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Impact of Green Logistics on International Trade: An Empirical Study in Asia – Pacific Economic Cooperation

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ABSTRACT

Green logistics has been a trend in the world. This research evaluates the impact of green logistics on international trade among APEC nations over the period of 9 years (2010-2018). The research uses an augmented gravity m€€odel to investigate the effects of green logistics on international trade through the environmental logistics performance index (ELPI). The results show that exporting countries applying green logistics increase the export volume to other members of APEC. In the long term, importing countries engaging in green logistics increase trade volume with green logistics countries in APEC. With the aim of enhancing international trade, APEC countries must improve domestic logistics performance. Through those analyses, research proposes several recommendations to encourage nations and enterprises to apply green logistics effectively.

Keywords: APEC, FGLS, Green Logistics, International Trade
JEL Classifications: F13, F18, L98

1. INTRODUCTION

Logistics has been being developed, which plays an essential role in the economic development of many countries, including international trade competitiveness (Bensassi et al., 2015). However, the logistics industry consumes a large number of energy resources and generates high carbon emissions. The estimated level of CO2 from the logistics accounts for 13% of total global emissions (World Economic Forum, 2016), causing negative impacts on the environment and society. Therefore, applying green logistics is the solution to solve these problems.

As a global forum, however, APEC's greenhouse gas emissions account for 60% of the world. Not only that, 6/10 of the world's largest GHG-emitting economies were APEC members (APEC Policy Support Unit, 2021). To achieve the goal at COP 26, APEC needs to make a lot of effort including applying green logistics, solving the APEC's emissions problem. Therefore, it is necessary to research and make assessment of green logistics' impacts on international trade within APEC.

The research uses the quantitative research method by ordinary least squares regression (Pooled OLS), fixed-effects model (FEM), random-effects model (REM), and feasible generalized least squares (FGLS). From that, the research proposes recommendations for governments and enterprises to apply green logistics effectively.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1. Literature Review

The studies on logistics have been being conducted primarily from a macro viewpoint to improve the business environment for the global supply chain and from a micro to evaluate the impact of green regulations on the region, industry, or business.

It has been suggested that logistics has a wide-ranging impact on trade. Bilateral trade is connected to logistics performance index (LPI). Efficient logistics services minimize the effect of geographical distance but do not completely eliminate it (Arvis et al., 2007). GDP and geographical distance between two nations are followed by LPI which has a significant influence on trade, mainly of the exporting country (Puertas et al., 2014). Using data from 112 countries and Hong Kong from 2007 to 2014, Wang et al. (2018) discovered that the export and import country LPI is positively correlated with trade; green logistics in exporting countries is positively correlated with export volume; green logistics in importing countries has an negative relationship with export volume.

Green logistics and economic development are inextricably linked to each other (Arvis et al., 2007; Marti et al., 2014; Bensassi et al., 2015; Aldakhil et al., 2018). The environmental issues generated by logistics drive governments to impose additional rules on the exchange of products. The selling commodities to foreign nations are certain to deal with regulatory isssues (Ojala and Elebi, 2015; Omar and Zallom 2016; das Chagas et al., 2018). The "non-green" logistics system limits the chances for products exported and customs cleared (Werikhe and Jin, 2016). Green logistics solutions alleviate social problems and have a favorable association with economic indicators and environmental sustainability (Khan and Qianli, 2017; Wang et al., 2018; Nassani et al., 2017). The increase in emissions leads to the increase in volume of commodities and logistical services exchanged (Zaman and Shamsuddin, 2017).

In Vietnam, there have not been many studies on green logistics. Most of them use qualitative methods and have not been in-depth in relation between green logistics and international trade. Five groups of factors affect logistics development in Vietnam, including legal framework, and administrative procedures; human resources; infrastructure; logistics enterprises; technology, and commodity exchanged (Nga, 2021). Vietnam has its own potential to develop green logistics and become a regional logistics center, but there are several limitations such as small business size, shortage of capital, lack of high-quality human resources; weak retail supply services; poor infrastructure conditions; (Bac, 2015). Green logistics development is an inevitable trend; and modern information technology system has a significant contribution to logistics and the level of logistics greening (Anh, 2020).

