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Relationship between Trade Openness and Carbon Emission: A Case of Bangladesh

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Abstract

This study attempts to empirically test the causality between trade openness and carbon dioxide emission in Bangladesh context applying time-series econometric techniques covering 1972-2009 periods. The author tests this interrelationship in a vector autoregressive (VAR) framework followed by Granger causality, impulse response function to find the plausible causal relationship, direction of causality and the likely impact of one variable on the other. The VAR was tested for its stability also. The Granger causality analysis finds inconclusive causal relationship between variables. But the impulse response function derived through the stable unrestricted VAR model resulted in significant impact of trade liberalization on carbon emission but not any in the reverse order. This study is important for policy makers of Bangladesh and the countries alike.

Keywords: Causality, vector autoregressive, trade openness, CO2 emission

1. Introduction

Due to rapid globalization, international trade increased significantly associated with concerns over its impact on energy use and carbon emissions. Between 1999 and 2010 global merchandise trade experienced tremendous growth from $6 trillion to over $ 15 trillion (Hoekman and Kostecki, 2001; Aklin, 2013). In this backdrop, analyzing the role of foreign trade on emissions of greenhouse gas (GHG), especially carbon dioxide (CO2), has been focal point in the international negotiations aiming at curbing its emissions (Fang et al., 2012). CO2 has been identified to threaten scientific and economic uncertainties that would affect the globe for decades or even for centuries (Nordhaus, 2007).

Chinese economy has been growing fast and its rapid growth in international trade along with deterioration of its environment has drawn researchers' attention to study the relationship between its foreign trade and CO2 emission. Manufactured products from China exported to the USA in 1997 and 2003 accounted for 7% and 14% of CO2 emissions respectively for the former (Shui and Harris, 2006). Similarly, net exports from China produced 23% of its total CO2 emissions in 2004, Wang and Watson (2007) found. Again, findings of Weber et al.(2008) revealed that in 2005, production of exports resulted in around one-third of Chinese CO2 emissions that rose to 21% in 2002 from 12% in 1987. In the last decade, all four BRIC (Brazil, Russia, India and China) nations have experienced the highest economic growth along with the fastest expansion in trade having, simultaneously, emerged as the largest GHG emitting countries (Yang, 2012). Recent study, on global scale, suggests that India and China are increasing emissions by 7.7% and 5.9% respectively, leading the way on growth of emissions (thinkprogress.org/climate/2013).

On the Bangladesh front, the global warming phenomenon is of special concern since this country is said to be the most vulnerable one to this problem. Intergovernmental Panel on Climate Change (IPCC), in its Fourth Assessment report, has mentioned that between 1985 and 1998 average temperature rise in Bangladesh in May and November have been 1^0C and 0.5^0C respectively. IPCC also states that changing climate and its adverse effects on demand, supply and water quality have further worsened water shortages in

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Bangladesh resulting from population growth, rapid and unplanned urbanization and industrialization. Bangladesh has experienced more than 90 major disasters between 1991 and 2000 having losses of around 200,000 lives, and USD5.9 billion worth of losses in agriculture and infrastructure(Sep 2007,DoE, GOB**).** Due to climate change, a sea level rise of 0.5 meter over the last 100 years has already eroded 65 percent landmass of 250 sq. kilometers of Kutubdia, 227 sq.km. of Bhola and 180 sq.km. of Sandwip islands(Sep 2007,CDMP,GOB). Scientists of the country have assessed that the coastal area has already experienced coastal inundation and erosion, saline intrusion, deforestation, loss of bio-diversity and agriculture and large scale in-country migration. Reaching Millennium Development Goals (MDGs) for Bangladesh that include eliminating extreme poverty and hunger by 2015 is also threatened by effects of climate change (Sep 2007,CDMP, GOB). According to the OECD and the World Bank estimates, 40% of overseas development assistance (ODA) to Bangladesh is climate sensitive. Analyzing the causes of CO2 emission and ways to address those are important for this nation also at this critical juncture.

