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The Relationship between Trade Liberalization and Carbon Dioxide Emissions

Fahima Kabir [1]
[1](*Lecturer, Department of Economics, Southeast University, Bangladesh)*

Abstract:
This paper examines the relationship between international trade and carbon dioxide emissions in the context of Bangladesh. The results are based on the empirical findings of co-integration and granger causality tests. For these tests, trade and carbon dioxide data have been used for the period 1976-2012. The existence of long-term relationship between carbon dioxide emissions and international trade is supported by the co-integration test. Carbon dioxide and net trade have a one-way relationship where carbon dioxide emissions Granger causes net trade. The study is further extended to discover how these two are related and, in the process, export and import are also incorporated in the models. The results explain that carbon dioxide emissions cause growth of imports and exports in the context of Bangladesh.

Key Word*: Trade Liberalization; Carbon Dioxide; Bangladesh; International Trade; Environment.*

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I. INTRODUCTION

Theories of international trade use natural resources and climate as variables that affect labor productivity, as suggested by the Ricardian model. Consensus is that issues pertaining to the environment influence production costs, industry location, gains from and patterns of trade and even international relations. Therefore, an elaborate and multidimensional condition is raised regarding the environment and international trade.

International trade is considered as a helpful tool for economic growth, mainly for developing countries. Countries that have sustained growth, the share of trade in gross domestic product (GDP) has increased because of their increased participation in international trade through trade liberalization. Trade liberalization means opening up of a countries trading options with other countries through the relaxation of government policies on trade. These can include policies such as, lowering or removal of import and export duties or tariffs, quotas, ban. As a result, trade becomes easier between countries, and the citizens benefit from a wider range of better-quality products.

The relation between international trade and environment pollution is debatable. International trade may yield positive environmental impacts or it may also lead to environmental downfall. This outcome depends on a number of factors such as development level of the country, their comparative advantage, their resource intensity of the traded product, current level of environmental awareness and the existence of environmental policies. Overall, economists and environmentalists suggest that increase in international trade or liberalization of trade will lead to more pollution and hence, to degradation of the environment in developing countries. This can happen through the transfer of polluting industries from countries with strict environmental policy, or owing to increased production in dirty industries.

Carbon dioxide is the most harmful greenhouse gas and Bangladesh is contributing 0.14% to the world's emission of carbon dioxide. Though this is low in terms of percentage, it is expected to increase. The data on carbon dioxide emission of Bangladesh has an upward trend. The main source of carbon dioxide in Bangladesh is the combustion of fossil fuels (Gunter and Rahman, 2012); for instance, coal, gas, and petroleum products; and combustion via electricity generation, transportation, industry, and domestic use. This gas is naturally emitted by living animals, wetlands, volcanoes and other sources. This harmful gas is emitted not only through production activities but also through consumption. Greenhouse gases are harmful for the environment as this leads to global warming, melting of polar ice sheets and caps, a rise in sea levels and subsequent coastal inundations, and damage to agriculture and natural ecosystems. All these will lead to serious environmental degradations.

Since the developing countries do not have abundant resources to fight the environmental problems, they should try to avoid the pollution caused through international trade and undertake appropriate environmental policies accordingly. They should go for trade liberalization keeping in mind that the benefits from this do not exceed the costs of environmental degradation caused by the liberalization.

Hence, the aim of the paper is to explore the current scenario regarding the relationship between international trade and environmental pollution, basically the CO2 emissions.

Trade can affect the environment in a number of ways. Firstly, trade liberalization will expand the level of economic activities. Then the country will produce higher amount of goods and services using the resources from the ecosystems. Secondly, developing countries do not have sufficient environmentally friendly technologies; through trade liberalization these countries may need to import the technologies for production purposes. Hence, they are benefitted as they receive such technologies in the process of trade liberalization. Lastly, trade liberalization is also expected to change the composition of goods and services produced by the country; in the process the share of pollution intensive commodities in total output may increase or decrease. The products traded can be environmentally friendly or harmful; for instance, some organic products may be hazardous for the environment. On the other hand, environmental policies of higher-standard countries may be passed on to lower-standard ones either voluntarily with the increases in interactions among countries, or as a result of new regulations on the synchronization of the standards among trading countries (Alpay, 2001). According to him, the threat to impose trade sanctions may also induce better environmental performance. When the income levels of the country increases, there will be higher demand for environmental quality and hence, the condition of the environment will improve.