Green logistics studies are numerous in general, but they all focus on examining the correlation between logistics and environmental sustainability, as well as logistics and per capita income or FDI. They are constrained by a group of physically proximate nations such as the south Asian association of regional cooperation (SAARC) and the European union (EU), notwithstanding international trade expansion, which provides an opportunity for research to inherit the scientific value of such efforts while also broadening the scope to include APEC nations.

2.2. Theoretical Framework

2.2.1. Logistics and green logistics

"Logistics is understood as a network of services that support the physical movement of goods, trade across borders, and commerce within borders. It comprises an array of activities beyond transportation, including warehousing, brokerage, express delivery, terminal operations, and related data and information management" (World Bank, 2018).

Logistics plays an important role in trade which reduces transportation costs and stimulates growth (Bugarčić et al., 2020). The combination of logistics and economic liberalization increase the trade volume (Hausman et al., 2013). Logistics has a positive effect on economies of scale, production and growth (D'Aleo and Sergi, 2017).

Green logistics is environmental-friendly, including greening of various processes in logistics such as transportation, warehousing, distribution, waste treatment and green recycling (Wu and Dunn, 1995). It strictly adheres to green consumption and production standards, to a greater extent the national capacity index for environmental protection. The purpose of green logistics is to achieve a sustainable balance among economic, environmental and social benefits (Dekker et al., 2012).

Green logistics is an important and ideal policy choice to promote global sustainability by assessing the environmental impact of logistics on sustainability (Chunguang et al., 2008). Better green logistics efficiency reduces transaction costs and eliminates inefficiencies in traditional shipping and handling operations.

2.2.2. International trade and APEC

International trade is a trade of goods and services in which the exchange takes place between entities from foreign countries (Đurović et al., 2010, as cited in Grozdanovska et al., 2017). The four major areas of international trade are goods, services, investment, and intellectual property rights. It plays an important role in the development and the growth of the world economy. In international specialization and division of labor, countries can make efficient use of the resources derived from international trade. International trade increases production capacity and stimulates consumption, technology transfer, and investment, which supports growth.

APEC is an economic cooperation forum between countries in the Asia-Pacific region to strengthen economic and political ties (Canada and the Asia-Pacific Economic Cooperation (APEC), 2021). Established in November 1989, APEC has 21 members, including Australia, Indonesia, Malaysia, South Korea, Thailand, Brunei Darussalam, United States, Japan, Singapore, New Zealand, Canada, Philippines, China, Peru, Hong Kong, Taiwan

(ROC), Mexico, Chile, Papua New Guinea, Russia and Vietnam. According to the APEC in Chart 2021 report, APEC accounts for 38% of the global population (in 2020), 62% of global GDP, and 48% of total trade in goods and services (in 2020). The top six economies in the region include: The United States, China, Japan, Canada, Russia, and South Korea.

3. METHODOLOGY

3.1. Research Model and Hypothesis

3.1.1. Gravity model

Tinbergen (1962) firstly introduced a gravity model with three variables affecting trade between any two economies as follows:

1. The export turnover of a country is determined by its economic size (its GDP)
2. The turnover sold to a specific country varies with the size of that country's market (GDP of the importing country)
3. The trade turnover is affected by transportation costs (corresponding to the geographical distance between the two countries).

The equation is written as follows:

$$EXP_{ei} = \alpha_0 GDP_e^{\alpha 1} GDP_i^{\alpha 2} D_{ei}^{\alpha 3} \ (*)$$

in which EXP_{ei} is the export turnover from the exporting country to the importing country. GDP_e and GDP_i are the GDP of the exporting and importing country, respectively. D_{ei} is the geographical distance between 2 countries. α_0 is a constant and α_1 α_2 α_3 are the parameters.