Bangladesh, being an over-populated nation, offers cheap labor to various global firms for manufacturing their products for the world market. Also due to increase in purchasing power on a regular basis, Bangladesh is destination for many imported finished goods and also input materials and intermediary goods are imported to be used in local manufacturing units.

Although linkage between trade openness and environmental quality (including growth in CO2 emissions) has been hypothesized by good number of researchers, still there is ample scope for the empirical verification of the same (Antweiler et al., 2001).

This paper aims at studying the nature (direction and magnitude) of causality, if any, between trade openness and CO2 emission, applying econometric techniques and to make some policy suggestions based on the findings. Data covers the period between 1972 and 2009 due to availability from the source of these data (World development Indicators).

The paper has five more sections. The next section reviews the literature followed by description of data and methodology used in the analysis. The findings of econometric analysis cover the third section. The fourth section discusses policy implications of this international trade-CO2 emission nexus for Bangladesh along with the direction for future research for more comprehensive analysis. The last part concludes.

2. Literature Review

Researchers have been working on energy consumption-economic growth, carbon emission-trade and also energy consumption-trade openness and carbon emission-trade openness and of course electricity consumption and economic growth relationships for quite some time now and the reason is evident in the initial discussion of this paper. Hence, in this section the review will cover researches on the above-mentioned relationships considering the similarity in the core areas of those studies.

The empirical studies have so far found all four types of causality namely, no causality, uni-directional causality from energy to growth and vice-versa and bidirectional causality taking data from various economies covering different time-periods. And also the modified Kuznets (1955) curve considering per capita income growth and environmental degradation, known as environmental Kuznets curve (EKC) has been tested in different countries covering various time-period with findings of various kinds both in favor of and against the EKC. The first empirical work in analyzing trade-environment nexus, assuming negative effect of trade on environment, was carried out by Grossman and Krueger (1993). Grossman and Krueger (1995) divide the environmental outcome of NAFTA into three effects, namely the scale effect, the composition effect and the technique effect, and such a division has been widely used in empirical studies on the trade– environment nexus. Findings of numerous researchers in this area have not been consistent and have been attributed by Chen et al. (2007) to variations in countries' characteristics such as different indigenous energy supplies, political and economic histories, cultures, and different institutional arrangements. The developed countries do not exhibit causality between energy and level of economic prosperity as evident in the studies of Akarca and Long (1980), Yu and Hwang (1984), Stern (1993), and

Cheng (1995). Fatai et al. (2002), Yu and Choi 1985), (Erol and Yu 1988) covering the USA, the UK, New Zealand and France. Studies on Argentina (Soytas and Sari 2003), South Korea (Masih and Masih, 1997, and Glasure, 2002), Cyprus (Zachariadis and Pashourtidou 2007), Japan (Erol and Yu 1988), Malawi (Jumbe 2004), and Pakistan (Masih and Masih 1996), the Philippines and Thailand (Asafu-Adjaye, 2000) have found bidirectional causality between energy and economic growth. The nature of this phenomenon in Bangladesh has not been studied much. But Mozumder and Marathe (2007) tried to put light in this regard taking Bangladeshi data. They have found the causality to run from per capita GDP to per capita electricity consumption covering 25 years' data. In another study on Bangladesh, Hye and Mashkoor (2010) obtain positive bidirectional causality between economic growth and energy consumption covering 1971-2008 data. For India Ghosh (2009) finds similar result.

Wyckoff and Roop (1994) estimates that 13% of the total carbon emissions of the six largest OECD countries are embodied in their imported manufactured goods, which is further supported by Mongelli et al. (2006). CO2, the main Green House Gas (GHG), alone accounts for about 72% of the global warming effects and researches have been conducted to find CO2 emissions embodied in international trade (Yunfeng and Laike, 2010). It is well known today that through the globalized trading framework, the movement of goods takes place among the economies either for consumption or for further processing and pollution across nations is thus generated in this process. Frankel (2008) thus argues that relocation of production across nations increases global greenhouse burden. Aklin, using propensity matching design, claims that the countries that develop later exhibit a disadvantage by emitting more carbon dioxide per capita at similar income-level(Aklin, 2013).