1.1 OBJECTIVE OF THE STUDY

The main objective of the study is to discover the relationship between international trade and carbon dioxide emissions in the context of Bangladesh and also to explore how export and import can be used to explain the level of pollution that is created through the process of trade liberalization. Since Bangladesh is a developing country, trade liberalization is crucial for its growth. But the problems associated with trade liberalization may lead to increased difficulties, which may hinder the growth process. Therefore, this study is important.

1.2 OVERVIEW OF BANGLADESH'S INTERNATIONAL TRADE

Bangladesh has implemented series of policies to increase trade liberalization through changes and reduction in tariff and quotas and improvement in customs and excise procedures. In the 1970s, Bangladesh followed import-substituting industrialization strategy. High import tariffs, quantitative restrictions, foreign exchange rationing and overvalued exchange rate were the main policies. As these failed to provide the desired outcomes, in the early 1980s, trade policies were reformed. Since 1985, trade policy reforms were implemented.

The major export items of Bangladesh include readymade garments, frozen foods (shrimps), leather, leather products, jute, jute products, tea, ceramic, textile fabrics, home textile, chemical product, light engineering products including bi-cycle (EPB, 2012). The production of these export items involves power and energy and also consumes carbon dioxide emissions (Islam, Cheng and Rajib, 2012). The main import items are oil, edible oil, petroleum product, wheat, seeds, fertilizer, yarn, capital goods, machinery, power generating machinery, scientific and medical equipment, iron and steel, motor vehicles, raw cotton, chemicals.

The important trading partners for the country are USA, EU countries, China, India, Pakistan, Japan, South Korea, Canada, Australia, Malaysia, Hong Kong, Taiwan, Thailand, Indonesia, Saudi Arabia and UAE (EPB, 2012).

Imports have been liberalized over the years so that they are consistent with the changes in the world market. According to the Bangladesh Economic Review (2009), the import policies aim at ensuring the supply of essential commodities and supplying qualitative and hygienic commodities to the consumers.

1.3 THE STATE OF ENVIRONMENTAL POLICIES IN BANGLADESH

Bangladesh has environmental protection policies and environmental laws but these are not sufficient for protecting the environment. In 1965, according to the MoEF, the Factory Act was the first regulation related to environment. Then in 1970, Water Pollution Control Ordinance came into existence. But, neither of these two is related to air pollution. Later, in order to control, prevent, and abate pollution of the environment, Environmental Pollution Control Ordinance (EPC) was propagated in 1977.

In 1989, the Ministry of Environment and Forest, and the Department of Environment were created. Here measurements of suspended particulate matter, Sulphur dioxide and nitrogen oxide are recorded. DoE also conducts vehicular emission measurements in Dhaka (MoEF, 2012).

The Environmental Policy of 1992 formally recognized the idea of environmental protection through national efforts. The NEP is mainly in charge of maintaining the ecological balance, ensuring proper Environment Impact Assessment prior to undertaking of industrial and other development projects and ensuring sustainable use of all natural resources.

Later the government adopted a number of supplementary policies over the years. The sectoral policies were Forest Policy (1994), the Fisheries Policy (1998), the Water Policy (1998), the New Agriculture Extension Policy (1995), The Energy Policy (1995). Besides, policies like the National Conservation Strategy (NCS) and particularly the National Environment Management Action Plan, 1995 (NEMAP) were developed to deal with environmental issues and ensure sustainable development. But these policies do not specifically address the issue of carbon dioxide pollution.

Bangladesh is a part of a number of International Conventions, Treaties and Protocols (ICTP's) such as the Climate Change Convention, the Biodiversity Convention, Montreal Protocol on the Control of Substances that deplete the Ozone Layer, United Nations Convention to Combat Desertification (UNCCD), BASEL Convention, The Convention on Wetlands of International Importance (RAMSAR), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), Stockholm Convention on the Control of Persistent Organic Pollutants (POPs). The MoEF is responsible to undertake actions under the conventions and protocols and also participate in international meetings and negotiations.

II. LITERATURE REVIEW

Extensive studies have been conducted over the years to test the relationship that exists between trade and the environment, often with mixed empirical evidences. For example, the study by Antweiler et al. (2001) illustrates the benefits of reduced pollution through trade liberalization whereas the discoveries by Dasgupta et al. (2002) shed skepticism on the benefits of trade liberalization on the environment.

