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Article

The impact of green logistics on the trade balance between Vietnam and ASEAN countries

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Abstract: This article investigates how green logistics influences Vietnam's trade balance with Association of Southeast Asian Nations (ASEAN) countries. By using the gravity model, the article applies fixed effects (FEM) and random effects (REM) to analyze panel data on trade balance, GDP, population, trade openness, and the green logistics index of Vietnam with ASEAN countries from 2012 to 2018. The research findings indicate that green logistics has not significantly affected Vietnam's export trade balance with ASEAN countries. The article suggests solutions for the Vietnamese government and export businesses to enhance Vietnam's trade balance with ASEAN countries by integrating green logistics activities. By following these recommendations, Vietnam can ensure that international trade aligns with environmental conservation, laying the groundwork for sustainable and inclusive economic development in Vietnam.

Keywords: green logistics; ASEAN; trade balance; gravity model; green logistics performance index

1. Introduce

Green development is not just a passing trend but an urgent and essential factor in today's global business landscape. Building a green supply chain is crucial within the sustainable development strategy and the shift to a greener economy. Integrating environmental considerations into the supply chain is part of an overall green investment strategy for businesses, helping them make efficient use of natural resources, become more environmentally friendly, and enhance their competitiveness and business efficiency. Creating a green supply chain involves several stages, with green logistics being a key component. To establish a green supply chain, businesses begin by sourcing and partnering with environmentally conscious raw material suppliers and implementing green designs and eco-friendly production practices, such as utilizing clean energy, energy-saving production methods, and waste recycling. They also incorporate green packaging and innovation in their processes. Additionally, progress in warehouse management and operations is essential to furthering green initiatives. Subsequently, green logistics comes into play as businesses develop and implement environmentally friendly transportation systems to deliver green products to consumers.

Maintaining a balanced trade balance is a crucial aspect of every country's sustainable economic development strategy. It is also essential to promote a green economy. The trade balance plays a significant role in a country's economic development and international relations. Most importantly, it generates income and job opportunities, fosters economic growth, and improves people's quality of life.

As a part of Vietnam's sustainable development strategy, promoting green

logistics and improving the balance of payments are key objectives. In recent years, Association of Southeast Asian Nations (ASEAN) has emerged as Vietnam's second-largest trading partner, with an average growth rate of 14.5% per year over the past decade. This partnership has played a crucial role in sustaining Vietnam's economic growth. ASEAN stands as the third largest export market for Vietnamese businesses, following the US market and the European Union (EU) member countries. Additionally, ASEAN ranks as Vietnam's second-largest trading partner, serving as a significant source of goods for Vietnamese businesses, trailing only behind China. Despite these positive aspects, Vietnam's trade balance of goods with ASEAN consistently remains in a deficit state. Notably, the deficit level has seen a sharp increase following Vietnam's accession to the WTO and the implementation of the ASEAN Trade in Goods Agreement (ATIGA).

What steps does Vietnam need to take to promote green logistics, improve the national trade balance, and minimize the trade balance deficit with ASEAN countries? How can Vietnam work towards sustainable economic development? This article will analyze the impact of green logistics development on the trade balance between Vietnam and ASEAN countries. It aims to highlight the role of green logistics in international trade specifically with ASEAN countries. Based on this analysis, the article will also suggest policies for Vietnam to enhance its trade balance with ASEAN countries and transition towards a more environmentally friendly approach in its logistics operations.

2. Theoretical basis

The terms "green logistics" or similar terms such as "sustainable logistics", and "sustainable green logistics" ... were first mentioned in the 1980s. Since then, many organizations and researchers have proposed different concepts of green logistics from many various approaches. Green logistics emphasizes efforts and measures to minimize the negative impacts of logistics activities, thereby achieving a sustainable balance between economic, social, and environmental goals (Sbihi and Eglese, 2010). Green logistics is a model that aims to reduce carbon emissions and minimize negative environmental impacts in the logistics field by utilizing green technologies and eco-friendly solutions in transportation, packaging, recycling, and storage activities. In Vietnam, the concept of green logistics is still relatively new, so there is currently no unified and clear understanding. According to the opinion of the Editorial Board of the Vietnam Logistics Report of the Ministry of Industry and Trade in 2022, the views on green logistics are as follows: green logistics is a logistics activity aimed at sustainable, friendly, and environmental protection goals, minimizing negative impacts on the environment. Accordingly, the green logistics development framework governs all three economic, social, and environmental goals simultaneously. These three goals are not exclusive, but on the contrary, they reinforce each other. All efforts of green logistics focus on contributing to and ensuring sustainable development.