The linear form of the equation (*) is as follows:

$$lnEXP_{ei} = \alpha_0 + \alpha_1 \, lnGDP_e + \alpha_2 lnGDP_i + \alpha_3 ln\, D_{ei} + \varepsilon$$

With ε is the random error.

3.1.2. Proposed research model

Developed from the gravity model, two regression models evaluating the impact of LPI and green logistics on trade, the details of each variable are explained in Table 1:

$$lnEXP = \beta_0 + \beta_1 lnGDP_e + \beta_2 lnGDP_i + \beta_3 POP_e + \beta_4 POP_i + \beta_5 D + \beta_6 lnLPI_e + \beta_7 lnLPI_i + \beta_8 lnRQ_i + \beta_9 PS_i + \beta_{10} BOR + \beta_{11} LANG + \varepsilon \quad (1)$$

$$lnEXP = \beta_0 + \beta_1 lnGDP_e + \beta_2 lnGDP_i + \beta_3 POP_e + \beta_4 POP_i + \beta_5 D + \beta_6 lnELPI_e + \beta_7 lnELPI_i + \beta_8 lnRQ_i + \beta_9 PS_i + \beta_{10} BOR + \beta_{11} LANG + \varepsilon \quad (2)$$

Regardless of restricted data sources for developing a unified index of measuring the implementation for green logistics, some research employs LPI and environmental indicators such as Kim and Min (2011) who developed the green logistics index (GLPI) based on the ratio of LPI to EPI. Hardly could ratios reflect the efficiency of inputs (total logistical efficiency) and outputs (total environmental performance) (Lu et al., 2019).

Therefore, the research incorporates the ELPI environmental logistics performance index into "eco-efficiency" (Dahlström and Ekins, 2005) as a measure of logistics efficiency and environmental performance. This is an effective scale for evaluating logistics' sustainability and environmental friendliness (Khan et al., 2016). Eco-efficiency is stated mathematically (Verfaillie, 2000):

$$\text{Eco} - \text{efficiency} = \frac{\text{Product or service value}}{\text{Environmental influence}}$$

As a result, ELPI is represented in the equation:

$$\text{ELPI} = \frac{\text{Logistics performance}}{\text{Environmental impacts}}$$

LPI indicates logistics efficiency while the logistics CO2 emission index (LCC) shows the negative impact of logistics on the environment, so the ELPI equation has been revised as follows:

$$\text{ELPI} = \frac{\text{LPI}}{\text{LCC}}$$

Transportation accounts for 80-90% of logistics carbon emissions (McKinnon, 2010). For this reason, the study uses CO2 emissions from transportation with secondary data source from Our World in Data as representative of LCC. Because of economic development discrepancies across nations, it is inappropriate to describe logistics' environmental performance by using LCC alone (Lu et al., 2019). Hence, LCC per unit of GDP has been applied to investigate CO2 emission intensity in logistics:

$$\text{Logistics } CO_2 \text{ intensity } (\text{LCI}) = \frac{\text{LCC}}{\text{GDP}}$$

In consumption:

$$\text{ELPI} = \frac{\text{LPI}}{\text{LCI}}$$

3.1.3. Hypothesis

There is widespread consensus among researches that LPI and its components have a positive and significant impact on trade flows across all regions (Marti et al., 2014; Uca et al., 2016; Bugarčić et al., 2020). The logistics performance index is positively correlated with export orientation (exports as a percentage of GDP) (Chakraborty and Mukherjee, 2016), while the quality of logistics infrastructure significantly affects regional export flows (Bensassi et al., 2015). Wang et al. (2018) conclude that the LPI of importing and exporting countries is positively correlated with international trade, in which, the impact of LPI on the international trade of exporting countries is bigger than that for importing countries. Hence, this research hypothesize the following:

H_1: Logistics performance of exporting and importing countries has a positive impact on international trade.