Effects of trade on environments have been subjects of various theoretical models already. Copeland and Taylor (1994,1995) using their North-South trade model have shown that free trade improves the developed countries' environment as these countries import certain products from the developing world which exacerbates environment of the latter. In case of China, it is observed that developed countries transferred their pollution-intensive industry to China considering labor costs, marketing, environmental regulation and other factors (Yunfeng and Laike, 2010). Adamowicz and McCarney (2005) also revealed that richer economies better protect their environment from pollution (like CO2 emission) at the cost of environmental degradation of their poorer counter parts (exporters).

Some authors have not found trade openness to be bad altogether in deteriorating environment. For example, Taskin and Zaim (2000) find that at the initial stage of economic growth trade liberalization pollutes environment and as it achieves a certain level of development it starts consuming environmental goods. Antweiler et al. (2001), investigating SO2 concentrations resulting from trade openness, also yielded the good effects of trade openness on the environment. On the other hand, Frankel and Rose's (2005) study finds support for environmental Kuznets curve stating trade's contribution to generate CO2. Study on China, Japan and Korea by Choi et al (2010) reveals that for Korea, trade openness ultimately directed towards more concern for environmental protection due to increased standard of living resulting from economic growth. And China also represents a typical developing economy, as found in the aforesaid paper, that in the stage of economic growth it is not much concerned about pollution, since it focuses more on fast growth capitalizing on cheap labor and thereby worsening its environment. For Japan, Choi et al (2010) found positive relationship between trade openness and CO2 emission.

Paul and Uddin (2010), working on output and energy consumption, found that output growth does not increase rather decrease energy consumption in Bangladesh and praised its performance in achieving energy efficiency as were also found by few others.

3. Data and methodology

In this study, international trade is represented by trade openness measured as ratio of export and import to gross domestic product, all in constant US$2005 from World Development Indicators (WDI)

database. And data on carbon emission (kilo tons) is sourced from the same database. The period covered is between 1972 and 2009 due to availability from the source.

At first, the data have undergone logarithmic transformation to compress the scale of measurement. To check for the unit roots in both series, as is done to analyze time-series data, both the series have been tested using Augmented Dickey-Fuller (ADF) test (Dickey-Fuller, 1979,1981) and Phillips-Perron test (Phillips and Perron, 1988) with intercept. The series were found to have unit roots and after first differentiation, the series became stationary (difference stationary process-DSP).

Due to uncertainty about level of interdependence between carbon emission and trade openness, the vector autoregressive (VAR) is used to test the interrelationship between these variables. It is well known that VAR treats the variables to be in symmetry, so the issue of their interdependence needs not be considered.

Before running both the series in a VAR model, Granger causality tests are run to test the direction of causality between trade openness and carbon emission. This finds the null hypothesis stated as 'carbon emission to Granger cause trade openness' to be significant only at lag level 3. The corresponding statistics are presented below (results at other lag levels are not reported).

Table 1: Granger Causality Tests of Trade Openness and Co2 Residuals: 1972-2009

Null hypothesis	Lag 3
Trade openness does not Granger cause carbon emission	
F-statistics	0.41349
Probability	0.7446
Carbon emission does not Granger cause Trade openness	
F-statistics	3.34627
Probability	0.0322

The next step is to determine the order of variables in VAR estimation and also to select the lag order, as VAR estimates are sensitive to these two factors (Paul & Uddin, 2010), and run both the series in VAR model. Sims (1980) recommends trying different orderings and Evans (1989) also changes the prior variable in the VAR while analyzing interplay between output growth and unemployment rate, and the author also follows this process in this paper.

