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TÁC ĐỘNG CỦA TỰ DO HÓA THƯƠNG MẠI Ở CÁC NƯỚC ĐANG PHÁT TRIỂN CHÂU Á ĐẾN BIẾN ĐỔI KHÍ HẬU (1990-2020)

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Tóm tắt

Để đo lường tác động của tự do hóa thương mại đến biến đổi khí hậu, nghiên cứu đã sử dụng dữ liệu từ hơn 50 quốc gia ở Châu Á từ năm 1990-2020 của Ngân hàng Thế giới. Theo mô hình GLS, độ mở thương mại không có tác động đáng kể đến môi trường thông qua các biến CO2, CH4 và GHG, tuy nhiên dựa trên việc tạo ra các biến tương tác từ độ mở thương mại và mức độ thu nhập cho thấy ở các quốc gia có thu nhập trung bình thấp, độ mở thương mại có tác động tích cực đáng kể hơn nhiều đối với khí thải CO2 so với các nước có thu nhập trung bình cao. Do đó, nhóm tác giả đề cập đến các chính sách gợi ý trong hoạt động kinh tế nhấn mạnh vào việc thúc đẩy sử dụng năng lượng tái tạo và các quy định chặt chẽ hơn về môi trường đối với các doanh nghiệp nhằm giảm thiểu tác động tiêu cực đến môi trường do tự do hóa thương mại.

Từ khóa: biến đổi khí hậu, Châu Á, độ mở thương mại, khí CO2, mô hình GLS.

IMPACTS OF TRADE LIBERALIZATION ON CLIMATE CHANGE OF ASIAN DEVELOPING ECONOMIES

Abstract

To estimate the impact of trade liberalization on climate change, our study uses data from more than 50 countries in Asia from 1990-2020 in the World Bank. According to the GLS model result, trade openness has no significant impact on environment via methane (CH4), carbon dioxide (CO2), nitrous oxide (N2O), and greenhouse gasses emissions (GHG), however based on creating the interaction

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variables from trade openness and income groups show that in lower-middle-income countries, trade openness has a much more significant positive impact on carbon dioxide emission than upper-middle income.Thus, the authors mention suggested policies in economic activities emphasizing on promoting the use of renewable energy and stricter environmental regulations on enterprises to alleviate negatively-affected environment by trade liberalization.

Keywords: Asia, carbon dioxide, climate change, GLS, trade openness.

1. Introduction

In line with the trend of economic globalization and regionalization, trade liberalization has become a necessity for some countries as it contributes to the elimination of the barriers hindering the exchange of goods and services (Sun *et al.*, 2019). Asian developing countries are among this group of countries which have benefited from trade liberalization (Jun *et al.*, 2020). Indeed, the prerequisite or the primary variables of the general terms "liberalization" can be seen as trade openness. Besides, some other factors like renewable energy consumption, energy use, and income are also significant variables to measure the impact of trade liberalization on the environment. However, the impact of trade liberalization is still in a controversial discussion as some studies say that trade openness reduces pollution (Cole & Elliott, 2003) while others find that trade liberation is one of the considerable factors of environmental deterioration (Jalil & Feridun, 2011).

Thanks to the reduction of trade barriers between Asian developing countries and all over the world, many countries can get rid of one the biggest economic recessions in 2007 (Aničić *et al.*, 2020). Due to the inequality of advanced technological development, pollution has been transferred into developing countries in Asia (Chang, 2015). This study is the first empirical study for developing countries in Asia by using GLS. Additionally, this study also utilizes methane, greenhouse gasses, and nitrous oxide for evaluating the impact of trade openness on the environment. Our study is unique from others in that it will analyze the connections of trade openness and climate change during and after the global recession. To be more specific, after analyzing interaction variables, the result shows that trade openness has a significant positive impact on carbon dioxide emissions in both lower-middle-income countries and upper-middle-income countries, the result in lower-middle-income countries is statistically insignificant. The study is organized as follows: the second part provides a review of the literature; the next part defines the model, data, and methodology; and after that the authors will provide the empirical findings and discussion in the fourth part, the last part highlights some concluding remarks.