Furthermore, a number of studies find evidence in support of the PHH (Suri and Chapman, 1998; Mani and Wheeler, 1998), whereas others (Grossman and Krueger, 1991; Gale and Mendez, 1998) can empirically back the factor endowment hypothesis (FEH) and against substantial effect of environmental regulation on trade patterns.

Wyckoff and Roop (1994) estimated the amount of carbon embodied in the imports of manufactured goods to six of the largest OECD countries - Canada, France, Germany, Japan, the UK and the USA. The study was aimed at determining if importing of products containing high amount of carbon was a problem that needed immediate attention. The authors, from their empirical findings stated that a significant amount, of about 13% of total carbon emissions were embodied in manufactured imports. The percentage of carbon embodied in each country's imports varies from 8% (Japan) to 40% (France), with an average of 13%.

International trade has impacts on the environmental quality and this was supported in a study conducted by Perroni and Wigle (1994). They applied the general equilibrium analysis and they also discovered that the extent to which trade benefits the economy is influenced by changes in environmental policies.

The interaction between trade and industrial pollutants for Japan and Indonesia was assessed by Lee and Lee and Roland-Holst (1997) for the period 1965–1990. They found that the economy is harmed by export-oriented growth because of higher production in the 'dirty-industries'.

Yang examined the environmental effects associated with Taiwan's application for membership at the World Trade Organization in 2001. Trade liberalization led to changes in the production activity in Taiwan and this affected carbon dioxide emissions. He estimated that total carbon dioxide emissions increase due to liberalization of trade through the shift in the structure of production towards the most carbon intensive sectors. Whether trade in goods have impact in the carbon dioxide emissions or not were explored in a study by Ahmed and Wyckoff (2003). They derived an indicator to measure the emissions from import and export of goods. They carried out the study on 24 countries for the year 1995 through the input output strategy. Their estimates suggest that emission from domestic consumption of products is more than the domestic production of emissions for the OECD as whole. According to Ahmed and Wyckoff (2003) estimates of CO2 emissions produced to satisfy domestic demand in the OECD in 1995 were 5% higher than emissions related to production. Carbon dioxide emission embodied in both imports and exports are important in absolute and relative terms.

Using data for 63 countries for the period of 1960 to 1999, Managi (2004) found that total amount of pollution must increases as economic activity expands, the total amount of pollution decreases after country's wealth increase due to the demand for better environmental quality, 1% increase in trade openness increases carbon dioxide at 0.579 percent. Therefore, trade is harmful for the environment according to this study.

To understand the association between international trade and greenhouse gas emissions, Maenpaa and Siikavirta (2007, January) performed a study for Finland. The results of the study were that Finland was a net exporter of CO2 from fossil fuel combustion and the GHG emissions embodied in the exports far exceeded the GHG emissions embodied in the imports from early 1990s. They also identified the reason for this, which is the change in magnitude of trade.

Hyun-Sik and Hae-Chun (2007, February) estimated the total CO2 emissions of Japan and South Korea using the input-output model for 1990. The outcomes of their study proved that Korean exports to Japan are more emission intensive.

Peters and Hertwich (2008, January) calculated the amount of carbon dioxide emissions embodied in international trade among 87 countries for the year 2001. They found that Annex B countries are net importers of CO2 emissions, carbon leakage from non-Annex B to Annex B countries was heavily dependent on geographic location and a total of over 5.3 Gt of CO2 emissions embodied in international trade flows.

In another research on the bilateral trade between the UK and China, Li and Hewitt (2008, March) found that the environmental impacts of international trade can be shifted from one country to another and emissions of greenhouse gases also increases. The outcome of the study indicates that through trade UK's carbon dioxide emissions declined whereas, China's increased. This also led to an increase in the global emission level of carbon dioxide by 0.4%.

Carbone, Helm and Rutherford (2009) have found that equilibrium agreements can reduce emissions to half; a permit trading system helps in carbon abatements. They also discovered that incentives to use environmental policies add to the performance of these policies.

Abdulai and Ramcke (2009, March) examined economic growth, international trade and environmental degradation and the relationship that exists between these factors from a both theoretical and empirical perspective. The findings of this paper show that the relation varies across countries and also for different pollutants. There is a negative coefficient for high-income countries which indicates that trade helps to lessen the per capita energy use in these countries, whereas the positive coefficient for low-income countries means that trade increases energy uses in this group of countries. This lends support to the Pollution Haven Hypothesis.