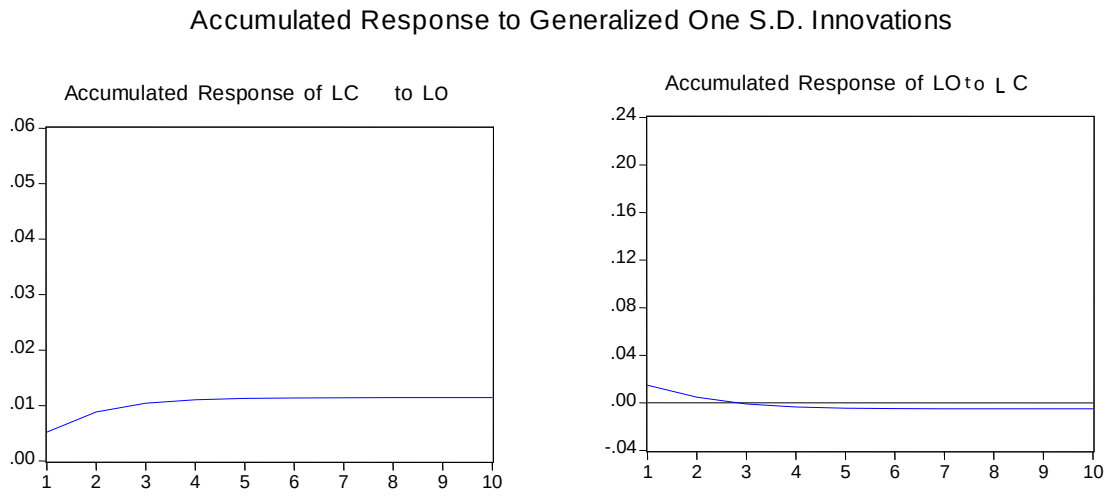

Figure 1A: Impulse response function {VAR(1)}

In selecting order of lag, based on Schwartz Bayesian Criterion (SBC) and Hannan-Quinn information criterion, one lag is taken to estimate VAR. The VAR (1) model is found to be stable as no roots of the polynomial in the VAR estimation lie outside the unit circle.

Then impulse response functions have been deployed to uncover more information, like how a one-standard deviation impulse in the innovation of one of the variables will determine the response path of the other. In this paper, generalized impulse response analysis is applied which is invariant to the ordering of variables in the VAR (Pesaran and Shin, 1998).