2. Literature review and Conceptual Framework

As trade openness has been attributed to the speedy growth of world economic integration (Jun *et al.*, 2020), more and more research has been conducted about the climatic impact of it on countries which join and accelerate this trend. The key points from these articles about the affected-environmental quality are based on 2 main aspects: the Pollution Haven Hypothesis (PHH) and the Environment Kuznets Curve (EKC).

With regard to the close relationship between the intensity of environmental policies and the potential resources in a country, the Pollution Haven Hypothesis, which was first postulated by Copeland & Taylor (1994) and aimed at researching the environmental consequences of NAFTA (Bulus & Koc, 2021), states that when trade barriers are reduced, pollution-intensive industries from countries with severe environmental regulations will be transferred to countries with looser laws

(Makiyan *et al.*, 2022). Moreover, when demand for traded goods manufactured by contaminating methods increases, countries in turn produce more polluted goods ceteris paribus (Sun *et al*., 2019), and thereby the polluting sector is transferred from industrialized nations to underdeveloped economies.

Another aspect is the Environment Kuznets Curve (EKC) is normally characterized by an inverted "U" curve relationship with economic growth (per capita gross domestic product (GDP)), which first rises and then falls. The theory indicates that when the level of economic development is low, economic growth increases environmental pollution, and when the level of economic development rises to a certain level, economic growth reduces environmental pollution (Kahn, 2009). Moreover, there is a relationship between environmental degradation indices and per-capita income: in the early stages of economic development, with the increase in per-capita income, income distribution inequality increases, and after reaching a certain level or a return point, the inequality of income distribution gradually decreases (Makiyan *et al.*, 2022).

Generally speaking, trade openness has a direct and indirect impact on the environment thus the topic of the correlation between trade liberalization and environment have been discussed controversially, but the number of studies on the trade openness and climate alteration by measurement of methane, nitrous oxide is still limited. The previous research is mainly concentrated on economic growth, FDI and lack of other vital factors such as renewable energy consumption, energy use.

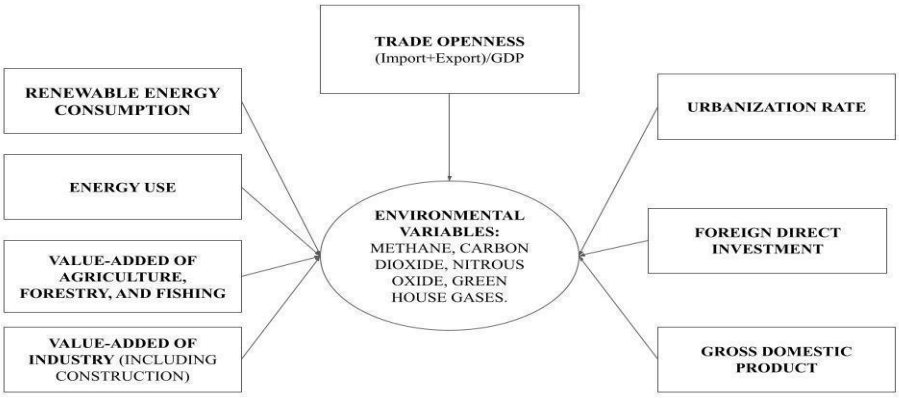

Figure 1. Theoretical Framework

Source. Yan & Tu (2021)

3. Research method

Gujarati (2004) recommends starting with the three models (pooled ordinary least squares (OLS) regression model, the fixed effects model (FEM), and the random effects model (REM)) and performing hypothesis testing to find the most suitable one, but there exist other worth-considering models, Generalized Least Squares (GLS) typically. In this study, the authors will perform regression on all models and choose the one that best suits their research. The variables are listed in table 1.