China is the predominant emitter of CO_2 compared to any other country. Employing the input-output method, Lin and Sun (2010, January) explored the carbon dioxide emissions from China's exports and imports. Their findings prove that the production-based emissions of China are more than the consumption-based emissions, which is evidence that carbon leakage occurs under the current climate policies and international trade rules. China's exports account for 3357 million tons CO2 emissions whereas; its imports are responsible for 2333 million tons in 2005.

A study on the environmental impacts of trade liberalization in Indonesia was conducted by Gumilang, Mukhopadhyay and Thomassin in 2010. It was found that the rate of growth in air pollution greatly exceeded the rate of output growth. By 2022, the emission of CO2 and NO2 has increased by 731% and 664% respectively, which is more than double the rates of output growth (263%) while CH4 emission grew by 497%. Emission of CO2 grew the fastest as it increased by 731% to 1.84 million Gg with the transportation sector contributing to the bulk of it.

In between the time periods of 1990 to 2008, even though CO2 emissions in developing countries have grown twofold, it has remained relatively stable in developed countries. Some studies suggest that the stabilization of emissions in developed countries was partially because of growing imports from developing countries (Peters, Minx, Weber and Edenhofer, 2011). The consequence was that the consumption-based emissions for developed countries amplified faster than their territorial emissions. Net emissions passed on to developed countries from developing countries through cross-border trade increased from 0.4 Gt CO2 in 1990 to 1.6 Gt CO2 in 2008. Therefore, they concluded that international trade can explain changes in emissions through production and consumption in many countries.

Islam, Cheng and Rajib (2012) investigated the relationship between trade liberalization and environmental degradation regarding CO2 emissions in Bangladesh. 'There is a strong positive relationship between international trade and carbon (CO2) emissions from the gas fuels (Islam, Cheng and Rajib, 2012). Carbon emissions from gas fuels are through various manufacturing sectors like fertilizer, ceramic, textile & garments, metal, and pharmaceutical industries along with the power generating sector of Bangladesh that are primarily involved with the international trade. Liquid fuel is generally used in transportation and in some small power areas. Solid fuel is mostly used for domestic purpose. Hence, according to Islam, Cheng and Rajib (2012) international trade plays a vital role in influencing the generation of carbon (CO2) emissions in Bangladesh.

III. DATA, METHODOLOGY AND MODEL

This section provides the data, methodology and models that have been employed in the study.

3.1 DATA

The study primarily depends on the results of the models developed to find the relationship between trade liberalization and carbon dioxide emissions. CO2 is considered as the most important greenhouse gas because of its large share and longevity. Data on CO2 have been collected from the World Bank databank website. To represent the level of international trade net trade on goods (NT) has been used. The data on net trade on goods is collected from the World Bank databank website as well. In order to explore the relation between international trade and carbon dioxide emissions in depth, export (X) and import (M) were also used in modeling. The export and import data were also found from the World Bank website for the same time period. Net trade, export and import values are in million US$.

3.2 METHODOLOGY

The statistical works have been done using the statistical software EViews. The process used to determine the existence of any relationship between international trade and carbon dioxide emissions is the Johansen's Co-integration test. Before testing for co-integration, stationarity of the data is tested. Later, the types of relationships that exist between the variables have been identified using the Granger Causality test.

In order to avoid the problems of spurious results from regression models Granger Causality test have been performed to determine whether there is any cause effect relation among these time series. The null hypothesis for this test is that there is no Granger Causality between two data series. To reject the null hypothesis, the probability has to be less than 0.05. When the null hypothesis is rejected, it means that the lagged values of one series can explain the other series; in other words, the historical values of one series are responsible for the other series.

3.3 MODEL

CARBON DIOXIDE AND NET TRADE

CO2 and NT are co-integrated using the Johansen Co-integration test, to see if the linear combination of these two variables is stationary. The co-integrating equations are:

$$Z_1 = \alpha_1 CO_2 + \alpha_2 NT \quad (1)$$

This equation shows the linear relationship between carbon dioxide and net trade. The type of impact net trade has on carbon dioxide emission is tested using regression.

$$CO_2 = c_1 + b_1 NT \quad (2)$$

The following sets of equation represent the test of Granger Causality between carbon dioxide and net trade.

$$CO_{2t} = \beta_0 + \beta_1 CO_{2t-1} + \lambda_1 NT_{t-1} + \epsilon_t$$
$$NT_t = \beta_0 + \beta_1 NT_{t-1} + \lambda_1 CO_{2t-1} + \epsilon_t \quad (3)$$

