosed that the carbon emissions, income, energy consumption and population have detrimental effects on environmental quality. On the other hand, the fixed effects model indicates that both GDP and trade openness has positive impact on environment, while overall findings indicates that trade openness, population and energy consumption detriments environment. Another work is done by Hakimia and Hamdic (2019) where they study the effect of trade on environmental issues by considering the role of institutions. The result of aggregated analysis found that trade has no impact on the environmental quality. On the other hand, disaggregated analysis showed that trade deleterious the environment but the institutions preserve the environment.

A specific limitation in most of the previous studies is that they used limited sample sizes; therefore, they cannot find the actual result for environment quality. Moreover, another particular drawback is to focus on the impact of trade openness on environmental quality but have not specifically showed the long run relationship, short run and long run causality direction in a context of Bangladesh, India, Pakistan and Sri Lanka. Therefore, we have made an attempt to shed light on the links between these variables by considering the four South Asian countries. And after the discussions of the drawbacks for the previous studies we can set our null hypothesis relevant to our research question which is, Null Hypothesis: Trade openness, GDP, population does not cause carbon emissions and Alternative Hypothesis: does cause. In addition, we will also focus on the coefficients of the variables.

3. Environmental Issues and Trade Openness in South Asian countries: An overview

People all over the world have seen the actual reality of climate change because of the obvious result of increasing amount of extreme weather events in whole worldwide. According to Global Climate Risk Index (2019), more than 526000 people have died in the whole worldwide and losses of US$ 3.47 (in PPP) trillion has been incurred by the causes of more than 11500 extreme weather events from 1998 to 2017. As per UNEP Adaptation Gap Report 2016, the increasing impacts of climate change leads to increase the global adaptation cost by 2030 to 2050 which will be much higher than the currently expected. Intergovernmental Panel on Climate Change (IPCC) said in their report on “Global Warming of 1.5°C” that "Mean net present value of the costs of damages from warming in 2100 for 1.5°C and 2°C (including costs associated with

climate change-induced market and non-market impacts, impacts due to sea level rise, and impacts associated with large scale discontinuities) are $54 and $69 trillion, respectively, relative to 1961–1990".[3] This gives indication that there is a gap between necessary financing which is deal with climate induced impacts and risks where it is far bigger than earlier. On the other hand, Global warming is about to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate 0.2°C per decade—due to past and ongoing emissions.[4] Global warming is on the way to reach above 3°–4°C preindustrial temperatures which potentially causes further warming across the world.

According to Internal Displacement Monitoring Centre (2018), due to weather disaster, there were 18 million new internal displacements in 135 countries. In 2018, natural catastrophes again reached above-average levels than the previous year; as a result, it causes more than 10000 deaths. Least developed countries faces the highest disadvantages from the climate change. LDC's estimated the proportion of national income (more than 15 per cent of GDP) and foreign exchange from tourism which is threatened by climate change.

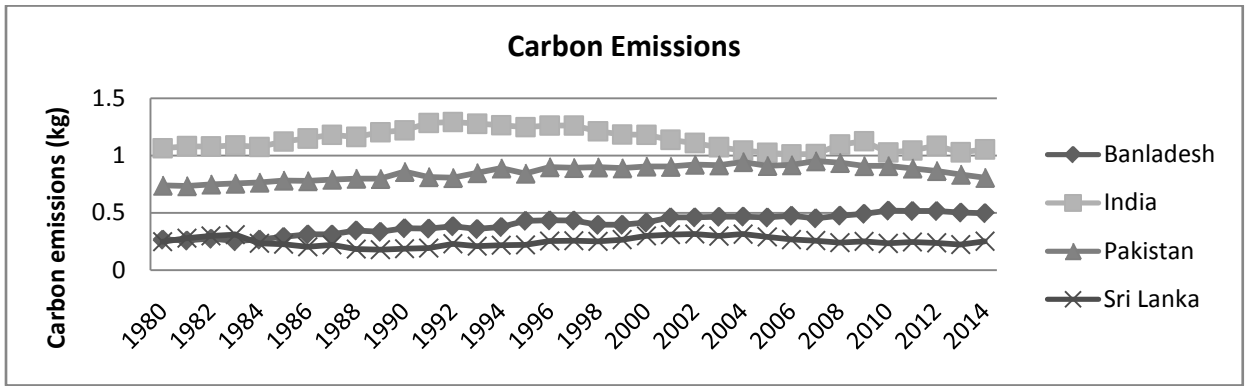
Recently, the current environmental situation of South Asia countries is related to air pollution and extreme weather events which causes the economic loss. According to Climate Analytics (2019) report, "South Asian (SA) countries is striving to bring their large population out of poverty including through large scale industrial and fossil fuel-based power projects, resulting in an increase in green-house gas (GHG) emissions, hence increasing the vulnerability of these countries due to climate change."[5]

South Asian countries is one of the most fastest growing regions in terms of growing population, industrialization and urbanization which increases the carbon dioxide emissions between 1990 to 2010 while India is ranked as one of the top green-house gas (GHG) emitting country in the world. The overall increase in the emissions of the South Asian region is not only harming the region but also the world. Additionally, the emissions also have huge impact on economic growth in South Asian region. Asian countries are closely related to strong trade agreements and ethic group, therefore, a shock in one country may reverberate strongly across many areas in the region. There will be a strong international ties and partnership can grow between this regions by limiting the emissions.