Table 1. Sources and description of study variables

Variables	Description	Expected Sign	Research Source	Data source
Dependent variables to measure climate change				

Variables	Description	Expected Sign	Research Source	Data source
co2	Carbon dioxide emissions, in metric tons per capita	+	Bulus & Koc (2021)	WB
lnn2o	The natural logarithm of nitrous oxide emissions in energy sector, thousand metric tons of carbon dioxide equivalent	-	Onwachukwu *et al.* (2021)	WB
lnch4	The natural logarithm of methane emissions in energy sector, in thousand metric tons of carbon dioxide equivalent	-	Ali *et al.* (2020)	WB
lnghg	The natural logarithm total greenhouse gas emission, in kt of carbon dioxide equivalent	-	Nemati *et al.* (2018)	WB
	Independent variable			
ope	Trade openness (the total ratio of exports and imports of goods and services to gross domestic product as a percentage)	+	Soylu *et al.* (2021)	WB
int2 int3	int2=inc2*ope, int3=inc3*ope	+	Kazemi & Mousavi (2015) found a positive relationship between income and pollution. Li & Haneklaus (2022) found that an increase in trade openness raises carbon dioxide level.	
lnfdi	The natural logarithm of net foreign direct investment inflows, measured by percentage of foreign direct investment over gross domestic product	+	Onwachukwu *et al.* (2021)	WB
lngdp	The natural logarithm of the number of gross domestic product per capita, in current US$	+	Bengoa *et al.* (2021)	WB
urb	The ratio of urban population to total national population, in percentage	+	Ali *et al.* (2020)	WB

Variables	Description	Expected Sign	Research Source	Data source
rne	Renewable energy consumption over total final energy consumption, in percentage	-	Soylu *et al*. (2021)	WB
lnen	The natural logarithm of the energy consumption, in kg of oil equivalent per capita	+	Sun *et al.* (2019)	WB
lnagri	Agriculture, forestry, and fishing, value added, in current US$	-	Orhan *et al.* (2021)	
lnind	Value-added of industry (including construction), in current US$	-		
yr	yr=1 if year>2007, yr=0 otherwise	-	Wang & Wang (2021)	
incit	incit is a dummy variable with: low income country then i=1, lower middle income country then i=2, upper middle income country then i=3, high income country then i=4	+	Yao *et al.* (2019)	

Source: The authors (2023)

In addition, according to Wang et al. (2022), Asian emerging economies underwent a global economic crisis in 2007, influencing these countries' total import value, export value and GDP. In order to clarify the effects of trade openness and other factors on climate change throughout different situations, the author group splits the study period into two phases namely during and after the global recession, applying income and year as dummy variables.

4. Results and discussion

4.1 Results

Descriptive statistics

Before performing regression analysis, the author performs descriptive statistics on the variables in the mentioned research model. Table 2 presents the descriptive statistics for the variables included in the model.

Table 2. Descriptive statistics of variables in the model

Variable	Obs	Mean	Std. Dev.	Min	Max
lnch4	1,365	8.6679	2.3647	2.3026	13.9778
co2	1,550	5.7906	7.8794	0	50.9540
lnn2o	1,361	6.9258	2.2869	2.3026	13.2220
lnghg	1,440	11.1368	1.9115	5.2983	16.3575

Variable	Obs	Mean	Std. Dev.	Min	Max
ope	1,550	1.26555	4.2883	0	61.1411
lnfdi	1,343	-3.9665	1.6531	-19.5840	1.0301
lngdp	1,482	24.7418	3.0561	19.1864	38.5353
rne	1,485	0.2061	0.2721	0	0.9592
lnagri	1,328	21.9594	2.1258	17.3423	27.7539
urb	1,550	0.5669	0.2589	0.8854	1
lnen	1,110	7.2640	1.1683	4.0830	10.0043
lnind	1,366	23.3077	2.3072	16.9473	29.3463
yr	1,550	0.4194	0.4936	0	1
inc2	1,530	0.3223	0.4675	0	1
inc3	1,530	0.1660	0.3722	0	1
inc4	1,530	0.2503	0.4333	0	1

Source: The authors (2023)