With increasing regional economic integration, international trade is becoming more and more competitive. Therefore, logistics as an important link in trade become increasingly important (Ahmadi and Taghizadeh, 2019; Tan and Wang, 2020). Green

logistics is to solve the "green barriers" of international trade and achieve sustainable trade development (Ren and Huang, 2015). Li et al. (2021) also demonstrated the importance of green logistics in enhancing green economic activities in countries.

In Wang et al.'s (2018) study, the authors examine the connection between green logistics and international trade. They use Heckman's two-stage procedure to estimate an augmented gravity model, incorporating green logistics variables, with data from 113 countries and regions spanning from 2007 to 2014. The study shows that the green logistics performance of exporting countries has a positive impact on both export probability and volume when considering the entire sample. However, for trade flows between different country groupings (developing-developing, developed-developed, developed-developing), the green logistics performance of importing countries negatively affects the export volume of exporting countries. Specifically, in the case of trade flow between developing and developed countries, the green logistics performance of importing countries has a negative impact on export probability but a positive impact on export volume.

In a study by Fan et al. (2022), the authors use the logistics performance index proposed by the World Bank to create a green logistics performance index and analyze how it affects China's export trade with Regional Comprehensive Economic Partnership (RCEP) countries. The study shows that the green logistics performance of RCEP countries significantly promotes China's export trade with those countries. The research also finds that different measures to improve green logistics performance have varying impacts on China's export trade. Regression results reveal that the green logistics performance index has a significant and positive impact on export trade with RCEP countries, with a coefficient value of 2.887 at a 1% level of significance. The components of the green logistics performance index also positively and significantly influence export trade, although carbon emissions and nitrogen emissions have negative impacts.

Le et al. (2022) utilized an augmented gravity model to examine the impact of green logistics on international trade using the Environmental Logistics Performance Index (ELPI). The findings indicate that exporting countries implementing green logistics experience an increase in export volume to other members of Asia-Pacific Economic Cooperation (APEC). Importing countries that adopt green logistics experience a long-term increase in trade volume with green logistics countries in APEC.

Tran (2024) examined how green logistics impact Vietnam's regional trade within the frameworks of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), Regional Comprehensive Economic Partnership (RCEP), Association of Southeast Asian Nations (ASEAN), and Asia-Pacific Economic Cooperation (APEC) from 2007 to 2020. The study used a newly created Green Logistics Performance Index (GLPI) based on Principal Component Analysis (PCA) to evaluate how sustainable logistics practices influence trade performance. An extended gravity model was used to analyze the effect of green logistics across different regional trade agreements. The research found that improved green logistics were associated with enhanced trade outcomes, demonstrating the dual benefits of sustainability efforts in both the environmental and economic aspects. This study fills a gap in empirical research on the relationship between green logistics and trade

in Vietnam and offers a methodological approach for future analyses in this field.

In summary, the literature on logistics performance research on the impact of international trade is rich. However, in research methods, domestic and foreign scholars mainly use the Logistics Performance Index (LPI) to measure logistics performance, ignoring the current "greening" requirement in each country's economic development. In this study, inheriting the research results of Fan et al. (2022), we will evaluate the impact of green logistics through the GLPI index on the trade balance of Vietnam-ASEAN to partly fill the gaps in research on the effectiveness of logistics activities in international trade.

3. Research methods

3.1. Description of variables

To evaluate factors affecting trade between countries around the world, most studies use gravity models. Therefore, the author proposes research on the trade balance between Vietnam and ASEAN with the core factor being an index showing the level of green logistics of each country and several other factors as follows:

Economic scale or market size is usually measured through the total value of domestic product (GDP). According to economic theory, the larger the economy or the higher the income, the higher the trade flow. Therefore, the economic scale of Vietnam and ASEAN countries is expected to have an impact on Vietnam's trade balance with these countries.