CARBON DIOXIDE AND GROWTH OF EXPORTS

CO2 and DX, are tested for co-integration. The co-integrating equation, which illustrates the long term relationship between carbon dioxide and export, is:

$$Z_2 = \beta_1 CO_2 + \beta_2 DX \quad (4)$$

Then carbon dioxide is regressed on export as shown by this equation:

$$CO_2 = c_2 + b_2 DX \quad (5)$$

The following equations are estimated for Granger Causality test between carbon dioxide and export:

$$CO_{2t} = \Theta_0 + \Theta_1 CO_{2t-1} + \Theta_2 CO_{2t-2} + \psi_1 DX_{t-1} + \psi_2 DX_{t-2} + \epsilon_t$$
$$DX_t = \Theta_0 + \Theta_1 DX_{t-1} + \Theta_2 DX_{t-2} + \psi_1 CO_{2t-1} + \psi_2 CO_{2t-2} + \epsilon_t \quad (6)$$

CARBON DIOXIDE AND GROWTH OF IMPORTS

To check the relationship between carbon dioxide emissions and import, CO2 and differenced import are tested.

$$Z_3 = \mu_1 CO_2 + \mu_2 DM \quad (7)$$

This equation deals with the growth of imports instead of import because import series of Bangladesh is I (2). Then regression is performed between carbon dioxide and growth of import.

$$CO_2 = c_3 + b_3 DM \quad (8)$$

The Granger Causality test equations are:

$$CO_{2t} = \Omega_0 + \Omega_1 CO_{2t-1} + \Omega_2 CO_{2t-2} + \Phi_1 DM_{t-1} + \Phi_2 DM_{t-2} + \epsilon_t$$
$$DM_t = \Omega_0 + \Omega_1 DM_{t-1} + \Omega_2 DM_{t-2} + \Phi_1 CO_{2t-1} + \Phi_2 CO_{2t-2} + \epsilon_t \quad (9)$$

IV. RESEARCH FINDINGS

4.1 STATIONARITY TEST RESULTS

The results from the stationary tests show that all the variables, CO2, NT, X and M have unit root in their levels, that is, they are non-stationary under both the ADF and PP tests. The results from the tests in table 1 show the acceptance of the null hypothesis for each of the data series under both tests at level as the p-values are 1.0000 and the t-statistics are also greater than the critical values.

Table 1: Stationary Test Results. (10)

		ADF		PP	
		t-statistics	p values	t -statistics	p values
Carbon Dioxide	Level	2.12 1310	1.0 000	5.42 3467	1.0 000
	1st difference	-5.84 0132	0.0 002	-5.84 9925	0.0 001
Net Trade	Level	2.32 7508	1.0 000	0.01 5417	0.9 949
	1st difference	-7.04 1537	0.0 000	-7.08 4903	0.0 000
Export	Level	3.63 3700	1.0 000	1.80 3644	1.0 000
	1st difference	-0.93 5217	0.9 362	-6.02 3552	0.0 001
	2nd difference	-3.80 3219	0.0 327	-15.9 0067	0.0 000
Import	Level	3.85 4033	1.0 000	3.26 5561	1.0 000
	1st difference	-0.84 6695	0.9 504	-6.03 8566	0.0 001
	2nd difference	-10.4 2753	0.0 000	-13.4 9033	0.0 000

Table Size (8)

CO2 and NT become stationary in their first difference. Carbon dioxide is I (1). This is proved by the t-statistics and p values in the table above which are significant; p values of ADF and PP tests are 0.0002 and 0.0001 respectively, which are less than 5% significance level. Hence, the null hypothesis that CO2 is non-stationary can be rejected. Test is significant for net trade in the first difference. The p values for ADF and PP tests are 0.000 and 0.000 respectively, which are less than the 5% level of significance as well. Therefore, net trade is I (1).

However, both export and import become stationary in their second difference. The null hypothesis that D(X, 2) has unit root is rejected with a probability of .0327 for ADF test and 0.0000 for PP test (both less than 5% level of significance level). So, export is I (2). Import series becomes stationary in the second difference as well. The p value is 0.0000 for ADF test and 0.0000 for PP test, way less than the 5% level. So, for imports, test is significant in second difference and import is I (2).