Descriptive statistics table includes 16 variables, among which *ch4, co2*, *n2o*, and *ghg*, *the value-added of agriculture, forestry, and fishery industry (agri), energy use (en)* and *industrial added value (ind)* are variables that possess relatively large standard deviations, causing disproportions in the overall value. Therefore, the authors decided to take the natural logarithm of these variables to gain normal distribution. Looking at the detail, the standard deviations and net levels of dependent variables, consisting of *lnch4, lnn2o*, and *lnghg* lie in the range of around 2 and 11 respectively, while their values for average mean vary widely. Regarding independent and control variables, *trade openness (ope)* shows the largest net value among the variables, with 61.14 and the second largest standard deviation after *co2*. This indicates that trade openness has a widespread dispersion among Asian developing countries. *the net inflows of foreign direct investment (lnfdi), gross domestic product (lngdp), the value-added of agriculture, forestry, and fishery industry (lnagri), energy use (lnen)* and *the value-added of industry (including construction) (ind)* show a considerable disparity in their net values, as well as mean numbers. However, these variables all have comparable standard deviations, ranging from 1.16 of *energy use (lnen)* to 3.0 of *gross domestic product (lngdp)*. Except for *the net inflows of foreign direct investment (lnfdi)*, the four variables *gross domestic product (lngdp), the added value of agriculture, forestry, and fishery industry (lnagri), energy use (lnen)* and *added value of industry (including construction) (lnind)* all have bigger average mean values than *trade openness (ope).*

Among all variables, *lngdp* holds the largest average value of 24.74, while *the net inflows of foreign direct investment (lnfdi)* average value, the only below-zero average value, is the smallest at -3.967. Regarding the standard deviation of the examined variables, *co2* has the highest number of 7.88, and *the urbanization rate (urb)* has the lowest with 0.26. This implies that there is a large

disparity in the carbon dioxide level among developing Asian nations and regions, meanwhile, a subtle urbanization dispersion is witnessed among the research countries.

A model where the independent variables satisfy the condition of being not correlated with each other is an ideal model, denoting that each independent variable carries exclusive and non-repeated information about the dependent variables. To effectively examine the correlation between the dependent variables and independent and control variables in the model, the correlation coefficient matrix of variables in the model will be applied. The results explain that the correlation coefficient between the pairs of explanatory variables in the model is less than 0.8. Therefore, it can be concluded that the two dependent variables are not strongly correlated with each other and that there is no multicollinearity in the model.

Model testing

Several tests have been performed in this study to investigate defects in regression models. Variance Inflation Factor (VIF), Modified Wald test, and Wooldridge test are used to analyze the level of multicollinearity, heteroskedasticity, and autocorrelation of variables in the model.

Before ending up with the GLS model, the study had conducted the F test and Hausman test to opt for the most suitable model among Pooled OLS, FEM, and REM. However, due to the presence of heteroskedasticity and autocorrelation mentioned above, GLS is used for the result discussion of the four models in this study.

Model results measuring the impact of trade liberalization on climate change

This study analyzes the impact of trade liberalization on climate change through the interaction between four dependent variables regardings pollutants and independent variables relating to economics as the table below:

Table 3. Regression results of impacts of trade liberalization on climate change with interaction variables

Variables	Model (1) lnch4	Model (2) co2	Model (3) lnn2o	Model (4) lnghg
int2=inc2*ope	-0.0616	0.2870**	0.0753	-0.0117
	(0.0871)	(0.1160)	(0.0668)	(0.0498)
int3=inc3*ope	-0.3090**	0.4600**	0.0713	-0.1550**
	(0.1200)	(0.2220)	(0.1000)	(0.0778)
ope: Trade openness	-0.00424	0.000860	-0.00316	0.00253
	(0.00954)	(0.00847)	(0.00949)	(0.00328)
lnfdi: Net foreign direct investment inflows	-0.0195**	-0.0183	0.00298	-0.0124**
	(0.0077)	(0.0151)	(0.0061)	(0.0052)