Climate change is not only being driven by long lived existence of green-house gases such as carbon dioxide (CO_2) which are well mixed globally but also there is short lived climate forcers which is black carbon. Carbon emissions in South Asia are acquired from four sectors such as: industrial, open biomass burning, residential and transportation. Industrial and transportation sectors plays as significant contributors and India is the largest emitter of carbon in the region. In India, brick kilns emit two-third of industrial sector and heavy duty truck represents more than half of the transportation sector emissions. According to Department of Environment of Bangladesh, recently the rate of brick kiln has been increased by 59% for the last five years in Bangladesh. In 2013 the amount of brick kiln was 4959 but it increased to 7902 in 2018. The worst situation is they use agricultural land illegally for brick kiln; as a result, it is difficult for farmers to produce vegetables. On the other hand, brick kiln creates black smoke which

hampers the environment. In Figure-1, India and Pakistan has encountered the highest carbon emissions among the South Asia country, whereas, carbon emissions of Bangladesh and Sri Lanka has increased but it is lower than India and Pakistan.

Figure1: Carbon Emissions of South Asian Countries (Kg of US$ of GDP)



Source: World Bank Indicators, 2019

The total emissions in the industrial sector, waste generations sectors and agriculture sectors in Bangladesh, Nepal, Bhutan, India, Sri Lanka and Pakistan have been estimated which is nearly double in 2030 from the 2005 level 69.82 million tons of carbon dioxide (CO_2). Out of these five countries, Bangladesh has the highest share of 79% which is 57.96 million tons of CO_2whereas the total emission has been calculated as 73.26 million tons of CO_2e in 2020 which is originating from industrial sector, waste sectors and agriculture sectors. The share of carbon sink in Bangladesh is 5% (1.3 million tons of CO_2) and total carbon sink capacity is 25.6 million tons of CO_2. It has been seen that, Nepal has the highest carbon sink capacity at 16.6 million tons of CO_2. In case of Abatement cost in South Asian countries, forestry sectors showed highest abatement potential of CO_2 at 23.5 million tons out of total abatement potential of 29.1 million tons of CO_2.

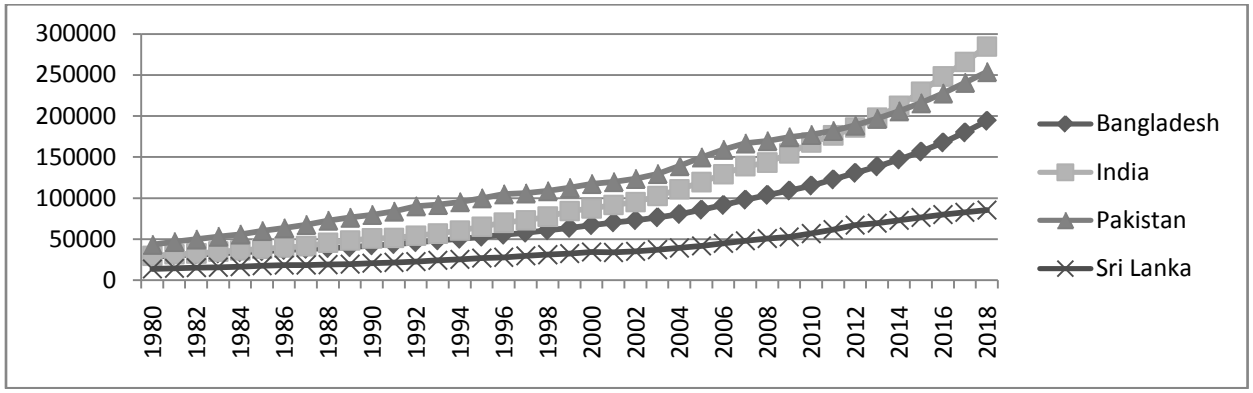
In the industrial sector, the post-combustion carbon capture and storage (CCS) has significantly higher abatement potential than the oxy-combustion CCS but it's a bit larger IAC per ton of CO_2. In agriculture sector, the abatement potential of crop production is higher with a low IAC of 3.01 million per ton of $C0_2$. The abatement cost of waste sector on composing municipal solid waste is the lowest among these options in South Asia countries. Assume that, India target to reduce their emission by 30% respectively over the period 2005-2020.[6] Also assuming that, Bangladesh will also follow the similar path to reduce the emissions by 20% over the period 2005-2020.[7]

According to World Economic Situation and Prospects (WESP) 2019 report, economic activity is immoderately depends on carbon-intensive fossil fuels. The growth of GDP and carbon emissions is closely related. As per the report, carbon emissions continue to rise but later it will start to decrease before 2030 and there will be substantial changes in natural and human systems. Therefore, this requires a rapid shift where the world powers economic growth. The reason behind the rises of greenhouse gases and other

gases stemming is, the persistent rises of global economy and population growth and human activity. The global energy related carbon emissions increased in 2017 (1.5 percent) which is a historically high rate, after three years of remaining at the same level. As a result, global economic growth increased which is supported by the low cost of fossil fuels, weaker energy efficiency efforts.

The GDP growth of South Asian countries are expected to expand by 5.4 percent in 2019 and 5.9 percent in 2020. However, results are highly dissimilar across the countries. The economic growth in few countries including Bangladesh and India remains robust in a short period of time. On the other hand, the economic situation of Pakistan is slowly visibly. In Figure-2, it shows that the GDP is increasing. Among the four countries, India has achieved sustained rapid growth of GDP for last two decades. The GDP growth of Pakistan, Bangladesh and Sri Lanka has increased but they are far more below than India.