Population size (POP) is a factor that directly impacts a country's production capacity. This is also a factor that directly affects a country's production capacity from different perspectives, specifically: from the perspective of labor resources, the scale of the labor source will increase as the population increases, thereby contributing to increased production capacity leads to increased export volume; Similarly, as the population of partner countries increases, product consumption also increases, leading to increased imports of goods. But besides that, as the population increases, the ability to produce goods domestically also increases, which affects the import turnover of goods. Thus, in theory, the population of the exporting country and partner countries can have a positive or negative impact on a country's trade volume with those partner countries. The factor of economic openness of Vietnam and partner countries. Since Adam Smith and David Ricardo published the results of their research, economists have acknowledged the positive role of international trade openness on import and export turnover. The higher the trade openness, the greater the need for international trade.

The "green logistics" factor has been confirmed in the theoretical basis of its inevitable impact on trade in general and the trade balance in particular. This factor will be measured through the Green Logistics Performance Index—GLPI index. Green logistics aims to minimize the environmental impact of the logistics process. It builds on traditional logistics in a green and low-carbon era. Understanding green logistics performance requires considering traditional logistics performance and the concept of green development. Traditional logistics performance prioritizes low-cost and efficient services. Green logistics focuses on environmental friendliness and resource conservation. The LPI index measures traditional logistics performance,

while the GLPI index also considers greenhouse gas emissions and fossil fuel consumption. According to Fan et al. (2022), on the basis of the six sub-indexes of the traditional LPI index, this study provides green-level indexes, including greenhouse gas emission intensity index and the greenhouse gas emission index. fossil fuel consumption to build the GLPI index. Among them, greenhouse gas emission intensity indices include CO_2 emission intensity, N_2O emission intensity, methane (CH_4) emission intensity, and fluorine greenhouse gas (Fgas) emission intensity. The fossil fuel index includes fossil fuel consumption. Then, the LPI index and green level score published by the World Bank were reprocessed using the entropy method and the result was the GLPI index of RCEP countries from 2012 to 2018 (Fan et al., 2022). Therefore, in this study, the author will inherit the GLPI calculation results of Fan et al. (2022) in the article's research model.

3.2. Empirical model

Based on the gravity model theory and a review of related studies, a research model on the impact of green logistics on the trade balance between Vietnam and ASEAN countries is proposed as follows:

$$TB_t = \beta_0 + \beta_1 GDP_{it} + \beta_2 POP_{it} + \beta_3 OPEN_{it} + \beta_4 GLPI_{it} + \beta_5 GDP_{jt} + \beta_6 POP_{jt} + \beta_7 OPEN_{jt} + \beta_8 GLPI_{jt} + \varepsilon$$

The variables are described in detail in **Table 1** below.

Table 1. Description of variables, expected sign, and data source (Source: Recommended by the author).

Variable	Interpretation and units	Expectationsign	Data sources
TB*t*	Trade balance between Vietnam and ASEANcountries from 2012 to 2018 (Export turnover value divided by import turnover value)	/	Trademap
GDP*i*	Vietnam's gross domestic product from 2012 to2018	+/−	World Bank
GDP*j*	Gross domestic product of ASEAN countriesfrom 2012 to 2018	+/−	World Bank
POP*i*	Population of Vietnam from 2012 to 2018	+/−	World Bank
POP*j*	Population of ASEAN countries from 2012 to2018	+/−	World Bank
OPEN*i*	Vietnam's trade openness from 2012 to 2018	+/−	World Bank
OPEN*jt*	Trade openness of ASEAN countries from 2012to 2018	+/−	World Bank
GLPI*it*	Green logistics index of Vietnam from 2012 to2018	+/−	Fan et al., 2022
GLPI*it*	Green logistics index of ASEAN countries from2012 to 2018	+/−	Fan et al., 2022
t	Year		

