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Article

The role of transportation connectivity in Vietnam's trade with ASEAN countries

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Abstract: This article focuses on studying how transportation connectivity affects Vietnam's trade with Association of Southeast Asian Nations (ASEAN) countries. By using a gravity model, the article applies fixed effects (FE) and random effects (RE) to analyze panel data on trade, GDP, tariffs, border effects, and indicators. The number represents Vietnam's transport connectivity with ASEAN countries from 2004 to 2021. Research results show that transport connectivity hurts Vietnam's trade with other countries. ASEAN. The article proposes solutions for the Government and Vietnamese export enterprises to promote intra-ASEAN trade in the direction of increasing the added value of Vietnam's imported and exported goods within ASEAN countries and balancing between Developing intra-ASEAN and foreign trade.

Keywords: transportation; ASEAN; trade; gravity model; panel data

1. Introduction

The transportation and logistics industries are vital components of the global economy. They facilitate the movement of goods, people, and information across borders and continents. These industries play a crucial role in enabling economic growth and development by providing businesses with access to new markets, reducing costs, and significantly improving operational efficiency. The movement of goods and people create new opportunities for trade and investment, connecting producers with consumers and facilitating the exchange of ideas and information.

After over five decades of establishment and progress, Association of Southeast Asian Nations (ASEAN) has emerged as one of the most successful regional organizations globally. Notably, ASEAN consistently prioritizes connectivity and integration when implementing measures to materialize the ASEAN Economic Community, thereby enhancing the prospects of a vibrant, central, and high-potential ASEAN economic region. A crucial step towards achieving this objective involves bolstering cooperation and connectivity in transportation.

In recent years, Vietnam has signed bilateral Maritime/Sea Transport Agreements with ASEAN countries such as Thailand, Indonesia, Philippines, Malaysia, Singapore, Brunei, and Myanmar to facilitate maritime transport activities among member countries. After 28 years of joining ASEAN, the economic and trade relations between Vietnam and ASEAN have seen significant development. In 1996, when Vietnam first joined the ASEAN Free Trade Area (AFTA), the two-way trade with countries in the bloc was nearly 6 billion USD. However, this number has now increased to more than 60 billion USD, showing a remarkable increase in the breadth and depth of economic cooperation.

The article aims to develop a research model to measure the impact of transportation connectivity on Vietnam's trade with ASEAN countries. Based on this

analysis, the article will propose various policies to enhance the efficiency of transportation connections and boost trade between Vietnam and ASEAN.

2. Theoretical basis

The gravity model used in economics is based on Newton's Law of Universal Gravitation, where the force of gravity is directly proportional to the product of the masses of two objects and inversely proportional to the distance between them. Tinbergen (1962) was the first scholar to apply the gravity model in examining the relationship between economics, distance, and trade levels. As the theoretical foundation developed and its application became widespread, the gravity model became the most successful model in the analysis of international trade (Anderson, 2016).

The traditional gravity model in international trade can be represented by the following formula:

$$T_{ij} = (G \times Y_i Y_j)/D_{ij}$$

In the given equation, *T* represents the trade flow between country *i* and partner *j*, typically measured by the total value of import and export turnover. *Y* represents the size of the economy, often determined by gross domestic product (GDP) or gross national product (GNP). *D* represents the physical distance between the two countries, and *G* is the gravitational coefficient. The gravity model predicts that trade between two countries is positively correlated with the size of their economies and negatively correlated with the distance between them. The larger the economies, the greater the trade, and the greater the distance, the lower the trade volume.

To estimate this non-linear formula, we need to convert it into a linear equation by taking the natural logarithm of both sides. This will give us the gravity model equation in the form:

$$\ln(T_{ij}) = \ln(G) + \ln(Y_i) + \ln(Y_j) - \ln(D_{ij}) + e_{ij}$$

The gravity model in international trade analysis has been developed in various versions. Instead of relying solely on geographic distance, analysts have also considered alternative indicators of import and export costs, including tariffs, transportation expenses, infrastructure, and connectivity. This approach is evident in the works of Hulme (2009) and Stone and Strutt (2010), among others.