Companies from different sectors must comply with environmental regulations to remain competitive (Zhang and Xu, 2016). Under pressure from environmental regulations, customers, other stakeholders and internal management, exporters must comply with green logistics practices such as:

Green purchasing, green transportation, green packaging, etc. achieve ISO14000 certification and reverse logistics, reduce their environmental impact and promote their economic, operational, environmental and social performance. By practicing green logistics, exporters better comply with the environmental regulations of the importing country to enhance their competitiveness (building a positive image domestically and internationally to have more export opportunities, increase market share, seek new markets) and lead to an increase in export volume (Lai and Wong 2012; Ueasangkomsate and Suthiwartnarueput 2018). Hence, this research hypothesize the following:
H_2: The green logistics level of the exporting country has a positive impact on the export volume.

Many studies have shown the relationship between trade and the environment. However, empirical literature on the relationship between the environmental regulation of importing countries and international trade is relatively scarce (De Santis, 2012). Van Beers and Van Den Bergh (1997) based on data of The organization for economic cooperation and development (OECD), concluding that the stringent environmental regulations of importing countries have a number of effects negative impact on other countries' exports. Similarly, Wang et al. (2018) based their study on data of 112 developed and developing countries plus Hong Kong, indicate that there is a negative relationship between the level of green logistics of the importing country and the export volume of the exporting country. A possible reason for this result is that environmental regulations of the importing countries, such as the end of life vehicles (ELV) or restriction of hazardous substances (RoHS), form trade barriers to green trade, which raises the technological threshold and results in reduced export volumes for foreign exporters. Hence, this research hypothesize the following:
H_3: The level of green logistics of the importing country has a negative impact on export volume of the exporting country.

3.2. Data Processing

The study uses green logistics and international trade data for 19 APEC countries from 2010 to 2018, excluding Hong Kong and Taiwan (ROC), since international trade data of these territories is not published. Research data is obtained from some reliable sources, mainly from the United Nations (UN), the World Bank (WB), and Centre d' Etudes Prospectives et d' Informations Internationals (CEPII).

In Table 2, the model's variables fluctuate considerably when a big disparity witnessed between the maximum and minimum values, notably for export volume and GDP. Apart from LPI, all variables have standard deviations greater than the mean.

In Table 3, regarding the relationship between the independent variables, all coefficients have absolute values <0.8. The highest correlation coefficient is observed between lnGDPi and lnPOPi at 0.7607. The variance inflation factor (VIF) of most variables is <10 excluding the VIF coefficient of POPe at 13.95. However, the mean VIF of the variables is 5.32 <10, which illustrates a low multicollinearity in research data.

4. RESULTS AND DISCUSSTION

4.1. Results of Estimating and Hypothesis Testing

To analyze panel data, some models such as Pooled OLS model, FEM or REM are taken into consideration. This research uses the Breusch-Pagan LM test to select the relevance between Pool OLS and REM. The Breusch-Pagan test results show prob> chibar2 <0.05, consequently, the REM model is more suitable than Pool OLS.

Then, the Hausman test is run to choose between the FEM and REM, based on the evaluation of the correlation between the error and the independent variable. Hausman test results, Prob>chi2 is <0.05, FEM model results are better than REM. After the Breusch-Pagan test and Hausman test, the results from the FEM fixed-effects model are selected.

After that, technical inspections detect the model's defects. Heteroskedasticity affects the bias of a linear model. However, due to a variety of economic factors, time series data can have heteroskedasticity. In addition, autocorrelation occurs if the random errors correlated with each other across time, which does not affect the bias and stability of the linear model. However, autocorrelation is related to the variance of the estimated coefficients; therefore, detecting heteroskedasticity and autocorrelation is important to implement corrections and ensure the statistical significance of the model.