4. Research results

4.1. Descriptive statistics

Table 2 presents the results of descriptive statistical analysis of each indicator in ASEAN countries. From there, it turns out that countries differ greatly in terms of GDP, population, and trade openness. In terms of the GLPI index, there are also big differences between countries. There are significant differences in green logistics performance among ASEAN countries. Singapore, which has a high GLPI index, shows a balanced development in six sub-indicators of the logistics level. The ability to track and query goods, as well as the efficiency of customs clearance procedures,

has the greatest impact on improving green logistics performance. Singapore also has relatively low emission intensity and fossil fuel consumption of CO_2, N_2O, CH_4, and Fgas. Conversely, countries with low GLPI indexes, such as Laos and Myanmar, have weak links in green logistics, particularly in the efficiency of customs clearance procedures and the timeliness of cargo transportation. Additionally, these countries have relatively high emission intensity and fossil fuel consumption of CO_2, N_2O, CH_4, and Fgas, which negatively affects their GLPI index scores.

Table 2. Descriptive statistics of variables in the model.

Variable	Obs	Mean	Std. Dev.	Min	Max
TB	63	−1,266,139	3,166,294	−9,023,834	2,281,277
GDP*it*	63	2.47×10^{11}	3.67×10^{10}	1.96×10^{11}	3.10×10^{11}
OPEN*it*	63	143.6355	14.23356	123.2241	164.6639
POP*it*	63	9.22×10^{7}	1,891,114	8.93×10^{7}	9.49×10^{7}
GLPI*it*	63	1.871429	0.2135934	1.5	2.1
GDP*jt*	63	2.70×10^{11}	2.86×10^{11}	1.02×10^{10}	1.04×10^{12}
OPEN*jt*	63	127.301	82.02336	37.42134	369.213
OPEN*jt*	63	127.301	82.02336	37.42134	369.213
GLPI*jt*	63	1.9	0.3979788	1.2	3

4.2. Estimated results of the regression model using the least squares method (POOL OLS)

Checking the multicollinearity phenomenon of the POOL model in **Table 3** resulted in vif = 51.39 greater than 10, so the POOL model has multicollinearity. These show that this estimate gives misleading results, is inefficient, and the independent variables do not have a linear relationship with each other. Therefore, the author continues to perform estimation using fixed effects (FEM) and random effects (REM) models.

Table 3. Estimated results of the regression model using the least squares method.

TB	Coef.	Std. Err.	*t*	*P* > |*t*|	Beta
GDP*it*	0.0000277	0.0000355	0.78	0.439	0.3205097
OPEN*it*	6461.211	167,418.9	−0.04	0.969	−0.0290453
POP*it*	0.5222962	1.304493	−0.40	0.690	−0.3119487
GLPI*it*	−985,936	2,953,164	−0.33	0.740	−0.0665097
GDP*jt*	−0.0000137	3.31×10^{-6}	−4.13	0.000	−1.234087
OPEN*jt*	−24,586.25	4054.953	−6.06	0.000	−0.06369107
POP*jt*	0.0401599	0.0110886	3.62	0.001	0.988705
GLP*jt*	1,885,433	1,417,354	1.33	0.189	0.2369844
cons	4.36×10^{7}	1.04×10^{8}	0.42	0.676	-

4.3. Estimated using fixed effects and random effects models

Performing the Hausman test to see whether to choose the FEM in **Table 4** or

REM in **Table 5** model, the test results show that Prob = 0.7203 is greater than 0.05, so the REM model is accepted.

Performing a heteroscedasticity test for the REM model shows that Prob = 0.0000 is less than 0.05, so the REM model has heteroscedasticity.

Table 4. Estimation results according to the fixed effects model (FEM).

TB	Coef.	Std. Err.	*t*	*P* > |*t*|	95% Conf. Interval	
GDP*it*	0.0000193	0.0000214	0.91	0.370	−0.0000237	0.0000623
OPEN*it*	−28,498.4	89,364.23	−0.32	0.751	−208,379.3	151,382.5
POP*it*	−0.0647622	0.7694666	−0.08	0.933	−1.613618	1.484094
GLPI*it*	−2,052,071	1,631,171	−1.26	0.215	−5,335,447	1,231,305
GDP*jt*	−0.0000145	5.71×10^{-6}	−2.55	0.014	−0.000026	-3.04×10^{-6}
OPEN*jt*	2887.856	13,926.37	0.21	0.837	−25,144.48	30,920.19
POP*jt*	0.1157413	0.0727623	1.59	0.119	−0.0307217	0.2622042
GLP*jt*	3,880,503	1,785,747	2.17	0.035	285,980.3	7,475,025
cons	−2,944,141	6.15×10^{7}	−0.05	0.962	-1.27×10^{8}	1.21×10^{8}

Table 5. Estimated results according to the random effects model (REM).