4.2 THE RELATIONSHIP BETWEEN INTERNATIONAL TRADE AND CARBON DIOXIDE EMISSIONS

CARBON DIOXIDE AND NET TRADE

The relationship in equation (1) is proved through the Johansen co-integration test. Carbon dioxide and net trade are both stationary in their first differences. So, co-integration is run at level. The results from the Johansen co-integration test shows that trace statistic (21.00669) is more than the critical value (15.49471) at 5% level for r = 0; this leads to the rejection of the null hypothesis that there is no co-integration between carbon dioxide and net trade. So, there is the presence of co-integration which is supported by the trace statistic for r = 1; the trace statistic (3.240587) is less than the critical value (3.841466) as portrayed in table 2.

Table 2: Johansen Co-integration between Carbon Dioxide and Net Trade

Included observations: 35 after adjustments
Trend assumption: Linear deterministic trend
Series: CO2 NT
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.398063	21.00669	15.49471	0.0067
At most 1	0.088431	3.240587	3.841466	0.0718

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Though the presence of a long-term relation between carbon dioxide emissions and net trade is proved, the effect of one-time series on the other cannot be discovered by this. Therefore, carbon dioxide is regressed on net trade to see if changes in net trade led to more or less emission of carbon dioxide. The relationship is as shown in equation (2). The result (appendix, table- xxvii) is that the value of c1 is negative (-0.00000658), that is, decrease in net trade increases carbon dioxide emission. However, the result is not acceptable since the regression model is run on non-stationary data. But it is only taken into consideration to understand the type of impact net trade has on carbon dioxide and not for the degree of impact. Net trade decreases when import increase or export fall or both occur. So, more carbon dioxide emission should be the result of higher import or fall in export or both. In other words, carbon dioxide should positively depend on import and negatively on export.

Granger Causality test have been carried out in order to reach a more conclusive result.

Table 3: Granger Causality between Carbon Dioxide and Net Trade

Pairwise Granger Causality Tests

Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
NT does not Granger Cause CO2	36	0.20057	0.6572
CO2 does not Granger Cause NT		8.20385	0.0072

Between carbon dioxide and net trade, there is a one-way relationship which is estimated from equation (3). Carbon dioxide emissions Granger causes net trade. This is evident from the test as the probability (0.0072) is less than 0.05, as seen in the table 3, which rejects the null hypothesis that CO2 does not Granger Cause Net Trade.

Therefore, carbon dioxide emissions and net trade are negatively related and changes in carbon dioxide emissions only lead to changes in net trade. This can be true in the sense that consumption of carbon dioxide intensive locally produced goods causes higher pollution. If locally produced goods are such, then this can also lower export of the country and decrease net trade. Consumers then shift to imported products which increases imports, hence decreases net trade of Bangladesh.

To understand the relationship between international trade and carbon dioxide emissions in depth, the connection between carbon dioxide and export (X) and between carbon dioxide and import (M) are studied separately.

CARBON DIOXIDE AND EXPORT

In the case of the relationship between carbon dioxide and import, the co-integrating equation changes (equation (4)) as carbon dioxide is I (1) but export is I (2). So, differenced export is used in modeling. DX is the growth in exports. From the results in table 4, the trace statistic (30.59525) is more than the critical value (15.49471) at 5% level, which means that the null hypothesis of no co integration is rejected. For r = 1, the trace statistic (13.77015) is more than the critical value (3.841466), which means that null hypothesis of r = 1 can be rejected, that is, there are two co integrating relationships between carbon dioxide and growth of export.

Table 4: Johansen Co-integration between Carbon Dioxide and Growth of Export

Included observations: 34 after adjustments				
Trend assumption: Linear deterministic trend				
Series: CO2 DX				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.390341	30.59525	15.49471	0.0001
At most 1 *	0.333026	13.77015	3.841466	0.0002

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level	
* Denotes rejection of the hypothesis at the 0.05 level	
**MacKinnon-Haug-Michelis (1999) p-values	

Running regression between carbon dioxide and growth of export as in equation (5), it is found that there is a positive relationship between growth of export and carbon dioxide emission (appendix, table-xxviii). Higher emission of carbon dioxide is the result of increased export growth. This contradicts with the result found in the case of carbon dioxide and net trade because increase in export increases net trade which should lower carbon dioxide emission.

The result of the Granger Causality test (equation (6)) between carbon dioxide and growth of export with 2 lags shows that the probability that carbon dioxide does not Granger Because export is 0.0008 indicating the rejection of null hypothesis. Therefore, carbon dioxide emissions Granger Cause growth of exports.