The heteroskedasticity was detected when the Wald test is taken. With Prob>chi2 <0.05, the model has heteroskedasticity. Wooldridge test detects autocorrelation in the model. With Prob>F >0.05, the model does not appear autocorrelation. After the Wald test and Wooldridge test, the model has heteroskedasticity and is overcomed by the FGLS method. In essence, FGLS uses equivalent transformations to bring about a new model which the random error in the model has homoscedasticity, then uses the OLS method to estimate the new model.

In the FGLS estimation results for the Model 1, only the effect of the LPI on the export volume of the exporting country. The effects of the remaining variables are studied in Model 2.

In Table 4, the coefficients of two variables lnLPIe and lnLPIi are both positive, showing that the LPI of the two exporting and importing countries have a positive impact on international trade between these two, the conclusion is significant at 1% level. It is consistent with the study of Behar and Manner (2008), Marti et al. (2014), Bensassi et al. (2015), Chakraborty and Mukherjee (2016), Uca et al. (2016), Wang et al. (2018). The LPI of the exporting country will impose greater impacts on the export volume. However, the difference in the coefficients of two LPI variables in the model is not significant. H1 is accepted.

In Model 2, the model selection and technical testing are taken similarly to Model 1. In Table 5, the results from two tests Breusch-Pagan LM and Hausman reveal that the FEM model is suitable. The results from two tests Wald and Wooldridge express that the model has heteroskedasticity defect, and the FGLS estimation method is used to surmount this defect.

Table 1: Data sources and expected side of variables

Variable	Expected side	Source
Export volume		
LnEXP		UN Comtrade Database
Gross domestic product		
$lnGDP_e$	+	The World Development Indicators (WB)
$lnGDP_i$	+	
Population		
$lnPOP_e$	+	
$lnPOP_i$	+	
Regulatory quality		
RQ_i	+	
Political stability		
PS_i	+	
Logistics performance index		
$lnLPI_e$	+	Logistics Performance Index (WB)
$lnLPI_i$	+	
Enviromental logistics performance index		
$lnELPI_e$	+	Synthesis of the research team
$lnELPI_i$	+	
Distance		
lnD	−	GeoDist database (Mayer and Zignago, 2011) (CEPII)
Common border		
BOR	+	
Common language		
LANG	+	

Source: Synthesis of the authors. *e* stands for exporting country; *i* stands for importing country,

Table 2: Descriptive data statistics

Variable	Obs	Mean	SD	Min	Max
EXP	2.699	1.51e+10	4.37e+10	1	4.80e+11
GDP_e	2.699	2.50e+12	1.14e+10	1.14e+10	2.06e+13
GDP_i	2.699	2.39e+12	4.43e+12	1.14e+10	2.06e+13
POP_e	2.699	1.60e+08	3.11e+08	414.914	1.40e+09
POP_i	2.699	1.54e+08	3.05e+08	414.914	1.40e+09
LPIe	2.699	3.39	0.44	2.57	4.14
LPI_i	2.699	3.34	0.47	2.17	4.14
$ELPI_e$	2.699	44,954.92	39,110.34	11,044.67	217,330.40
$ELPI_i$	2.699	44,264.64	38,339.77	11,044.67	217,330.40
RQ_i	2.699	0.76	0.86	−0.67	2.26
PS_i	2.699	0.12	0.86	−1.65	1.61567
D	2.699	9190.27	5532.75	315.54	19711.86
Bor	2.699	0.06	0.24	0	1
Lang	2.699	0.16	0.37	0	1

Source: Authors' calculation

In Table 6, the environmental logistics efficiency of an exporting country has a positive effect on that country's export volume, which is significant at the 1% level. Specifically, the coefficient lnELPIe is 0.6519, when the ELPI index of the exporting country increases by 1%, the export volume of that country's goods increases by 0.65%, other factors being held constant. This conclusion is relevant to previous studies (Khan and Qianli, 2017; Wang et al., 2018; Lu et al., 2019). The above conclusion comes from the fact that exporting countries have proactively changed to meet the green logistics regulations issued by the importing country, thereby helping to increase export output in both quantity and quality. H2 is accepted.