TB	Coef.	Std. Err.	*t*	*P* > |*t*|	95% Conf. Interval	
GDP*it*	0.0000266	0.00002	1.33	0.182	−0.0000125	0.0000658
OPEN*it*	−8179.302	88,438.05	−0.09	0.926	−181,514.7	165,156.1
POP*it*	−0.3999682	0.6948124	−0.58	0.565	−1.761776	0.9618392
GLPI*it*	−1617875	1,631,439	−0.99	0.321	−4,815,437	1,579,688
GDP*jt*	−0.0000172	4.27×10^{-6}	−4.02	0.000	−0.0000256	-8.82×10^{-6}
OPEN*jt*	9963.779	8741.075	−1.14	0.254	−27,095.97	7168.414
POP*jt*	0.0614078	0.0178935	3.43	0.001	0.0263371	0.0964784
GLP*jt*	2,789,609	1,581,487	1.76	0.078	−310,049.8	5,889,267
cons	3.01×10^{7}	5.55×10^{7}	0.54	0.587	-7.87×10^{7}	1.39×10^{8}

Checking the correlation of the REM model shows that Prob = 0.0749 is greater than 0.05, so the REM model does not have autocorrelation.

Therefore, the author continues to implement the GLS model in **Table 6** to overcome the phenomenon of variable variance of the REM model, the estimated results are as follows:

Table 6. Estimated results according to the GLS model.

TB	Coef.	Std. Err.	*t*	*P* > |*t*|	95% Conf. Interval	
GDP*it*	0.0000177	0.000013	1.36	0.174	-7.80×10^{-6}	0.0000432
OPEN*it*	4832.795	61,360.98	0.08	0.937	−115,432.5	125,098.1
POP*it*	−0.3672416	0.4765735	−0.77	0.441	−1.301308	0.5668252
GLPI*it*	−262,946.7	1,056,670	−0.25	0.803	−2,333,983	1,808,089
GDP*jt*	−0.0000126	1.93×10^{-6}	−6.50	0.000	−0.0000164	-8.79×10^{-6}
OPEN*jt*	−20,597.34	1699.067	−12.12	0.000	−23,927.45	−17,267.23
POP*jt*	0.0417242	0.0063351	6.59	0.000	0.0293076	0.0541407
GLP*jt*	759,674.1	773,344.1	0.98	0.326	−756,052.5	2,275,401
cons	2.98×10^{7}	3.80×10^{7}	0.78	0.433	-4.47×10^{7}	1.04×10^{8}

Thus, the research results indicate that the correlation between the trade balance between Vietnam and ASEAN countries is can be represented by the following equation:

$$TB_t = 0.0000177GDP_{it} - 0.3672416POP_{it} + 4832.795\beta 3OPEN_{it} - 262{,}946.7GLPI_{it} - 0.0000126GDP_{jt} + 0.0417242POP_{jt} - 20{,}597.34OPEN_{jt} + 759{,}674.1GLPI_{jt} + 2.98 \times 10^7$$

The above equation shows that green logistics activities have a significant impact on the trade balance between Vietnam and ASEAN countries. The green logistics index of ASEAN countries has a positive correlation with the trade balance, while Vietnam's own green logistics index has a negative correlation. Furthermore, Vietnam's trade openness has a positive impact on the trade balance, while the trade openness of ASEAN countries has a negative impact on the trade balance between Vietnam and ASEAN countries. Additionally, the size of the economy, as indicated by the gross domestic product and population indices of both Vietnam and ASEAN, has minimal impact on the trade balance between the two.

5. Comment on research results and policy implications

The research findings indicate that the trade balance between Vietnam and ASEAN countries is directly correlated with the level of green logistics implementation in ASEAN countries, but inversely correlated with the level of green logistics implementation in Vietnam. This suggests that the ongoing promotion of green logistics development in Vietnam hurts the trade balance, leading to a growing trade deficit between Vietnam and ASEAN countries. These results align with theoretical frameworks, experimental studies, and initial hypotheses.