Figure 2: GDP Growth of South Asian Countries (US$ Trillions)



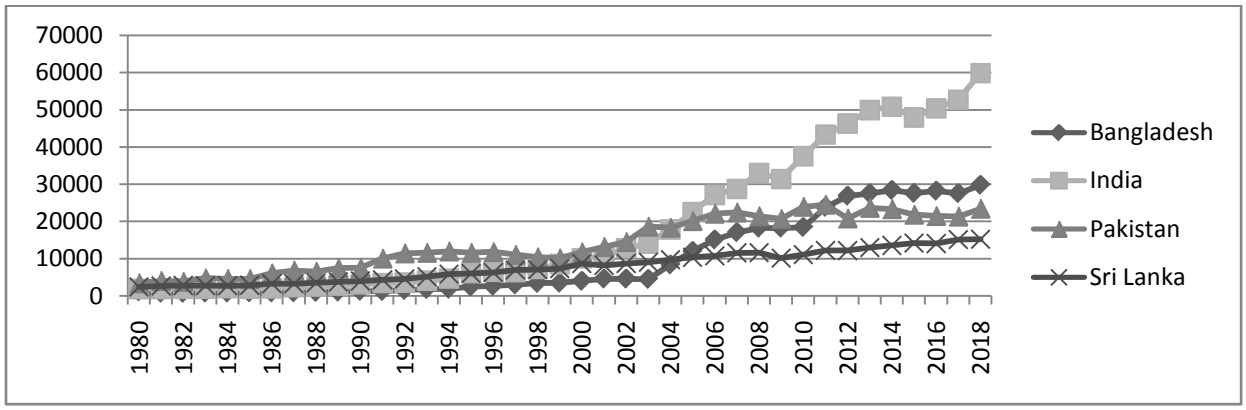
Source: World Bank Indicators, 2019. (The data of India is very high compare to other data set; therefore, it was taken as a fraction of 1/10 to accommodate within the scale.)

There are some issues which countries face during the phase of achieving the expected GDP growth. One of the main hurdles for South Asian countries for future development is the overpopulation and chronicle poverty. In spite of having rapid economic development in South Asian countries, the population and poverty level remains slightly high. On the other hand, because of climate change, global financial conditions and ongoing trade disputes, the region are facing the increasing rate of fiscal and current account deficits. The regions are lagging in attracting the foreign investments, increasing new markets, upgrading and diversifying its export products and these segments is a key to strengthen the international competitiveness among countries.International trade can be a powerful driver of economic growth. Trade openness had tremendous stimulating effect on the South Asian economics. In 1980's, the most deregulation measure were introduced which stimulates the privatization of public enterprises and emergence of Bangladesh's future economic powerhouse, which is readymade garments industry. Flexible exchange regime of Bangladeshi Taka and export promoting incentives increased the trade openness 19% in 1991 to nearly 49% in 2008. According to Trade and Development report 2015, "trade has increased in many

South Asian countries from 20 percent to 50 percent since 1990 while GDP increased by 2.5 to 4.9 percent annually".[8] Governments try to protect their economics from international competitions and trade barriers such as: different forms of tariffs and taxes, but in 2015, the world merchandise exports increased to 17 US$ trillion. Additionally, the expansion of service sector is a feature of successful modern economics but the demand of industrial sector drives its growth, such as the boom in India of digital services (Trade and Development report, 2019).

The Figure-3 has shown the trend of trade openness of South Asian countries. Trade openness of India shows the increasing trend, while other countries are far beyond than India. Bangladesh's trade openness is higher than Pakistan and Sri Lanka. The export of Bangladesh increased in 2018 which is higher than the previous year. But the overall volume of export has decreased from 5.8 percent in 2017 to 2.5 percent in 2018. (Trade and Development report, 2019). However, according to Trade and Development report, (2019) "the deceleration would have been greater in the region as a whole, if India had not registered acceleration in growth between 2017 and 2018, from 6.9 per cent to 7.4 per cent."[9] The speed of the trade growth of India will decrease in 2019 because of the below target collections which is introduced by Goods and Services Tax. The Goods and Services tax have combined with fiscal consolidation efforts to limit the public spending of India, and this will further slow down the growth in the South Asian region as a whole. The trade growth in Bangladesh is quite robust.

Figure 3: Trade Openness of South Asian Countries (US$ Trillions)



Source: World Bank Indicators, 2019. (The data of India is very high compare to other data set; therefore, it was a taken as a fraction of 1/10 to accommodate within the scale.)

But, Pakistan is in the middle point of a crisis: the growth rate has divided into two parts, the balance of payments is in poor shape, the Pakistani rupee has depreciated significantly and external debt is large and rising. While support from China and Saudi Arabia and a large IMF loan have helped address the immediate problem, the crisis has not been resolved. (Trade and Development report, 2019).