Vu Bach Diep and colleagues (2018) conducted a study using an extended gravity model to analyze the factors affecting Vietnam's exports of goods to the EU market from 2005 to 2017. The results revealed that factors such as GDP, population, institutional quality, and WTO accession had a similar positive impact on export turnover. On the other hand, factors like geographic distance and technological distance had a negative effect. The study also found that the influence of the "historical" factor was negative, although not statistically significant. These findings can provide valuable insights for the government and policy enforcement agencies in identifying potential solutions to enhance exports to the EU market.

Saeed et al. (2021) analyzed the connections between maritime connectivity, trade, and economic growth. The study employed an extended gravity model

framework to examine the impact of maritime connectivity on trade flows and domestic production. This model was adapted to incorporate variables related to maritime connectivity, such as port infrastructure, shipping routes, and frequency of services, in addition to the traditional factors like GDP, distance, and other control variables. They found a reciprocal relationship between export values and GDP per capita, but no such relationship for import values. The study also highlighted the importance of maritime connectivity for economic and trade policies at global, regional, and national levels.

The study by Martínez-Zarzoso et al. (2003) examines the factors that affect maritime and overland transport costs and their impact on trade between countries using data from the tile sector. In this case, the authors extended the basic gravity model to incorporate transport costs as a key variable influencing trade. It emphasizes the importance of understanding the differences between overland and maritime transport for economic policy-making. The research highlights the influence of infrastructure on transport costs and trade and suggests that investing in new port infrastructures can promote trade. The findings reveal that longer distances and inadequate partner infrastructure significantly increase transport costs. Additionally, importer income has a positive impact on bilateral trade flows, while higher transport costs discourage trade. Distance was found to be an inaccurate proxy for transport costs in the ceramics sector.

Arnold (2009) emphasizes that advancements in transportation infrastructure and services have lessened the impact on trade volumes between East and South Asia. The author employs descriptive analysis and empirical methods to investigate the relationship between transportation infrastructure, logistics services, trade facilitation, and their influence on trade in Asia. This study is a component of a broader analysis of economic integration between East and South Asia. Although sea transport continues to be dominant, it is anticipated that land transport will assume a greater role in the future. The significance of air transport is increasing, albeit at a slower pace than sea transport.

Giuliano et al. (2014) discovered that historical geographic factors continue to impact current transportation costs. The authors used a quantitative econometric approach with an extended gravity model to analyze how genetic distance and transportation costs impact international trade flows. These factors help explain the connection between trading patterns and genetic diversity. Their research indicates that when the influence of geography is taken into account, the impact of genetic distance on trade decreases. To support their conclusions, the researchers developed a database on geographical barriers, introduced a new dataset on transportation costs, and proposed a new classification of goods based on their ease of transport.

Gallego and Llano (2014) estimated internal and external border effects using a new dataset capturing domestic and international shipments between Spanish regions Den and regions in eight European countries using alternative treatments of the non-linear relationship between distance and trade. The authors used an extended gravity model to examine the non-linear impact of distance on trade and the influence of borders on trade flows.

According to Bergstrand et al. (2015) estimated the declining impact of “international borders” on world trade in the context of deepening international

economic integration. The authors utilize an augmented gravity model to examine the impact of economic integration agreements (EIAs), border effects, and distance elasticities on international trade flows. At the same time, the authors also proposed some solutions to the problem of distance elasticity in international trade.

Franco-Bedoya and Frohm (2022) argue that reduced border effects account for most of the increase in international manufacturing trade. Country border costs are estimated to have decreased by about 4.3% per year for final goods trade and 2.8% for intermediate input trade. Furthermore, the authors show that it is important to control for differential border effects on final goods and intermediate inputs when estimating the trade effects of FTAs in the gravity equation. Given this improvement, the results of this study show that FTAs increase final goods trade by 52% after ten years, with no statistically significant difference in intermediate input trade. This study evidenced that more comprehensive FTAs like the European Union have a larger trade impact than average FTAs.