Variables	Model (1) lnch4	Model (2) co2	Model (3) lnn2o	Model (4) lnghg
lngdp: The rate of growth of gross domestic product	0.0202	0.0009	0.0509***	0.0177**
	(0.0133)	(0.0155)	(0.0137)	(0.00720)
rne: Percentage of renewable energy out of total final energy consumption	-1.5660***	3.8180***	-0.7580***	-0.6250***
	(0.2850)	(0.5790)	(0.2930)	(0.1620)
lnagri: Value-added of agriculture, forestry, and fishing	0.5630***	-0.1140***	0.5420***	0.6420***
	(0.0228)	(0.0436)	(0.0221)	(0.0138)
urb: Urbanization rate	-2.176***	1.494**	-1.100***	0.610***
	(0.4320)	(0.7520)	(0.3630)	(0.2130)
lnen: Energy use	0.730***	4.625***	0.261***	0.360***
	(0.0672)	(0.1760)	(0.0623)	(0.0356)
Lnind: Industry (including construction) value added	-0.1310***	-0.1200***	-0.1410***	-0.1270***
	(0.0177)	(0.0364)	(0.0150)	(0.0102)
yr if year>2007, yr=0 otherwise	-0.0451	0.0611	-0.0275	-0.0698***
	(0.0316)	(0.0608)	(0.0256)	(0.0212)
inc2=1 if it is lower middle income country,inc2=0 otherwise	0.0181	-0.1860**	-0.0792	-0.0650
	(0.0609)	(0.0926)	(0.0498)	(0.0432)
inc3=1 if it is upper middle income country,inc3=0 otherwise	0.0401	-0.2560	-0.1610*	-0.1330*
	(0.1040)	(0.1570)	(0.0921)	(0.0693)
inc4=1 if it is high income country,inc4=0 otherwise	-0.3420***	0.7100***	-0.2000**	-0.2450***
	(0.0989)	(0.1970)	(0.0885)	(0.0625)
Constant	-4.5590***	-24.6700***	-4.1120***	-2.8730***
	(0.8070)	(1.7400)	(0.7640)	(0.4650)
Observations	757	762	757	762
Number of ctry1	40	41	40	41

Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Source: The authors (2023)

It can be seen from the table that trade openness (ope) does not have a considerable impact on the emission of methane, carbon dioxide, nitrous oxide, and greenhouse gases. This result is consistent with the study of Ansari *et al*. (2019) indicating that trade openness is statistically insignificant for Iran, the UK, Australia, France, and Spain on *co2* as the increase in *co2* due to higher rates of production resulting from freer trade (scale effect) is compensated by the impacts of changing industrial structure towards environmentally friendly activities (composition effect) and the use of cleaner production processes (technique effect).

Besides, *the net inflows of foreign direct investment (lnfdi)* have a significant negative impact on emissions of *lnch4* and *lnghg* at the significant level of 5%, which is similar to renewable energy consumption at a 1% significant level. The increase in *lnfdi* or *renewable energy consumption (rne)* will lower *ch4* and *lnghg*, holding all other factors unchanged; this finding is similar to Paul *et al.* (2021) that concludes *lnfdi* had a negative impact on *lnch4.* However, renewable energy also has a significant negative impact on *lnn2o* and a positive impact on *co2*, both at the level of 1%. The result of *rne* impact on *lnn2o* is in line with the study of Sinha *et al.* (2019). The result of the positive impact on *co2* is in line with the research of Soylu *et al*. (2021).

In this study, authors create two interaction variables based on trade openness and income groups. The aim is to analyze the difference in the impact of trade openness on *lnch4, co2, lnn2o, and lnghg* in different groups of income levels.

The interaction variable int2, which is calculated by lower-middle income x trade openness, has a positive impact on *co2* at a 5% significance level, which is similar to the impact of variable int3, which is measured by upper-middle income x trade openness. However, this impact in lower-middle-income countries is more than double that in upper-middle-income countries. This is due to the scale effect of trade openness and the fact that at the early stage of development, more attention is paid to growth than the quality of the environment, which is according to Ali *et al*. (2020).