The coefficient lnELPIi is 0.4821 opposite the expected side affecting the export volume in Model 2. When the ELPI of the importing country increases by 1%, the export volume of goods of the exporting country increases by 0.48%, ceteris paribus. The rationale is strict environmental protection regulations enacted by developed countries in the early stages. In the short term, the lack of ability to meet environmental regulations among enterprises in developing country leads to trade volume downturn. In the long term, if exporters adapted to environmental regulations and comprehensively apply green logistics standards, they would significantly benefit from improved environmental quality, enhance international competitiveness, and create new comparative advantage which can offset short-term losses in the end (Porter and Van der Linde, 1995). H3 is rejected.

The size of an exporting and importing country's economy both positively affects the volume of trade between the two countries, which is significant at 1% is relevant to the conclusion in the gravity model. The GDP coefficient of the importing country is higher than that of the exporting country, which means that the quantity of demand has more impact on the trade flow between the two countries.

In geographical terms, the negative coefficient of distance variable suggests that the distance between two countries poses a negative effect on trade. This conclusion is significant at 1%. Two countries with a common border positively affect the volume of trade between them, which is significant at 1%. Demographic factors such as population and common language have a positive effect on international trade, which is significant at the 1% level. This conclusion is relevant to the study of Puertas et al. (2014); Wang et al. (2018).

Table 3: Correlation matrix

	lnEXP	$lnGDP_e$	$lnGDP_i$	$lnPOP_e$	$lnPOP_i$	lnD	$lnELPI_e$	$lnELPI_i$	RQ_i	PS_i	Bor	Lang
lnEXP	1.0000											
$lnGDP_e$	0.4538	1.0000										
$lnGDP_i$	0.5380	−0.0492	1.0000									
$lnPOP_e$	0.3615	0.7530	−0.0343	1.0000								
$lnPOP_i$	0.4296	−0.0403	0.7607	−0.0513	1.0000							
lnD	−0.3862	0.0580	0.0517	−0.0160	−0.0182	1.0000						
$lnELPI_e$	0.2418	0.2220	−0.0070	−0.2630	0.0179	−0.0690	1.0000					
$lnELPI_i$	0.2207	−0.0063	0.2276	0.0199	−0.2401	−0.0611	−0.0469	1.0000				
RQi	0.0373	0.0338	−0.0052	−0.5742	0.0294	0.1125	0.6911	−0.0414	1.0000			
PS_i	0.0502	−0.0002	0.0431	0.0275	−0.5119	0.0317	−0.0384	0.6500	−0.0448	1.0000		
Bor	0.2198	0.0270	0.0236	0.0599	0.0484	−0.4334	−0.0637	−0.0555	−0.0569	−0.0349	1.0000	
Lang	0.0771	0.0057	−0.0511	−0.1404	−0.1527	−0.1050	0.2023	0.1727	0.2728	0.1479	0.1585	1.0000

Source: Authors' calculation

Table 4: Technical inspections and model selection – Model 1

Variable	Pool OLS	FEM	REM	FGLS
$lnGDP_e$	0.2104***	0.7434***	0.6190***	0.4000***
$lnGDP_i$	0.4474***	0.4732***	0.6138***	0.4831***
lnPOPe	0.6150***	−1.1263**	0.2927***	0.3981***
$lnPOP_i$	0.3707***	−0.0990	0.2913***	0.3267***
lnD	−1.1548***		−1.4073***	−1.1887***
$lnLPI_e$	5.8238***	0.2574	0.8049***	4.7400***
$lnLPI_i$	5.0417***	0.3569*	0.9936***	4.6905***
RQ_i	0.2513***	−0.1013	0.0505	0.0571***
PS_i	−0.0517	−0.0500	−0.0752	−0.0557***
Bor	0.3423***		−0.1003	0.3038***
Lang	0.2515***		0.7848***	0.2777***
Const	−22.7964***	9.1925	−12.7161***	−16.5628***
R-square	0.7930	0.0353	0.7253	
Obs	2.699	2.699	2.699	2.699