On the other hand, the condition of Sri Lanka in terms of trade openness is not very significant, though it is in increasing trend, but it less significant compare to other South Asian countries. According to Naranpanawa (2011), "Trade liberalization in Sri Lanka,

which has been happening for the last two decades, has not significantly contributed to generation of CO_2 emissions", also he added "The main trade intensive industries in Sri Lanka, such as Tea, Rubber, Coconut and Garments industries are less emission intensive." Since carbon emission is connected to trade openness, therefore, Truong (2010) suggested in his paper that, if India adjusted their emissions intensity for trade, then their emissions intensity will be downward, while Bangladesh will have emission intensities adjusted upward. Trade can increase emissions, but that does not mean that reducing or eliminating trade will decrease the emissions. Therefore, in autarky level, countries will produce their own goods for domestic consumption, so, domestic production is more emission intensive activities than import or export. Therefore, reducing trade may increase emission than decrease for the world as a whole.

4. Methodology and Data

In the beginning at this paper, the panel unit root tests are estimated to check the whether the variables are stationary or not. Augmented Dickey-Fuller or Dickey-Fuller tests are extended. An extension is done because most of the tests include it as a regression component and by doing so we can get more robust results (Amin, 2011). Total five unit root tests are applied in this paper which are: Levin, Lin & Chu, Breitung, Im, Peasaran and Shin, ADF- Fisher Chi-square and PP-Fisher Chi square. First two unit root test Levin, Lin & Chu and Breitung are the most common tests for cross-sections data. The unit root tests have two hypotheses: null and alternative hypothesis. The null hypothesis states that the data are non-stationary or have a unit root test and alternative hypothesis explains that the data are stationary or do not have a unit root. Other three unit root tests are Im*et al*., (2003), Augmented Dickey-Fuller (ADF) and Phillips Pheron Tests (Maddala and Wu, 1999) which check the individual unit root rest for the cross-sections data.

Johansen co integration test is examined to check the long run relationship among the variables. To check the co integration among the variables, Soren Johansen (1988) proposed two different approaches: likelihood ratio trace statistics and maximum eigen-value statistics.

$$\lambda_{Trace} = -T\sum_{i-r+1}^{n} \ln(1-\lambda_i) \quad (1)$$

$$\lambda_{max}(r, r+1) = -Tln(1-\lambda_{r+1}) \quad (2)$$

Maddala and Wu (1999) used Johansen's (1998) test for co-integration by consider the Fisher's (1932) test to combine the individual test. From the previous two tests Maddala and Wu (1999) proposed an alternative way for estimating the co-integration in panel data framework. If π_i is the cross section p-value co-integration of *i*, therefore, the null hypothesis of the whole cross section would be,

$$-2\sum_{i=1}^{N} log_e\, \pi_i \quad (3)$$

It is distributed as χ^2_{2N} in the sample. There will be one direction of causality, if two variables are co-integrated. Granger causality introduced by Granger (1969, 1980 and 1988). Engle and Granger (1987), they explained the presence of non-stationary and

the existence of long run relationship between non-stationary time series data and the result will be shown when the variables are co-integrated. On the other hand, Dumtrescu and Hurlin (2012) proffered Granger non-causality heterogeneous panel data model. In the linear autoregressive data, the extension of panel standard causality can explain by investigating the cross-sectional linear restrictions of the coefficients of the variables. Generally, the information of one cross section can extend to other cross-sections. The causality test can be tested in a context of panel data with NT observations, while, cross sectional data involves by accepting the heterogeneity. On the other hand, with any heterogeneity problem granger can allow to test causality.

Suppose, the two stationary variables are *x* and *y*. These two variables are observed for N individuals throughout T. Here i= 1, …, N and t= 1… T.

$$Y_{it} = \alpha_i + \sum_{k=1}^{K} \gamma_i^{\,k} \, y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{\,k} \, x_{i.t-k} + \varepsilon_{it} \quad (4)$$

Here, K belongs to N and $\beta_i = (\beta_i^{\,1}, \dots, \beta_i^{\,K})'$. Suppose, α_i is fixed in the dimension of time and lag order of K is identical for all cross-sectional panel units where the panel is fully balanced. Furthermore, $\gamma_i^{\,k}$ (autoregressive parameter) and $\beta_i^{\,k}$ (slope of the coefficient) in cross sections unit, they are allowed to different and both will be constant over time. Therefore, it creates a fixed environment rather than allowing random effects to change the values of the coefficients. Heterogeneity problem in panel data can appear from the presence of an individual effect and the parameters. It is known as the standard source of heterogeneity. It can directly affect the pattern of agent which can create a problem in causality relations. On the other side, homogenous specification does not allow any causal relations, while, Homogenous Non Causality (HNC) hypothesis allows both heterogeneity and causal relation in the parameters. The null hypothesis can be defined as,

$$H_o: \beta_i = 0 \quad \forall_i = 1, \dots, N$$

For the alternative hypothesis, it is assumed that there are N_1<N individual process where there is no causality between x and y.

$$H_1: \beta_i = 0 \quad \forall_i = 1, \dots, N$$
$$\beta_i \neq 0 \;\; \forall_i = \; N_1 + 1, N_1 + 2, \dots, N$$

Where N_1 is unknown but satisfies the condition of $0<N_1/N<1$. In the sample, causality exits in all individuals, when $N_1 = 0$. And if $N_1 = N$, then there will be no causality which means it is the null hypothesis. The structure is very similar to Im*et al*., (2003).

Causality test can perform within the framework of VECM by differentiating the short and long run causality, if the variables have presence of long-run relationship. Long run causal relationship is estimated by the significance of t test where it contains long term information about the variables and it is derived from long run co-integration association. But, in the short run there can be short term imbalance and dynamic structure which is known as VECM.