Previous research on international trade using the gravity model has shown empirical evidence of the link between countries' economic scales, tax relations, distance, and trade volume. However, little attention has been given to the connection between transportation connectivity and trade relations, particularly within ASEAN countries. This study aims to address this gap in the existing research.

3. Research methods

The article uses the extended gravity model proposed by Anderson and Wincoop (2003) to clarify the role of transportation connectivity in trade between Vietnam and ASEAN countries. It focuses on demonstrating the ability to connect transport between countries through two indices: the Liner Shipping Connectivity Index and the border effect.

$$\mathrm{Trade}_{ij} = \alpha_0 + \alpha_1 \mathrm{GDP}_i + \alpha_2 \mathrm{GDP}_j + \alpha_3 \mathrm{TRF}_i + \alpha_4 \mathrm{TRF}_j + \alpha_5 \mathrm{LSCI}_i + \alpha_6 \mathrm{LSCI}_j + \alpha_7 \mathrm{BE}_{ij} + e_{ij}$$

In there,

Trade: Trade between Vietnam and ASEAN countries. Trade value is determined by the sum of export value and import value.

GDP: Gross Domestic Product—GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars.

TRF: Tariff rate, applied, simple mean, all products (%)—Simple mean applied tariff is the unweighted average of effectively applied rates for all products subject to tariffs calculated for all traded goods. Data are classified using the Harmonized System of trade at the six- or eight-digit level. Tariff line data were matched to Standard International Trade Classification (SITC) revision 3 codes to define commodity groups. Effectively applied tariff rates at the six- and eight-digit product level are averaged for products in each commodity group. When the effectively applied rate is unavailable, the most favored nation rate is used instead. To the extent possible, specific rates have been converted to their ad valorem equivalent rates and have been

included in the calculation of simple mean tariffs.

LSCI: Liner shipping connectivity index (maximum value in 2004 = 100).

The Liner Shipping Connectivity Index captures how well countries are connected to global shipping networks. It is computed by the United Nations Conference on Trade and Development (UNCTAD) based on five components of the maritime transport sector: number of ships, their container-carrying capacity, maximum vessel size, number of services, and number of companies that deploy container ships in a country's ports. For each component a country's value is divided by the maximum value of each component in 2004, the five components are averaged for each country, and the average is divided by the maximum average for 2004 and multiplied by 100. The index generates a value of 100 for the country with the highest average index in 2004. The underlying data come from Containerisation International Online.

BE: Border effect on Vietnam's trade in ASEAN (BE will have a value of 1 when that country shares a border with Vietnam and a value of 0 when that country does not share a border with Vietnam).

i: Countries in ASEAN

j: Vietnam

The panel data model with research variables in **Table 1** will be used for the gravity model estimation process. Panel data is data that has a scale of both time and space. The table data structure is combined from two components: cross-section data component and time series data component. Combining two types of data has many advantages and disadvantages in analysis, especially when you want to observe and analyze changes in research groups after events or over time as well as analyze changes in research subjects. differences between groups of research subjects. Panel data regression in fundamental analysis often has the following two methods: FE (fixed effects), and RE (random effects).

Table 1. Description of research variables and hypotheses.

Variable	Variable Interpretation and unit	Research hypothesis	Data source
Trade	Trade between Vietnam and ASEAN countries by year from 2006 to 2021. Data are in current US Dollar thousand.	/	Uncomtrade
GDP	Gross Domestic Product of each country by year from 2006 to 2021. Data are in current US Dollar.	+/−	World Bank
TRF	Tariff rate, applied, simple mean, all products by year from 2006 to 2021. Data are in %	+/−	World Bank
LSCI	Liner shipping connectivity index	+/−	World Bank
BE	Border effect	+/−	

Source: compiled by author.