	P-value
Breusch-Pagan LM test	0.000
Hausman test	0.000
Wald test	0.000
Wooldridge	0.1964

Source: Authors' calculation. *P<0.1; **P<0.05; ***P<0.01

Table 5: Technical inspections and model selection – Model 2

Variable	Pool OLS	FEM	REM	FGLS
$lnGDP_e$	0.1179**	0.7720***	0.4785***	0.2592***
$lnGDP_i$	0.6206***	0.3696***	0.5138***	0.6088***
$lnPOP_e$	0.8903***	−1.1976**	0.4154***	0.6955***
$lnPOP_i$	0.3796***	0.1198	0.4022***	0.3563***
lnD	−1.2801***		−1.3516***	-1.2912***
$lnELPI_e$	0.6544***	–0.0325	0.2921***	0.6519***
$lnELPI_i$	0.4882***	0.1592	0.2214**	0.4821***
RQ_i	0.8747***	–0.0850	0.0483	0.5866***
PS_i	0.2890***	–0.0410	–0.0400	0.2599***
Bor	0.2749**		–0.0060	0.1680***
Lang	0.1442*		0.8296***	0.1719***
Const	–22.7964***	8.0197	–14.0312***	–21.9962***
R-square	0.7603	0.0350	0.7038	
Obs	2.699	2.699	2.699	2.699

	P-value
Breusch-Pagan LM test	0.000
Hausman test	0.000
Wald test	0.000
Wooldridge	0.1927

Source: Authors' calculation. *P<0.1; **P<0.05; ***P<0.01

Table 6: Result of hypothesis testing

Hypothesis		Result
H_1	Logistics performance of exporting and importing countries has a positive impact on international trade	Accepted
H_2	The green logistics level of the exporting country has a positive impact on the export volume	Accepted
H_3	The level of green logistics of the importing country has a negative impact on export volume of the exporting country	Rejected

Source: Authors' calculation

The regulatory quality of the importing country has a positive effect on the export volume of the exporting country, which is significant at the 1% level. Consequently, a change in a government's ability to formulate and implement policy has a significant impact on a country's export. This conclusion is similar to Anderson and Marcouiller (2002) who argued that a strong institution with a complete legal system for commercial contracts enforcement, fair laws and economic policies adopted by the government makes a great contribution to commercial development.

Table 7: Classified countries by GNI/capita

Group	GNI/capita	Countries
High-income countries	≥$12,055	Australia, Brunei Darussalam, Canada, Chile, Japan, New Zealand, Singapore, South Korea, United States
Middle-income countries	$996–$12,055	China, Indonesia, Malaysia, Mexico, Papua New Guinea, Peru, Philippines, Russia, Thailand, Vietnam

Source: Authors' computation based on World Bank

Political stability has a positive effect on export volume, which is significant at 1%. Govindan et al. (2014), said that political instability was an obstacle for exporting countries due to a lack of support from the host country. This result is contrary to the conclusion of Wang et al. (2018) who found a negative relationship between the level of political stability of the importing country and the probability of exporting.

4.2. Green Logistics Impact on International Trade between Group Countries

To further investigate the relationship between green logistics and trade flows of economies at disparate economic development levels, the research classified the countries in the sample into two groups (Table 7): 9 high-income countries and 10 middle-income ones, based on the threshold GNI/capita (value of income per capita in current USD exchange rate) updated by the World Bank on July 1, 2018.

In Table 8, the research estimated equation (2) with four samples: MIC-MIC (Sample 1), MIC-HIC (Sample 2), HIC-MIC (Sample 3), HIC-HIC (Sample 4) to find out whether there is a difference among the variables in the model.

For exporting countries, the regression coefficient of ELPI in four samples is positive and statistically significant, green logistics in exporting country is positively correlated with export. The higher the green logistics efficiency of the exporting country, the greater the export probability and export volume. It is consistent with the estimated results for the entire sample of 19 countries. In particular, in sample 4, the coefficient lnELPIe is 0.7452, recording a rather large influence of green logistics efficiency on export output between the two high-income countries.