The Dynamic OLS (DOLS) approach was presented by Stock & Watson (1993). DOLS estimator can be essential and efficient model to work with small sample size where it deals with dynamic sources of bias. DOLS is more efficient and improved than OLS estimator. DOLS equation is a robust single equation approach where it corrects the explanatory variables by incorporating lags and leads. DOLS estimator also estimates the long run equilibrium where variables are integrated in same or different order. DOLS estimator can be more promising than OLS and FM estimator to estimate the co integrated panel regressions because of appropriate properties and less biasness. Moreover, it has similar optimal version like Johansen distribution. Since our sample size is small and to avoid the false estimation, we have applied DOLS approach. If Y_t is the dependent variable with regressors $X_{i,t}$=1,2,3…,n then,

$$Y_t = \beta_1 X_{1,t} + \beta_2 X + \cdots + \beta_k X_{k,t} + \sum \alpha_{i\Delta} X_{1,t-1} + \sum y_{i\Delta} X_{2,t-1} + \cdots + \sum \delta_{i\Delta} X_{k.t-1} + \varepsilon_t \textit{(5)}$$

This study applied a basic economic method by using annual data from 1980 to 2014 which are obtained from World Bank Indicators for four South Asian countries which are Bangladesh, India, Pakistan and Sri Lanka to estimate the relationship between carbon emission, trade, GDP and population. The four separate regression model for four countries are considered in one regression line to estimate the association ship. The basic economic model is given below:

$$lnY_{it} = \alpha + \beta_1 lnGDP_{it} + \beta_2 lnTO_{it} + \beta_3 lnPOP_{it} + \varepsilon_{it} \textit{(6)}$$

Where, $Y_{it}$is carbon dioxide emission, $GDP_{it}$is GDP (Constant 2010 US$), $TO_{it}$is trade openness (Export+ Import/GDP), $Pop_{it}$is population (Total) and $\varepsilon_i$iserror term.

By adding that, the recent data of carbon emissions (kg of US$ of GDP) were difficult to find; as a result, paper focuses over the period 1980-2014 which is 34 observations are available. The inconsistence of data or the size of the underground economy can be a problematic to find the short run and long run relationship.

5. Results and Discussions

Before begin with the panel co-integration test to analyzed the long run relationship between these variable, Lavin, Lin & Chu, Breitung, Im, Pesaran & Shin, ADF Fisher Chi-Square and PP-Fisher Chi-Square has been performed in order to check whether all the series are co-integrated in the same order or not. The result of panel unit root in Table-2 shows that all variables are non-stationary which means we cannot reject the null hypothesis in the level form. Therefore, we had to test the first difference.

Table 2: Results of Panel Unit Root Test

Level Form						
Variables	**Lavin, Lin & Chu (Prob)**	**Breitung (Prob)**	**Im, Pesaran& Shin (prob)**	**ADF-Fisher Chi-Square**	**PP- Fisher Chi-Square**	**Decision on Stationary**
$LNCO_2$	1.09832 (0.8640)	1.30683 (0.9044)	2.18753 (0.9856)	3.49114 (0.8999)	3.36891 (0.9091)	Non-stationary
LNTO	-0.03776 (0.4849)	0.35102 (0.6372)	041692 (0.6616)	5.66745 (0.6844)	12.7306 (0.1215)	Non-stationary
LNGDP	-0.23415 (0.4074)	2.37083 (0.9911)	1.73135 (0.9583)	2.63417 (0.9552)	2.35420 (0.9682)	Non-stationary
LNPOP	-1.36073 (0.0868)	4.15670 (1.0000)	0.97724 (0.8358)	9.18882 (0.3266)	2.76880 (0.9480)	Non-stationary
First Difference						
Variables	**Lavin, Lin & Chu (Prob)**	**Breitung (Prob)**	**Im, Pesaran& Shin (prob)**	**ADF-Fisher Chi-Square**	**PP- Fisher Chi-Square**	**Decision on Stationary**
$LNCO_2$	-5.12793 (0.0000)	-3.51039 (0.0002)	-5.41651 (0.0000)	41.4795 (0.0000)	243.850 (0.0000)	Stationary
LNTO	-1.36912 (0.0855)	-2.92970 (0.0017)	-4.73506 (0.0000)	35.9547 (0.0000)	67.3730 (0.0000)	Stationary
LNGDP	-2.45037 (0.0071)	-3.79275 (0.0001)	-3.94630 (0.0000)	29.6234 (0.0002)	290.962 (0.0000)	Stationary
LNPOP	-5.33516 (0.0000)	0.67632 (0.7506)	-5.16827 (0.0000)	55.1039 (0.0000)	4.34189 (0.8250)	Stationary

The result of Lavin, Lin & Chu, Im, Pesaran & Shin and ADF Fisher Chi-Square test found all the variables are stationary or we can reject the null hypothesis at the first difference and they are integrated of order one (I(1)). Only the population variable in Breitung and PP-Fisher Chi-Square at the first difference is not stationary. But, the overall results of panel unit root suggests that all series are integrated of order one (I(1)) which implies the possibility of existence of the co-integration in the long run among the variables.