With the assumption that each unit has unique characteristics that can affect the explanatory variables, FE analyzes this correlation between the residuals of each unit and the explanatory variables, thereby controlling and separating the effects of individual characteristics (not over time) from the explanatory variables so that we can estimate the net effects of the explanatory variable on the dependent variable.

In the RE model, the differences between units affect the dependent variable. In which, the residual of each unit (uncorrelated with the explanatory variable) is

considered a new explanatory variable.

4. Empirical results and discussion

4.1. Descriptive statistics of variables in the research model

The descriptive statistics for the variables in the study in **Table 2** suggest that they are generally suitable for inclusion in a panel data model. The variable "Trade" has a high mean and significant standard deviation, indicating considerable dispersion. The variables "GDP_i" and "GDP_j," representing economic size, also show substantial variability. The tariff rate variables "TRF_i" and "TRF_j" exhibit moderate variability and can be incorporated into the model with minimal adjustments. Liner shipping connectivity index "$LSCI_i$" and "$LSCI_j$" while demonstrating dispersion, remain suitable for the gravity model, with "$LSCI_i$" showing greater variability but still being appropriate. The binary variable "BE," with a low mean and high standard deviation, can be directly included in the model to assess the impact of binary factors. Overall, the variables meet the basic criteria for a panel data model.

Table 2. Descriptive statistics of variables in the research model.

Variable	Obs	Mean	Std. Dev.	Min	Max
Trade	128	4953614	4308358	0	1.86×10^7
GDP_i	128	2.72×10^{11}	2.75×10^{11}	7.27×10^9	1.19×10^{12}
GDP_j	128	2.15×10^{11}	9.51×10^{10}	6.64×10^{10}	3.66×10^{11}
TRF_i	128	5.295469	3.664616	0.04	13.73
TRF_j	128	7.437188	2.074324	4.22	12.14
$LSCI_i$	128	38.87379	34.73409	3.409882	113.775
$LSCI_j$	128	48.87726	17.86911	20.93025	79.77808
BE_{ij}	128	0.125	0.3320184	0	1

4.2. Estimation by regression model using least squares method (POOL OLS)

Performing a heteroskedasticity test of the POOL model in **Table 3** gives the result that Prob = 0.0001 is less than 0.05, so the POOL model has heteroscedasticity. These show that these estimates give misleading and inefficient results. Therefore, the author continues to perform estimation using fixed effects (FE) and random effects (RE) models.

Table 3. Estimation results by regression model using least squares method (POOL OLS).

Trade	Coef	Std. Err.	*t*	*P* > |*t*|	Beta
GDP_i	8.87×10^{-6}	2.91×10^{-6}	3.05	0.003	0.5662147
GDP_j	0.0000224	0.0000126	1.78	0.078	0.4946762
TRF_i	125,606.7	100,590.1	1.25	0.214	0.1068389
TRF_j	717,733.6	309,979.2	2.32	0.022	0.3455637

Table 3. (*Continued*).

Trade	Coef	Std. Err.	*t*	*P* > |*t*|	Beta
$LSCI_i$	−14,743.95	13,468.89	−1.09	0.276	−0.1188661
$LSCI_j$	16,414.12	67,058.45	0.24	0.807	0.0680783
BE_{ij}	−7,439,015	2,137,353	−3.48	0.001	−0.5732787
cons	−7,585,869	3,947,321	−1.92	0.057	

Source: Result from stata 14 software.

4.3. Estimation according to 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 = 0.0779 is greater than 0.05, so the RE model is accepted.

Table 4. Estimation results by fixed effects model (FEM).