Currently, the implementation of green logistics in Vietnam is hindered by limited financial and human resources. Businesses need investment capital to purchase new technological equipment and restructure existing activities, but financial difficulties prevent the application of green logistics. Additionally, there is a shortage of high-quality logistics human resources. The logistics infrastructure in Vietnam presents significant challenges for green logistics activities. Issues such as the quality of roads, ports, and train stations persist despite prior investments, leading to limited logistics efficiency.

Moreover, the focus on transportation in logistics activities has overshadowed other crucial aspects such as warehousing and logistics information technology systems. The lack of uniformity in the application and implementation of green logistics is also apparent due to limitations in regulations regarding recycling, repair, and recovery of waste, environmentally friendly packaging, and the use of renewable resources. These challenges create a substantial financial burden for import-export businesses, increasing import-export costs and reducing the competitiveness of Vietnam's exports.

Developed countries with well-established infrastructure and policies supporting green logistics activities do not experience increased export costs. Instead, they benefit from reduced costs, improved transportation efficiency, and enhanced product management. Businesses implementing green logistics can enhance their competitiveness in the market by offering sustainable products and

attracting environmentally conscious customers. Therefore, when trading with these countries, Vietnamese enterprises experience reduced import and export costs, improved product image, and increased turnover.

In summary, the research highlights that a higher green logistics index in ASEAN partner countries positively impacts the trade balance between Vietnam and ASEAN, emphasizing the significance of green logistics for trade relations.

Implementing green logistics is an indispensable requirement for the sustainable economic development of each country today. The results of this study show that the current implementation of green logistics has not had a positive impact on the trade balance of Vietnam-ASEAN in particular, as well as on Vietnam trade in general. However, Vietnam cannot help but implement green logistics following the current trend of greening the global economy. Meanwhile, green logistics implementation in Vietnam encounters numerous opportunities and challenges, such as: After the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26), the Vietnamese government is ramping up its efforts to implement and enforce measures for reducing CO_2 emissions. The Vietnamese Party and Government, in cooperation with relevant agencies, are prioritizing sustainable development activities. These involve prioritizing the development of environmentally friendly transportation by implementing various laws and policies to establish an enabling legal framework. To implement green logistics activities, businesses will need investment capital to purchase new technological equipment and restructure current operations. However, financial constraints directly hinder the adoption of green logistics. Moreover, there is a significant shortage of high-quality logistics professionals in Vietnam. The level of information technology application within businesses remains low, and unsynchronized systems cause delays in handling and implementing logistics activities.

The question is what Vietnam needs to do to effectively implement green logistics to contribute to promoting international trade. To develop Green Logistics in Vietnam, there are a number of solutions that businesses and governments can implement, including:

Invest in green logistics infrastructure: The government and businesses need to invest in green logistics infrastructure, including facilities, technology and management processes, to create a favorable environment. for implementing Green Logistics.

Human resource training and awareness raising about green logistics: Businesses and governments need to invest in human resource training, and awareness raising about green logistics, to increase skills and knowledge of technologies and green logistics management process.

Create preferential policies for green logistics: The government can offer preferential policies, including tax and fee reductions, to encourage businesses to deploy green logistics and reduce implementation costs.

Apply new technology and apply artificial intelligence (AI) to optimize green logistics: Businesses can apply new technologies and apply artificial intelligence (AI) to optimize green logistics and minimize emissions and energy consumption.

Building an integrated green logistics model: Businesses can cooperate with supply chain partners to build an integrated green logistics model, from production

to transportation and product distribution, to optimize efficiency and minimize impact on the environment.

Enhance information and solutions to access green logistics: Businesses can increase information and solutions to access green logistics through media channels and events related to green logistics, to create incentives for enterprises deploying green logistics in Vietnam.

6. Limitation

The article may not fully consider differences between different countries, such as levels of economic development, policy environments, and cultural differences, which can affect the implementation and effectiveness of green logistics. The author will try to conduct further research to supplement these areas and limitations of the article.

Conflict of interest: The author declares no conflict of interest.

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