Table-3 shows the results of Johansen-Fisher Co integration test where both trace statistics and max-eigen value reject the null hypothesis at most 1, 2 and 3. The probability of trace statistics and max eigen value is lower than the 5% critical value which means the probabilities are significant. Therefore, the results indicate that there is long-run relationship among the CO_2 emissions, trade openness, GDP and population in South Asian countries. Also, the variables are co-integrated and they will move together in the long run

Table 3: Results of Johansen-Fisher Co Integration Test

Hypothesized No. of CE(s)	Fisher Statistic (Trace Test)	Probability	Fisher Statistic (Max-Eigen Test)	Probability
None	131.80	0.0000	100.80	0.0000
At most 1	54.50	0.0000	34.53	0.0000
At most 2	31.88	0.0001	23.45	0.0028
At most 3	21.50	0.0059	21.50	0.0059

In the third stage, long run causality test examined through Panel D.H. Granger Non-Causality test estimates results shows in the Table-4, and it indicates that trade openness has no causality in the long run based on the insignificant coefficient. On the other side, the unidirectional causality exists running from GDP and population to carbon emissions which means population creates CO_2 in terms of energy consumption and we can reject the null hypothesis for population but not for carbon emissions. In other words, the previous value of GDP can help to predict the path of carbon emissions by aside the previous value of carbon emission. The large amount of population can help to determine whether carbon emission would increase or decrease. On the other side, carbon emission could stimulus population to use renewable energy resources or technology which can help to decrease carbon emissions.

Table 4: Results of Panel D.H. Granger Non-Causality Test

Variables	Null Hypothesis	W-Statistic	P-Value	Conclusion
LNTO $LNCO_2$	LNTO does not homogenously cause LN CO_2 $LNCO_2$ does not homogenously cause LNTO	4.55 4.60	0.3827 0.3643	No Causality
LNPOP $LNCO_2$	LNPOP does not homogenously cause LN CO_2 $LNCO_2$ does not homogenously cause LNPOP	14.7 4.83	0.0000 0.2892	Unidirectional causality POP to CO_2
LNGDP $LNCO_2$	LNGDP does not homogenously cause LN CO_2 $LNCO_2$ does not homogenously cause LNGDP	10.5 2.57	0.0000 0.6436	Unidirectional causality GDP to CO_2
LNPOP LNTO	LNPOP does not homogenously cause LNTO LNTO does not homogenously cause LNPOP	16.1 23.7	0.0000 0.0000	Bidirectional causality between POP and TO
LNGDP LNTO	LNGDP does not homogenously cause LNTO LNTO does not homogenously cause LNGDP	7.04 5.17	0.0107 0.1955	Unidirectional causality GDP to TO
LNGDP LNPOP	LNGDP does not homogenously cause LNPOP LNPOP does not homogenously cause LNGDP	30.8 6.12	0.0000 0.0532	Unidirectional causality GDP to POP

GDP has unidirectional causality which running from GDP to trade openness and population. If GDP increases it can cause trade openness through the strictness of trade policy, tax and tariff. Increasing amount of GDP does cause population through the increasing demand of goods and services with lower amount of supply, whereas,

the higher price of goods can cause GDP to decrease. At the same time, the increasing trend of population and trade can have effect on GDP. When trade increases it create a scope for people to earn for their living, as a result, the income will increase leads to establish to working more with advanced technology, increasing the export which can raise the growth of GDP. On the contrary, population and trade openness has bidirectional causality which means population does harm trade openness and vice versa.

After the panel granger non-causality test, Table-5 presents VECM test which also known as short run causality test. The result of vector error correction term of population and trade openness has positive and insignificant reveals that there is no causality moving from carbon emissions to population and trade openness. On the other hand, the error correction term of GDP is positive and significant exhibit that we can reject the null hypothesis and there is short run causality exists in the South Asian countries. Therefore, institutively we can interpret the result that, when GDP growth increases which leads to create more way for industrialization, urbanization and the use of advanced technology and it will raise the carbon emissions in the short run. After that, in order to improve the statistical specification of the model, the paper applied DOLS estimator to estimate the regression coefficients.

Table 5: Results of VECM test

Variables	Null Hypothesis	Chi-Square statistic	P-Value	Conclusion
LNGDP	GDP does not cause CO_2	7.3805	0.0250	Short Run Causality from GDP to CO_2
LNPOP	POP does not cause CO_2	1.0547	0.4712	No causality
LNTO	TO does not cause CO_2	0.6877	0.7090	No causality

Majority of the co integration test shows the presence of co integration among the variables. Therefore, the study analyzes the long run coefficient with Dynamic Ordinary Least Squares (DOLS) estimator (Stock, 1987; Saikkonen, 1991). This study prefer to use panel DOLS test for the estimation of long run coefficient which has more appropriate properties and less bias. Variables are expressed in logarithmic forms where it presents the elasticity of CO_2 emissions with respect to GDP, trade openness and population.

From the estimated result in Table-6, DOLS result indicates that GDP has negative and significant impact on carbon emissions in the long run, which means we can reject the null hypothesis and if GDP increases then carbon emissions will decrease in the long run. If GDP increase by 1 percent then carbon emissions will decrease by 20 percent. Therefore, in future, the income will grow without growing carbon emissions by putting taxes on carbon dioxide, emissions-trading schemes, and carbon capture and storage in South Asian countries. On the other side, population has positive and significant impact on carbon emissions. The rise in population leads to an increase in carbon

emissions. Higher amount of population use the scarce arable land to cut down the trees for energy, as a result, carbon emissions increases and food production decreases. Trade openness has negative and insignificant impact on carbon emissions which indicates we cannot reject the null hypothesis and also trade openness is not responsible for carbon emissions in the long run and this result also found by Runge (1994), and Helpman (1998).