Trade	Coef.	Std.Err.	*t*	*P* > |*t*|	[95% Conf. Interval]	
GDP_i	4.87×10^{-6}	2.19×10^{-6}	2.2	0.028	5.36×10^{-7}	9.20×10^{-6}
GDP_j	0.0000178	6.40×10^{-6}	2.78	0.006	5.10×10^{-6}	0.0000305
TRF_i	−587,001.1	173,778.8	−3.38	0.001	−931,255.6	242,746.6
TRF_j	129,828.3	146,201.5	0.89	0.376	−159,795.8	419,452.4
$LSCI_i$	−60,410.05	36,876.35	−1.64	0.104	−133,461.8	12,641.71
$LSCI_j$	−15,544.5	30,930	−0.50	0.616	−76,818.18	45,729.17
BE_{ij}	0 (omitted)					
cons	5,050,404	2,270,424	2.22	0.028	552,711.7	9,548,096

Source: Result from stata 14 software.

Table 5. Estimated results by random effects model (REM).

Trade	Coef.	Std.Err.	*t*	*P* > |*t*|	[95% Conf. Interval]	
GDP_i	4.96×10^{-6}	2.19×10^{-6}	2.27	0.023	6.69×10^{-7}	9.25×10^{-6}
GDP_j	0.0000179	6.36×10^{-6}	2.81	0.005	5.42×10^{-6}	0.0000303
TRF_i	−451,569.6	156,127.3	−2.89	0.004	−757,573.5	145,565.8
TRF_j	142,083.6	151,499.8	0.94	0.348	−154,850.6	439,017.9
$LSCI_i$	−37,329.78	25,201.94	−1.48	0.139	−86,724.67	12,065.11
$LSCI_j$	−16,131.94	32,062.97	−0.50	0.615	−78,974.2	46,710.33
BE_{ij}	−4,714,232	3,683,150	−1.28	0.201	-1.19×10^7	2,504,610
cons	3,915,696	2,537,446	1.5	0.123	−1,057,608	8,889,000

Source: Result from stata 14 software.

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

Checking the correlation of the RE model shows that Prob = 0.0011 is less than 0.05, so the RE model has autocorrelation.

Therefore, the author continues to implement the GLS model to overcome the phenomenon of heteroskedasticity and autocorrelation of the RE model, the estimated results are as follows:

Thus, the research results in **Table 6** show that trade between Vietnam and

ASEAN countries is expressed by the following equation:

$$\text{Trade}_{ij} = 0.00000531 \times \text{GDP}_i + 0.0000194 \times \text{GDP}_j + 24{,}372.5 \times \text{TRF}_i + 63{,}587.49 \times \text{TRF}_j - 49{,}298.55 \times \text{LSCI}_i - 17{,}988.95 \times \text{LSCI}_j - 2{,}140{,}829 \times BE_{ij} + 399{,}959.2$$

Table 6. Estimated results according to the GLS model.

Trade	**Coef.**	**Std.Err.**	***z***	***P*** **> |z|**	**[95% Conf. Interval]**	
GDP_i	5.31×10^{-6}	2.50×10^{-6}	2.13	0.033	4.20×10^{-7}	0.0000102
GDP_j	0.0000194	4.19×10^{-6}	4.63	0.000	0.0000112	0.0000276
TRF_i	24,372.5	81,007.4	0.30	0.764	−134,399.1	183,144.1
TRF_j	63,587.49	67,591.08	0.94	0.347	−68,888.6	196,063.6
$LSCI_i$	−49,298.55	18,793.52	−2.62	0.009	−86,133.16	−12,463.93
$LSCI_j$	−17,988.95	10,345.76	−1.74	0.082	−38,266.27	2288.365
BE_{ij}	−21,40829	3,203,599	−0.67	0.504	−8,419,768	4,138,109
cons	399,959.2	1,504,788	0.27	0.790	−2,549,371	3,349,289

Source: Result from stata 14 software.

The research result provides valuable insights into the factors influencing trade between Vietnam and ASEAN countries, while also highlighting some interesting contradictions with conventional economic theories. First, the positive regression coefficients for the GDPs of both Vietnam and ASEAN countries suggest that larger economic scales promote greater trade volumes. This result is logical, as countries with stronger economies generally have greater consumption and production capacities, thereby increasing trade activity.

