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Article

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The Impact of Economic Globalization on CO_2 Emissions: The Case of NAFTA Countries

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ABSTRACT

International trade with the economic globalization gaining wide currency has brought along the environmental problems. Transition to environment-friendly high-tech products and schemes in developed countries alleviated the impacts of these problems whereas underdeveloped environmental standards in developing countries still cause deterioration in the environmental quality. For this reason, there are different views on the environmental impacts of globalization. The study investigates the impact of globalization and trade openness on CO_2 emissions with reference to the NAFTA countries. Employing panel-data analysis, the study relies on the annual data for a period of 1990–2015. The findings reveal that there is a positive relationship between economic globalization and trade openness, and CO_2 emissions. The study further tests the validity of Environmental Kuznets Curve for the target countries. To this end, the research identifies a positive-direction relationship in both linear and square forms between CO_2 emissions and economic growth.

Keywords: Economic Globalization, CO_2 Emissions, Environmental Kuznets Curve
JEL Classifications: C33, F18, F64, Q50

1. INTRODUCTION

Globalization which has affected many walks of life including economy, politics and social affairs has also led to some problems as well. The environmental impacts of globalization constitute major part of the ongoing discussions in relation to international trade policy. Globalization appears to have both positive and negative impacts on the environment. It may exacerbate existing environmental problems while also laying the necessary ground for a settlement of the same issues.

Globalization leads to increased volume of the international trade and to intensification of the capital movements among the countries. It also contributes to greater cooperation and competitiveness and to the advancement of new technologies. The growing trade and economic cooperation, stimulated by the process of globalization, also improves the income levels of the countries. People develop environmental awareness in high-income countries, directing large companies to adopt environmental-friendly production methods. This eventually raises the environmental standards in these countries.

However, despite its positive impacts, globalization may also cause environmental degradation as well. Particularly in societies employing technologies not compatible with the environment, globalization may, by increasing the production scale, consumption of energy, international transportation and the uncontrolled exhaustion of natural resources, lead to deterioration in environmental quality. In addition, the strict rules on the protection of the environment in developed countries encourage large corporations to take their production activities and operations to the developing nations with little or no environmental awareness.

Developing countries can adopt lenient environmental standards in order to attract foreign investment. In this way, globalization might lead to unpleasant outcomes in terms of environmental protection.

Economic globalization has also led to the globalization of environmental issues. Pollution, global warming, depletion of ozone layer, destruction of ecosystems, climate change, exhaustion of natural resources, deterioration in biodiversity, elimination of forest areas and desertification are all problems that mainly emerged in the process of globalization. Economic growth and environmental degradation have made to the top of the political agenda with the intensification of globalization in 1990s. Economic growth has led to increase in the CO_2 emissions in recent decades. The correlation between environmental quality and economic growth has been investigated in the existing literature with reference to the Environmental Kuznets Curve (EKC) hypothesis. Created by Grossman and Krueger (1991), the EKC hypothesis argues that at the initial stage of economic growth, emissions increase as income level improves. However, when a certain level of income per capita is achieved, emissions start to decline even if the income is still on the rise. In other words, there is a positive relationship between economic growth and environmental degradation at the initial stages of the economic growth whereas this turns into a negative one after a certain point. Therefore, it could be argued that economic growth initially has negative impact on environmental quality whereas it contributes to environmental protection when a certain level of per capita income is achieved.

The study is organized as follows. The second part reviews the existing literature whereas part three is focused on the econometric method employed in the study and the relevant findings. The final part discusses the findings and potential future researches on the subject.

2. LITERATURE REVIEW

The increased volume of international trade in connection with economic globalization has led to increase in energy consumption and also to concerns over environmental sustainability. To this end, the impact of economic globalization and international trade on environmental pollution has attracted attention of researchers (Shahbaz et al., 2016; Jebli et al., 2016; Al-Mulali et al., 2015; Jebli et al., 2015). The works these researchers have done refer to the CO_2 emission as an indicator of environmental pollution because the amount of CO_2 emission increases over the years and is often regarded as the main culprit for the environmental degradation in the world. These works also test the validity of the EKC hypothesis. The existing literature on the subject is summarized as follows:

Antweiler et al. (2001) conducted research on the relationship between trade openness and environmental quality for 44 countries in a period of 1971-1996. In their study, they developed model to measure the impact of trade on environmental pollution in terms of scope, technique and composition. A consideration of all these three factors reveals that trade openness has a positive impact on environmental quality. Choi et al. (2010), on the other hand, investigated relationship between CO_2 emissions and economic growth and trade openness for China, Korea and Japan, employing time series analysis. The study identified a positive relationship between CO_2 emissions and trade openness for Japan and Korea and a negative relationship for China and determined that the EKC assumed different shapes depending on the characteristics and features of countries. The EKC is N for China and U for Japan. The relationship between CO_2 emissions and trade openness is identified as reverse U for Korea and Japan and as U for China. Naranpanawa (2011) examines the relationship between trade openness and CO_2 emissions for Sri Lanka in a period of 1960–2006. The findings reveal that there is a short term, not a long term, relationship between the two variables.

Rahman (2013) examines causality between trade openness and CO_2 emissions for Bangladesh over a period of 1972–2009 employing time series data. The findings of the study reveal that trade openness contributed to the increase in CO_2 emissions at the beginning, adding that carbon emission did not significantly affect trade openness. Yıldırım (2013) studied impact of trade openness and economic growth on pollution in 20 developed and developing nations for the period of 1990–2009. The study divided the target countries as 10 developed and 10 developing countries, and 5 European countries and 5 large economies. The findings in the study reveal that trade increases pollution emissions in developed and developing nations. In addition, the study confirms the validity of EKC hypothesis for all target countries. Gu et al. (2013) examined the causality between trade openness and CO_2 emissions in China for a period of 1981–2010. The time series analysis employed in the study reveals that there is a long term relationship between trade openness and CO_2 emissions in China. The authors further identified two-directional causality between foreign direct investment dependency and CO_2 emissions and a one-directional causality from trade dependency to CO_2 emissions.

Akın (2014) investigated impact of energy consumption, economic growth and trade openness on CO_2 emissions. Employing data of 85 countries for a period of 1990–2011, the study employs panel co-integration analysis. The findings reveal that there is a positive relationship between CO_2 emissions and energy consumption, income per capita and trade openness. On the other hand, the findings also demonstrate that trade openness may decrease CO_2 emissions in the long run. In the short term, however, there is one-directional causality from gas emissions towards trade openness. Le et al. (2016) reviewed the causality between trade openness and the environment for 98 countries; the panel co-integration test results reveal that there is a long term relationship between particle substance emissions, trade openness and economic growth. Yet results differ according to the income levels of the target countries. Trade openness has a positive impact on environment in high-income countries whereas there is negative correlation in mid and low-income countries. Zhang et al. (2017) reviewed the impact of trade openness on CO_2 emissions, real GDP and total primary energy consumption. The sample of the study includes 17 industrialized nations for a period of 1971–2013. The findings reveal that trade openness negatively affects emissions whereas it has a positive impact on real GDP and energy emissions. The study also tests the validity of EKC hypothesis and confirms that the hypothesis applies to the case. Bekar and Terzi (2018) examined relationship between carbon

emission and trade openness in Turkish economy for a period of 1974–2013, finding that there is causality between gas emission and trade openness in Turkey. The findings shows that trade openness and CO_2 emissions mutually affect each other. Hsiao and VAR causality tests confirm two-directional causality between variables whereas the Sims test results refer to one-directional causality from CO_2 emissions towards trade openness.

Shahbaz et al. (2015) examined the impact of globalization on CO_2 emissions in China for a period of 1970-2012. The findings reveal that globalization general index and sub-indexes (social, economic and political globalization) decrease CO_2 emissions in China. The analyses run in the study also confirm the validity of EKC hypothesis for Chinese economy. You and Lv (2018) studied the impact of economic globalization on CO_2 emissions in 83 countries for a period of 1985–2013. The prediction results in the study that employed spatial panel data analysis confirm spatial correlations for international CO_2 emissions. The study does not identify a direct and significant correlation between economic globalization and gas emissions. The indirect impact of economic globalization on CO_2 emissions is negative. The findings in the study also support the presence of reverse-U EKC relationship between CO_2 emissions and income.