Table 6: Results of DOLS Estimation

Variables	Coefficient
LNGDP	-0.202815(0.0017)
LNPOP	0.410721(0.0000)
LNTO	-0.071791(0.1677)

Probability in ( )

The overall results do not show the presence of Environmental Kuznets Curve (EKC) and in case of South Asian region. (Choi et. al, 2010) has found the same results in case of China, Korea and Japan where China and Japan had N shaped Kuznets curve because the relationship between income and carbon emissions shows a negative coefficient signs. Therefore, it shows an increasing trend. For Japan, there was no U-shaped EKC. Aye and Edoja (2017) results did not support for the Environmental Kuznets Curve (EKC). In our result, it shows the trade openness has negative impact on carbon emissions. It says, if trade increase by 1 percent then carbon emission will decrease by 7 percent. It means pollution is likely to decrease when the countries become more open. Since there is insignificant coefficient, therefore, trade openness has no effect on carbon emissions. There are some limitations which can create problem to find the actual results, such as: inconsistence of data, the size of underground economy, therefore, estimated model could not find the actual result.

6. Conclusion, Implication and Limitation

International trade is an essential ingredient of normal economic life in South Asian countries and export sector plays a fundamental role in determining the rate and structural blueprint of the development. With rapid industrialization, large amount of population, significant changes in lifestyle among the people which leads to an increase in energy consumption has steadily, as a result, carbon emissions has been doubled over the past few decades in South Asian countries. As the suggestion given by the Environmental Kuznets Curve (EKC) hypothesis, the level of carbon emission is anticipated to rise with the pace of development for many economics in the area and it will further increase the global warming. Carbon dioxide (CO_2) is the main threat of climate change and global warming and these are responsible at least 60% for global warming. Since 1990, global warming is increasing due to rapid population and economic growth.

Carbon emissions in South Asia are acquired from four sectors such as: industrial, open biomass burning, residential and transportation. Brick kiln is one of the most significant contributors for carbon emissions and India is one of them. Brick kiln has also been increased by 59% for the last five years in Bangladesh. In 2013 the amount of brick kiln was 4959 but it increased to 7902 in 2018. The total emissions in the industrial sector, waste generations sectors and agriculture sectors in Bangladesh, Nepal, Bhutan, India, Sri Lanka and Pakistan have been estimated which is nearly double in 2030 from the 2005 level 69.82 million tons of carbon dioxide (CO_2). In terms of GDP and trade, India is the leading economy among the four countries. The total emissions in the industrial sector, waste generations sectors and agriculture sectors in Bangladesh, Nepal, Bhutan, India, Sri Lanka and Pakistan have been estimated which is nearly double in 2030 from the 2005 level 69.82 million tons of carbon dioxide (CO_2). On the other side, though the economic situation of Pakistan is slowly visible. South Asian countries overall trade growth has been increased. According to Trade and Development report, 2019 “the deceleration would have been greater in the region as a whole if India had not registered acceleration in growth between 2017 and 2018, from 6.9 per cent to 7.4 per cent.”

The current situation of GDP and trade growth has been increased and so the carbon emissions. Therefore, the aim of this study is to determine the relationship between GDP, trade openness population and carbon emissions in case of South Asian countries such as: Bangladesh, India, Pakistan and Sri Lanka. The data of these variables cover the time period from 1980 to 2014 at an annual frequency and data are collected from World Bank Indicators. The study has used panel data framework: Panel unit root test, panel co integration, DOLS estimator, VECM test and panel granger causality test to analyze the relationship among these variables.

The results of Panel unit root test shows that all the variables are non-stationary in the level form, but they are stationary at the first difference and they are co integrated of order one (I(1)). The findings of Johansen-Fisher co integration test indicated that carbon emissions, GDP growth, trade openness and population of South Asian countries have long run relationship and they will move all together in the long run. DOLS estimator results showing the negative sign of GDP growth and trade openness on carbon emissions which means these two variables are increases, then carbon emissions will decreases in the long run but since trade openness has insignificant value, therefore, trade is not responsible for CO_2 and it has no effect, whereas, population is positive and significant impact on carbon emissions which means it can be a strong obstacles for carbon dioxide.

Moreover, the study has also estimates the VECM and Panel Granger causality Wald test to check the association ship among these variables. Trade openness has no causality effect on carbon emissions both in the short and long run. In Panel Granger Causality Wald test shows the unidirectional causality exists running from GDP and population to carbon emissions. Therefore, if GDP and population increase then carbon emission will cause. If economic development rises, the income of people will increase and the consumption of energy, develop of urbanization will occur, as a result, carbon emission will cause and it will effect. In other words, the past value of GDP can also

help to predict the path of CO_2 emission. In VECM test, population is positive and insignificant; therefore, population has no causality moving from carbon emissions to population. On the other side, GDP has positive and significant coefficient which indicates there is short run causality exists. The whole results of our study do not support the Environmental Kuznets Curve (EKC), so, Environmental Kuznets Curve (EKC) has no presence in South Asian region which is Bangladesh, India, Pakistan and Sri Lanka. Because trade openness is not responsible for carbon emissions which means trade has no causal link with carbon emissions.