Table 5: Granger Causality between Carbon Dioxide and Growth of Export

Sample: 1976 2012			
Lags: 2			
Null Hypothesis:	Obs	F-Statistic	Prob.
DX does not Granger Cause CO2	34	0.17877	0.8372
CO2 does not Granger Cause DX		9.13810	0.0008

According to the results, carbon dioxide emissions led to growth of export and their relationship is positive. That means emission of carbon dioxide through production processes will influence exports to increase. If the exported items are pollution intensive, then through international trade, the production of these goods can be shifted to developing countries. Hence, emission level in these countries increase and their export rises as well. The export basket of Bangladesh consists of agricultural products, manufactured commodities, knitwear, woven garments, raw jute, jute products, footwear, and frozen food. Textiles, clothing, and footwear account for approximately 80 percent of all exports. These items hardly emit carbon dioxide gas. The emission of particulate matter, Sulphur oxides, nitrogen oxides, carbon monoxide and ammonia are created from textile and dying, tanneries, pulp and paper, cement, metal, fertilizer and chemical factories. Historically, primary products used to be the major exported items; but even those had no function in carbon dioxide emission. So, export does not cause carbon dioxide emission as found empirically. But there are certain activities which emit carbon dioxide and this leads to increase in export to a certain extent. Under the export promotion policies of Bangladesh, exporters are provided with unrestricted and duty-free access to imported inputs, financial incentives in the form of easy access to credit and credit subsidies, and fiscal incentives such as rebates on income taxes and concessionary duties on imported capital machinery. This has definitely enabled improvement in the export condition of Bangladesh. This indicates that local machines do cause pollution which led to the import of these machines and subsequently helped increase export.

CARBON DIOXIDE AND GROWTH OF IMPORTS

Also, in case of the relationship between carbon dioxide and import, the co-integrating equation changes (equation (7)) as carbon dioxide is I (1) but import is I (2). So, differenced import is used in modeling. DM is the growth in imports. The test results (in table 6) indicate that there exists more than one co-integrating relationship between carbon dioxide and growth of import. For r = 0, the trace statistics is greater than the critical value and the trace test value (16.31522) is also greater than the critical value for r = 1, which rejects the null hypothesis of one co integrating relationship. Therefore, there are two co-integrating relationships between carbon dioxide and growth of import.

Table 6: Johansen Co-integration between Carbon Dioxide and Growth of Import

Included observations: 34 after adjustments
Trend assumption: Linear deterministic trend
Series: CO2 DM
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized	Trace	0.05

No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.452630	36.80465	15.49471	0.0000
At most 1 *	0.381130	16.31522	3.841466	0.0001

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

When carbon dioxide is regressed on growth of import, a positive relationship is observed between these two variables, relationship being established in equation (8). The value of b3 is 0.00000567 (appendix, table-xxix). So, growth of imports and carbon dioxide emission are positively related; that is, increase in carbon dioxide emissions leads to increase in growth of imports.

Table 7: Granger Causality between Carbon Dioxide and Growth of Import

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
DM does not Granger Cause CO2	34	0.36148	0.6997
CO2 does not Granger Cause DM		10.7272	0.0003

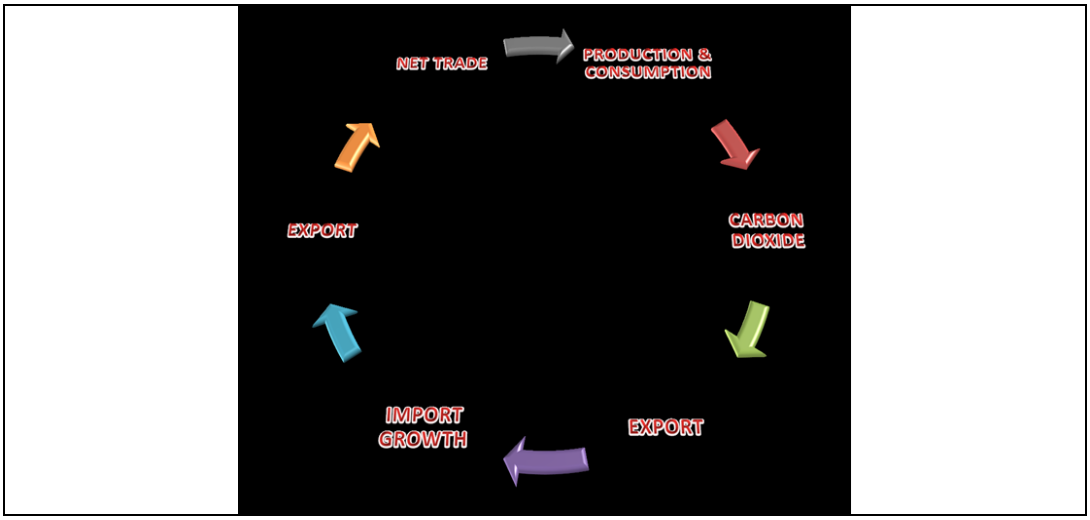
The Granger Causality test between carbon dioxide and growth of import, which is illustrated by equation (9), is carried out with lag interval of 2. Table 7 above shows that 0.6997 is the probability that growth of import does not Ganger Cause carbon dioxide emissions; and hence, it cannot be rejected. But the probability for the null hypothesis that carbon dioxide does not Granger Cause growth of import is less than 0.05 and hence it is rejected. So, through the emission of carbon dioxide, growth of import takes place.