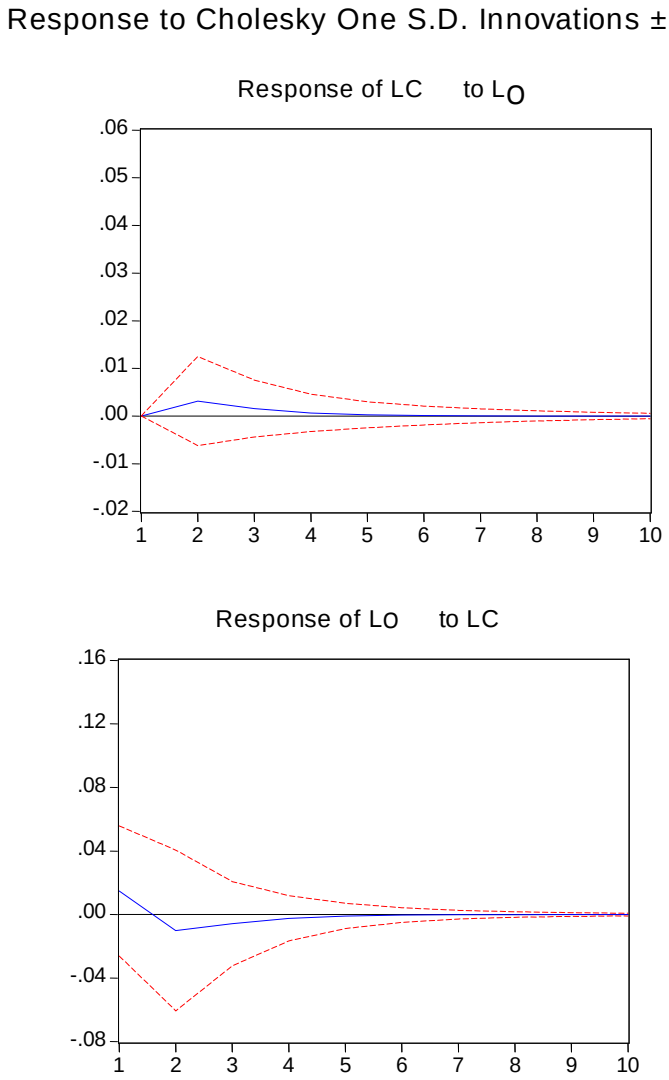

Figure 1B: Impulse response function

Of the two figures above, figure 1A depicts the accumulated responses of trade openness to CO2 in the right panel and the CO2 responses to trade openness in the left one. The response of CO2 seems to be slightly significant to trade openness since the beginning of the study period and increasing gradually it dies off after 3 years. On the other hand, trade openness is not significantly responding to CO2 since the initiation and by three years, innovation in CO2 does not result in response of the other.

The other figure shows that trade openness has significant and positive impact on carbon emission from period one and increases up to second period before starting to decline and dies off immediately in the fourth

period. But the innovation in CO2 has slight impact on trade openness initially before dying off even before the completion of the first year of observation. It can be said from this analysis that trade openness may have impact on carbon dioxide emission but it is not vice versa.

4. Policy implication

The effect of trade on environment is debatable. It is argued that developing economies have significant dependence on trade and they are increasingly becoming major polluters too (World Resources Institute, 2010).But trade-based incentives to enforce good environmental governance is also emphasized (Nimubona, 2012). The economies like Bangladesh can accrue benefit for its environment (and perhaps a net welfare benefit more broadly) only if environmental policy advances alongside trade liberalization (Anderson, 1992, 1998; Esty, 1994). Concerted efforts are required to prevent this economy from becoming one of the so-called 'pollution havens'.

Needless to say that institutional failures in the environmental realm often mean that the requisite strengthening of environmental performance in parallel with trade liberalization may not occur (Chichilnisky, 1994; Zhao, 2000). Again Frankel and Rose (2005) opine that this purely global externality needs regulation at multinational levels.

Bangladesh should build capacity and develop skills in trading environmentally friendly goods to achieve sustainable economic development. Appropriate policy measures can reinforce such research findings that advocates for free trade to be good for environment as well (Antweiler, 2001). Bangladesh also should look for alternative sources of energy to remain efficient in its consumption. This country should always keep in mind the vulnerability to environmental pollution and devise growth programs being concerned with ways towards fast and sustainable development.

Bangladesh needs concerted efforts from people from all walks of life including academics, professional experts dealing with relevant issues, administrators and managers for effective management of adaptation and mitigation programs undertaken by government and above all a mass awareness needs to be generated to face the challenge of global warming, in which it is an innocent victim with 145 kilograms of annual carbon emission (one of the lowest per capita in the world).

Future research

The existence of strong dynamic inter-relationships between output, energy consumption, environmental pollutants and foreign trade should be investigated in the same multivariate framework to have a wider view of effects of trade on income and environment. The study period covered in this paper has not been more than38 years due to unavailability of reliable data. Any researcher may work with more data of this economy should that be available.

5. Conclusion

Bangladesh as an emerging economy with increased trade volume offers scope to empirically test whether its trade regime is resulting in environmental degradation or not. This consideration made the author study the relationship between trade openness and carbon dioxide emission. Researchers have found that the developing economies are more vulnerable than their developed counter parts to the global warming phenomenon also due to manufacturing products for the latter taking advantage of poor or lack of regulations for environmental protection on the part of those developing nations (Smarzynska and Wei, 2005)

And the composition effect of trade on environment will shift production between environmentally beneficial or damaging goods, depending on the competitive advantages enjoyed by the MNCs (multinationational companies) between trading partners (McCarney and Adamowicz, 2005).

The author tested the relationship between two variables in the VAR (vector autoregressive) framework to avoid the direction of interdependence between the variables, the Granger causality is also employed but

the direction of causality between the two is not conclusively identified. However, employing impulse response function to check for effect of innovation in one variable on the other, the study reveals that trade openness significantly enhances the growth of CO2 emission initially and continues for up to three years. But carbon emission does not significantly influence trade openness, though it has effect on trade openness.

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