Though our study do not support the Environmental Kuznets Curve (EKC) but for further precaution government need to take some necessary steps to decrease carbon emissions. Because in our study, the results show that if population increases then carbon emissions also increases. South Asian countries are population oriented countries where large of the population depends on agriculture, they earn their living from agriculture sector which is directly related to environment. Poor population is mostly responsible for climate change which is visible in some extent and rapid environmental degradation can hamper the South Asian economics as a whole. In order to pursue sustainable development for South Asian countries, the policy maker should adopt balanced strategy to encourage GDP growth and international trade without sacrificing the environmental quality.

There are some necessary steps which the government of these countries need to take and these are given below:

- South Asian countries need to use their renewable energy resources; therefore, government should accelerate renewable energy resources and reduce the energy subsidy in the price level which can help to diminishing the carbon emissions.
- For pollution intensive industries, it needs to focus more on the clean energy or green investment by adding the implementation of environmental regulations.
- To decrease carbon emission, government can put taxes on carbon dioxide.
- The pollution intensive industries should adopt environment friendly technology to increase the production of products and it helps to reduce the carbon emissions
- To improve the trade situation of the South Asian region, strong and developed financial system can attract investors to invest and boost the stock market which leads to improve the efficiency level of economic activities.
- Carbon pollution pricing system should impose in these countries.
- Clean technology transfer from other developed countries and international collaboration would help these countries to follow a path of low carbon growth.

These are the policies that countries like Bangladesh, India, Pakistan and Sri Lanka should implement to reduce their carbon dioxide. Carbon emission is not a local pollutant but it is a global issue. International cooperation would help to overcome this problem. Perhaps creating a union between these South Asian countries and unified environmental acts can fight against this environmental issue and soon Bangladesh, India, Pakistan and Sri Lanka will be polluted free environment.

In this paper, the overall results do not find the existence of Environmental Kuznets Curve (EKC) for South Asian countries such as: Bangladesh, India, Pakistan and Sri Lanka. The reason behind the results could be inconsistence of data sets or the size of the underground economy, as a result, the estimated model could not able to find the actual result. It is difficult to find the actual data sets for developing countries. So, we will work more on results and use other economic methods in future. This paper has used few variables such as GDP growth, trade openness, carbon emission and population. In future, we will use more variables and panel study of other Asian or low developing countries to investigate whether the relationship between carbon emissions and other macroeconomic variables are similar or not.

End Notes

[3] IPCC 2018a, p-153
[4] World Economic Situation and Prospects: Monthly Briefing (2019)
[5] Climate Analytics (2019)
[6] Officially, China has announced that it will reduce its emission intensity by 40-45% between 2005 and 2020, and India by 20-25% (see the references for these announcements given in Stern and Jotzo (2010)). We assume a lower target for China and higher target for India because the BaU Scenario has projected a lower potential for reducing emission intensity in China but a higher potential in India (see previous section).
[7] This implies *additional* reductions (over and above the reductions shown in the BaU Scenario) of -1.8%, - 2.5%, -1.8%, and -6.2% respectively for Bangladesh, Indonesia, Thailand, and Viet Nam, and for China and India, the additional reductions in emission intensities over and above the BaU scenario reductions are -16.9% and -9.3%, respectively.
[8]Trade and Development report (2015)
[9] Trade and Development report, (2019)

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Appendix

Table 1: Key Empirical Literature on Carbon Emissions, GDP Growth and Trade Openness

Author	Countries	Methodology used	Key findings
Hakimi and Hamdi (2019)	Developed and Developing countries	Aggregated and disaggregated analysis	Trade has no impact on the environmental quality, while FDI and population will degenerate the quality of environment.
Bernard and Mandal (2016)	60 emerging and developing countries	GMM estimation and fixed effect model	Trade openness, energy consumption, income and population were found to have deleterious effect on environment.
Ameer and Munir (2016)	Asian developing countries	Panel unit root, panel cointegration, DOLS estimator and causality tests.	Found the existence of inverted U-shaped EKC between economic growth and SO_2 pollution, while free trade and CO_2 has long run causality.
Maji (2015)	Nigeria	ARDL approach	Results explained that trade openness and economic growth improves environmental quality, while, population will increase the deforestation.
Apergis and Oztruk (2014)	14 Asian countries	GMM methodology	Presence of an EKC for the sample of 14 Asian countries and unidirectional causality running from income to emissions,
Rahman (2013)	Bangladesh	VAR framework followed by Granger causality	Inconclusive causal relation between trade and emissions but VAR model found the significant impact of trade openness on carbon emissions.
Yang et al. (2013)	China	Fixed and random effects model	Trade has no direct effect on EKC, but it significantly contributes to economic growth. In addition, FDI has some negative influence on environment.
Kanjilal and Ghosh (2013)	India	ARDL and Threshold co-integration approach and parameters with two endogenous breaks	ARDL found no co-integration between CO_2 and trade openness, energy use and economic activity but threshold test found the existence of long run relationship.
Nasir and Rehman (2011)	Pakistan	Johansen maximum likelihood approach, VECM and diagnostic test	Confirmed the presence of EKC for Pakistan. Both energy consumption and trade has positive effects on carbon emissions, but short run results did not support the presence of EKC.
Naranpanawa (2011)	Sri Lanka	ARDL and Johansen-Juselius maximum likelihood approach	Found long run equilibrium but there is no long run causality between trade openness and CO_2 and short run causality running from trade openness to CO_2.
Choi et al. (2010)	China, Japan and Korea	Panel Unit root test, Johansen test, VAR, VECM and OLS estimation	Findings confirmed the existence of N-shaped curve for China and inverted U-shaped curve for Korea and Japan.