3. ECONOMETRIC METHOD AND FINDINGS

3.1. Methodology and Dataset

This study investigates impact of economic globalization and trade openness on CO_2 emissions for NAFTA[1] countries for a period of 1990-2015. Two models have been developed for this purpose. The models in the study that employed panel data analysis are as follows:

Model 1

$$LCO2_{it} = \alpha_i + \beta_1 GDP_{it} + \beta_2 GDP_{it}^2 + \beta_3 ECO_{it} + \beta_4 EUSE_{it} + u_{it}$$

Model 2

$$LCO2_{it} = \alpha_i + \beta_1 GDP_{it} + \beta_2 GDP_{it}^2 + \beta_3 TRD_{it} + \beta_4 EUSE_{it} + u_{it}$$

CO_2 emissions (kt) are used as dependent variable in both models. CO_2 emissions refer to emissions out of fossil fuels and cement production. The GDP variable utilized in both models refers to the gross domestic production. The real value in terms of US dollars in 2010, utilized as measurement of economic growth, is used in the study. The EUSE variable refers to the energy consumption per person (kg). The variables have been retrieved from the World Development Indicators (WDI) database of World Bank.

The ECO variable, utilized as an indicator of economic globalization in Model 1, has been retrieved from KOF globalization index, devised by the Swiss Institute for Economic Research. The KOF globalization index is composed of three sub-indexes (economic, social and political globalization).

Each of the variables in the KOF globalization index has been scaled in a way that each is ascribed a number from 1 to 100. In this scale, 1 refers to minimum globalization whereas 100 to a maximum (KOF, 2018a. p. 1). The economic globalization index involves commercial and financial globalization. A number of variables including international trade, foreign direct investments, portfolio investments, international debt, international reserves and international revenue payments have been utilized in the compilation of the index (KOF, 2018b. p. 1).

In Model 2, TRD, calculated based on ([export+import]/GDP), is utilized as trade openness indicator. This variable has also been retrieved from WDI database of the World Bank.

The study also tests the validity of the EKC hypothesis. Developed by Grossman and Kruger (1991), this hypothesis suggests that environmental pollution becomes a bigger problem at the initial stages of boosted economic growth whereas its significant loses pace after a certain threshold of economic growth. The EKC hypothesis is formulated as follows:

$$E = f(Y, Y^2)$$

In this formulation, E refers to environmental indicator and Y to income. The EKC hypothesis suggests that there should be a positive relationship between E and Y. On the other hand, because as the income level improves, there should be a greater environmental degradation, a negative correlation is expected between E and Y^2.

Basic explanatory statistics on the variables employed in the analyses are presented at Table 1. The figures in the table reveal that the CO_2 emissions in NAFTA countries have been 2096659 kt on average for a period of 1990-2015. The lowest GDP, representing economic growth, was −7.9% in this period whereas the highest GDP rate was 5.09%. Economic globalization has been 58.60 on average and trade openness was 47.72%. It appears that lowest and highest rates of energy consumption have been 1401.23 kg and 8441.185 kg respectively.

The correlation coefficients between the variables employed in the analyses are presented at Table 2. The presented data at the table reveals that there is a positive correlation between GDP, ECO and EUSE variables and CO_2, and there is a negative correlation between TRD and CO_2.

Table 1: Explanatory statistics

Variable	Mean±SD	Minimum	Maximum
CO_2	2096659±2332236	318427.6	5789727
GDP	1.26686±2.26079	−7.981587	5.095809
ECO	58.60004±9.750851	38.21916	72.73102
TRD	47.726±19.32854	19.73551	82.85773
EUSE	5678.298±2978.001	1401.23	8441.185

SD: Standard deviation

1 NAFTA is a free trade agreement concluded between The United States of America, Canada and Mexico. The objective of the agreement is to liberate trade among the member states.

3.2. Empirical Analysis and Findings

Employing panel data analysis, the study first features a Hausman test to determine which one of the fixed effect (FE) and random effects (RE) models will be utilized. The test reveals that fixed effects model is the most appropriate one for model 1 and model 2. Subsequently, deviations from the hypothesis have been tested to secure effective predictors in the models. To this end, heteroskedasticity and auto-correlation tests have been applied to the models. The results are presented at Table 3. A review of the findings on model 1 and model 2 reveals that there is a heteroskedasticity problem based on Modified Wald Test (Wald Chi2); the Durbin Watson test indicates an auto-correlation problem and Friedman Test results refer to a correlation problem between units. Estimation has been performed by the use of Driscoll and Kraay resistant estimator to secure a more consistent estimation in both models because of the above mentioned.