From table 3, we can also conclude that GDP has a significant positive impact on the emissions of nitrous oxide and greenhouse gasses at 1% and 5% significant levels, in turn. This result is the same as the results examined in Higher-income OIC countries by Ali, S. *et al.* (2020). Regardings *the urbanization rate (urb)*, it is significant at the level of 5% for *co2* and 1% for the remaining 3 pollutant emissions. Holding other factors the same, the more the urbanization rate is, the more emissions of carbon dioxide and greenhouse gasses are while there will be fewer methane and nitrous oxide emissions. This is consistent with the study of Li and Haneklaus (2022), saying that a 1% increase in the long term causes a change in urbanization in the form of a 1.27% decrease in *co2* at a 1% significance level.

Energy use, the value-added of agriculture, forestry, and fishery industry (lnagri) and the value-added of industry (including construction) (lnind) all have a significant impact on four pollutant emissions at a 1% significance level. But it is noticeable that *energy use* impacts them positively while *lnind* impacts them all negatively.

It is noticeable that there is a difference in the impact of trade openness on *ch4* and lnghg in lower-middle-income countries and higher-middle-income countries. Whereas the impact is insignificant in lower-middle-income countries, *ope* has a negative impact on the two pollutant emissions at a 5% level of significance. If all other factors are unchanged, an increase of 1% in trade openness leads to a decrease of 0.3090% and 0.1550% for *lnch4* and *lnghg*, respectively.

In addition, the authors has created a variable yr to identify the pattern between emissions of four kinds in the pre-recession period and the post-recession period. From the result, in the post-recession period, greenhouse gasses emissions in Asian countries have been decreasing. This result is similar to the study of Nemati *et al.* (2021) in which greenhouse gasses emissions reduce in the long run under the influence of free trade agreements between developing countries.

4.2 Discussion

As shown in the above results, the authors conclude that the general air quality of Asian developing countries suffers from negative effects when trade liberalization is widely adopted. To clarify the claim above, the authors discovered that: i) Trade activities in Asian countries with different income levels contribute significantly to the increased CO2; ii) Increasing urban population in an area equals the speed of the area's urbanization rate, leading to rising air pollution from construction, factories, and daily transportation; iii) The more people living in urban regions, along with higher overall energy use, the worse the air quality evolves, making allergies and respiratory problems a huge health hazard; iv) The value-added of agriculture, forestry and fishery industry also mitigate emissions intensity and contribute to cutting the greenhouse-gas emissions but this requires technology application, and consent of principles of sustainability; v) Industries and investors still exploit resources in high-income economies, making carbon emission worsened despite environment policies. As trade liberalization continues, high-income countries incline to invest and conduct more economic activities in low-middle and upper-middle-income countries to avoid a solid legal system.

5. Conclusion

The regression results indicate that trade openness does not have a considerable impact on the emission of the above emissions in developing Asian economies surveyed. Both governments and enterprises must implement environmental protection measures in the most effective way. The authors propose the following recommendations:

For the governments of Asian developing economies, policymakers should reduce air pollution by upgrading greener energy use and improving alternative transport systems. Authorities should establish private-public partnerships to provide funding for services such as waste disposal and housing. Trade openness should also undergo careful censorship by authorities, based on a greener and more sustainable approach. Moreover, policies and laws should incorporate the level of tax payment based on the amount of emission their work has produced.

Enterprises should understand and strictly comply with the regulations of the government set forth on emission reduction in business activities. Additionally, they would aim to produce greener and more environmentally friendly products. Corporations' budgets should be partially spent to invest in modern manufacturing technology and equipment so as not to cause high pollution as well as strictly comply with environmental regulations.

Despite the efficiency of the results obtained using the GLS model, the limitation of this study is that the prerequisite variable - trade openness does not show statistical significance in the model. However, further reliable data or some other models can be examined in the future to alleviate these limitations and strengthen the knowledge of the trade liberalization's impact on the environment.

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