For importing countries, the regression coefficients of ELPI in four samples are different, only statistically significant in sample 1 and sample 4. In sample 4, this coefficient has a positive value (consistent with the estimated results for the entire sample of 19 countries). However, in sample 1, this coefficient has a negative value meaning that the green logistics efficiency of the importing country has a negative impact on the export output of the exporting country, between the two middle-income countries.

Table 8: FGLS estimation results for four samples

Variable	MIC-MIC (Sample 1)	MIC-HIC (Sample 2)	HIC-MIC (Sample 3)	HIC-HIC (Sample 4)
$lnELPI_e$	0.3006*** (4.12)	0.3479*** (4.36)	0.4215*** (6.08)	0.7452*** (17.49)
$lnELPI_i$	–0.2618*** (–4.99)	–0.0579 (–1.01)	0.0607 (0.76)	0.8526*** (23.47)

Source: Authors' calculation. *P<0,1, **P<0,05, ***P<0,01

The reason may originate from increasingly strict requirements for environmental regulations set by importing countries, so middle-income countries have to spend much more money on waste treatment, construction investment costs and infrastructure improvement to comply with that. In general, the initial adoption of green practices requires heavy investment leading to huge fixed costs in the end-to-end supply chain system, and has a negative impact on the firm's financial performance in the short term (Khan et al., 2019). For middle-income countries, high compliance costs are challenging for exporters to catch up; therefore, green logistics becomes a trade barrier between two countries in the group of middle-income countries.

5. CONCLUSIONS AND POLICY IMPLICATIONS

The study evaluates the impact of green logistics on international trade through the augmented gravity model, the FGLS technique, and the ELPI index. The study guides countries with different levels of development to regulate green logistics and promotes enterprises to implement the green logistics process.

The estimated model results show that: Logistics efficiency of exporting and importing countries is positively correlated with trade, green logistics of exporting countries is positively related to export volume, and green logistics of importing countries is positively related to export volume of the exporting country.

The comparison of the green logistics' impacts on trade between groups of countries with varying levels of economic development on GNI per capita demonstrates that green logistics in exporting countries is positively correlated with export volume across all groups of countries, particularly trade between two high-income countries. In contrast, the effectiveness of green logistics in the importing nation has a negative impact on the export production of the exporting country between the two middle-income countries.

The research proposes APEC governments policies to improve the efficiency of logistics activities, such as improving logistics infrastructure and ensuring system uniformity; strengthening communication to raise awareness of green logistics by programs or campaign; encouraging the use of modern information technology; encouraging enterprises to exchange, learn, and cooperate at home and abroad; strengthening education and training of appropriate human resources, developing appropriate training programs about green logistics; building a set of criteria for green logistics for countries to establish appropriate policies.

In addition, there is a room for governments' measures to protect the environment through green logistics. In the short term, it is needed for the government to build up a green logistics environment by encouraging and supporting enterprises to implement green logistics, increasing the use of green renewable fuels, establishing a market for green logistics and industry. In the medium term, it is necessary to issue specific standards and regulations on carbon emissions; create legal requirements for green logistics; create a domestic market for green fuel resources. In the long term, the consideration of imposing high import tax, environmental tax or penalties on businesses utilizing harmful materials should be taken into.

Enterprises should use means of transport with lower emissions such as clean energy, water transport or use green packaging that is recyclable, biodegradable, and creates green supply chain to maintain and promote domestic and global competitiveness. Enterprises should update information technology to manage system data effectively, improve logistics quality, and save time in the transportation and delivery duration. The community of traditional logistics enterprises need to convert to the new version of green logistics. Import-export enterprises ought to build a reverse logistics system to satisfy consumers' demand and promote sustainable development, improve competitiveness and scale up import and export turnover.

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