For NAFTA countries, the impact of the economic globalization on the CO_2 emissions has been analyzed firstly. The findings of the Model 1 reveal that there is a positive and statistically significant relationship between economic globalization and gas emissions at 1% level. In other words, an increase in the economic globalization index leads to increase in CO_2 emissions in NAFTA countries. There is also a positive relationship between CO_2 emissions and energy consumption, added to the model as a control variable.

Model 1 also tests the ECK hypothesis. There is a negative relationship between CO_2 and GDP in the estimated relationship. In other words, an increase in economic growth leads to decline in the CO_2 emissions. On the other hand, there is also a negative relationship between CO_2 and GDP^2. In short, a negative relationship in both linear and quadratic form has been identified between GDP and CO_2. This finding shows that the NAFTA countries have reached a certain point of income level (threshold) and that an increase in economic growth has led to decline in environmental pollution. This can be best explained by the use of clean technologies in place of conventional technologies.

Table 2: Correlation matrix

	CO_2	GDP	ECO	TRD	EUSE
CO_2	1.0000				
GDP	0.0454	1.0000			
ECO	0.3161	0.0563	1.0000		
TRD	−0.7841	0.0456	0.2414	1.0000	
EUSE	0.5171	0.0618	0.8994	−0.0818	1.0000

Table 3: Results of the analysis

Variables	Dependent variable: CO_2	
	Model 1 - FE	Model 2 - FE
GDP	−0.0109* (0.0034)	−0.013* (0.003)
GDP^2	−0.0036** (0.0009)	−0.003* (0.0008)
ECO	0.0204*** (0.001)	
TRD		0.008** (0.0011)
EUSE	0.0001*** (0.00001)	0.0001** (0.00002)
Constant	11.9206*** (0.0920)	12.686*** (0.1121)
R^2	0.75	0.68
Hausman test	69.78 [0.000]	69.00 [0.000]
Wald Chi^2	86.46 [0.000]	7.60 [0.045]
Friedman test	23.028 [0.000]	37.342 [0.000]
Durbin-Watson	0.701	0.546
Baltagi-Wu LBI	0.849	1.662

*, **and***show statistical significances at the % 10, % 5 and % 1 levels, respectively. Values in parentheses are standard errors, the values in brackets refers to the level of significance

A review of findings for Model 2 reveals that there is a positive and statistically significant relationship between trade openness and CO_2 emissions at 1% level. In other words, increase in trade openness in NAFTA countries also leads to an increase in CO_2 emissions. There is also a positive and statistically significant relationship between energy consumption and CO_2 emissions at 5% level. In addition, the findings on the GDP and GDP^2 and CO_2 emissions corroborate findings in Model 1.

4. DISCUSSION AND CONCLUSION

Globalization fosters interaction among the nations but also leads to an environmental degradation as it provokes extensive use of energy in production and consumption activities in developed and developing countries. On the other hand, globalization also contributes to the improvement of technological advances and to the increase in GDP. When income level improves, corporations that are sensitive to environment become obligated to developed technologies that are less harmful to the environment. With the spread of environmental friendly technologies, the impacts of negative environmental factors during production and consumption become a smaller concern.

This study investigates the impact of economic globalization and trade openness on CO_2 emissions in NAFTA countries. The findings confirm that greater economic globalization and trade openness leads to greater CO_2 emissions. In addition, the study refers to a positive correlation between energy consumption and CO_2 emissions. This means that growing trade activities and energy consumption in these countries increase the CO_2 emissions.

In addition, the study also tests the ECK hypothesis for NAFTA countries. The test identifies a negative correlation in both linear and quadratic forms between CO_2 emissions and economic growth. The hypothesis suggests that there will be greater environmental pollution during the initial stage of economic growth whereas it becomes a less significant problem at the later stages. A negative correlation between CO_2 and GDP and GDP^2 proves that the reviewed countries have achieved a certain level of income and that greater economic growth leads to an alleviation in environmental pollution. This can be explained by transition of NAFTA countries to use clean technologies during the production stages.

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