Hence, they have a positive relationship and carbon dioxide emission causes growth of imports. This means that, activities like production of pollution intensive goods take place in the economy; as a result, consumers tend to shift to imported products. Hence, net trade decreases which is consistent with the findings of carbon dioxide and net trade.

Bangladesh's import mainly consists of capital goods, machineries, industrial raw materials, petroleum products, power generating machinery, scientific & medical equipment, iron & steel, motor vehicles, raw cotton, chemicals. The production of these items domestically can lead to emission of carbon dioxide because local production process may not be efficient and hence, the consumption of these will pollute the environment. For instance, local vehicles and machines used to emit more carbon dioxide as they were less efficient. Thus, imports of these items are encouraged highly which results in growth of imports.

Carbon dioxide emission is responsible for growth of export and growth of import, which means that impact on import, is the same as that on export. So, the relationship between carbon dioxide and net trade is verified and portrayed in figure 1. Initially, the production and consumption of the imported items locally create carbon dioxide emissions. This is not efficient at all. Demand for Bangladesh's export is hampered because of this. In addition, the consumers' demand for imported goods increases. In order to make export competitive again, export promotion policies, which provide more access to imports, are undertaken. These policies lead to more import in Bangladesh. Thereby, import growth occurs driven by higher import demand and easier import policies. When export items become competitive again through the use of imported raw materials and capital machines, export increases. Since, impact on import is of greater degree in this situation, net trade declines which explains the negative relationship between carbon dioxide emission and net trade found in the empirical tests. Net trade again has some effects on production and consumption that create carbon dioxide emissions.

Figure 1: International Trade and Carbon Dioxide



V. CONCLUSION

The relationship between international trade and carbon dioxide emission is an issue which cannot be confirmed on a general basis because the impacts one of them has on the other varies due to a number of factors like development level of the country, environmental standards, and composition of international trade or production methods. In Bangladesh, other factors that lead to carbon dioxide emissions include electricity and heat production, gaseous fuel consumption, liquid fuel consumption, solid fuel consumption, manufacturing industries and construction, residential buildings and commercial and public services, transport, and other sectors. Mostly, developing countries face environmental problems due to trade. International trade has led to rise in emissions of carbon dioxide in these countries.

This paper tries to investigate the relationship between trade liberalization and carbon dioxide emissions in Bangladesh. The focus has been on how these two variables are linked. The relationship has been studied in depth through the use of export and import in the analysis.

The co integration tests indicate that there exists a long-term relationship between carbon dioxide and net trade of Bangladesh. They have a negative relationship and carbon dioxide emissions Granger cause net trade. Carbon dioxide and export are also related as proved by co integration test and they have a positive relationship. However, export does not cause carbon dioxide emissions; but carbon dioxide emissions do lead to rise in growth of export. The relation between carbon dioxide and growth of import is very important. These two-time series are obviously related and the type of relationship is positive. Growth of import does not influence carbon dioxide emissions. However, lagged values of carbon dioxide can explain growth of imports as proved by the Granger Causality tests.

When these results are linked to reach a conclusion, it can be illustrated that in Bangladesh, carbon dioxide emissions take place first through domestic production and consumption. This influences export and gives rise to conditions to encourage imports through trade liberalization. Hence, eventually, import grows and net trade declines. This again leads to carbon dioxide emissions.

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