Second, the positive regression coefficient for the TRF variable indicates that higher tariffs between Vietnam and ASEAN are associated with increased trade. This is a surprising result, as traditional economic theory posits that higher tariffs increase the cost of goods, thereby reducing trade incentives. A plausible explanation is that higher tariffs might compel domestic businesses to boost exports to offset tariff costs, or that internal ASEAN trade policies, such as preferential tariff schemes, might encourage trade despite officially higher tariffs.

Third, while the Liner shipping connectivity index (LSCI) between Vietnam and ASEAN is expected to promote trade by reducing transportation costs and time, the study shows a negative regression coefficient. This means that as transport connectivity improves, trade volume between Vietnam and ASEAN decreases. This could be explained in several ways. One hypothesis is that better transport connectivity may enable domestic businesses to access markets beyond ASEAN more easily, reducing reliance on regional trade. Alternatively, a growing domestic market may diminish the need for trade with ASEAN countries.

The border effect (BE) does not seem to offer a significant advantage for trade between Vietnam and neighboring ASEAN countries. This lack of advantage may be attributed to non-tariff barriers, administrative issues, restrictive policies, or geopolitical factors. These factors make trade with bordering countries no easier than with non-bordering nations. This result contradicts the common expectation that proximity generally benefits trade due to shorter distances and lower transportation costs.

Overall, the study reveals that trade between Vietnam and ASEAN is not solely influenced by traditional economic factors such as GDP and tariffs, but is also shaped by complex variables such as policies, infrastructural development, and geopolitical relationships. These factors contribute to a more intricate trade dynamic than standard economic theories might suggest.

5. Comment on research results and policy implications

The research results have partly clarified the role of transportation connectivity in Vietnam's trade activities with ASEAN countries. As the transportation connectivity of Vietnam and ASEAN countries increases, Vietnam's trade with ASEAN countries tends to decrease. These show that when transportation connectivity is good, Vietnam will aim to promote trade with new market areas to seek better business opportunities. As we know, ASEAN includes 10 countries that have quite similar economic and natural conditions, so there is not much difference in national comparative advantages. Therefore, when conducting trade with these countries, it does not bring added value to Vietnamese import and export goods. Vietnam always considers ASEAN as a cheap input supply market for Vietnamese production because Vietnam's geographical distance from ASEAN countries is quite close, so transportation costs are low. Therefore, when transportation connectivity is better, perhaps Vietnam will try to promote import-export trade with developed countries in the European and American markets to seek opportunities to increase the price value of goods. In the short term, Vietnam can optimize the advantage of low transportation costs within ASEAN to support production and exports, while simultaneously enhancing the value-added component of its goods. In the long term, improved transportation connectivity could catalyze Vietnam to expand into more developed markets, such as Europe and North America, in conjunction with investments in modern logistics infrastructure and strategic partnerships. These short-term and long-term measures aim to maximize Vietnam's benefits from improved transport connectivity while promoting sustainable growth in international trade.

Besides, the border effect also does not have a positive impact on Vietnam's trade with bordering countries. In ASEAN, Vietnam shares borders with Laos and Cambodia. These are two countries with a fairly small economic scale, and their commodity structure is quite similar to Vietnam, so even though they share a border and low transportation costs, it is not a big motivation for Vietnam to boost trade with these two countries. This result once again shows that transportation connectivity through border effects does not play an important role in promoting Vietnam's trade with ASEAN countries. In the short term, Vietnam should focus on diversifying trade with other ASEAN countries that offer larger markets and varied economic structures. Enhancing trade facilitation and promoting regional trade agreements can also improve trade efficiency. For long-term strategies, Vietnam should invest in market development and infrastructure to better connect with emerging markets. Strengthening economic integration and bilateral relations through targeted initiatives can further enhance trade opportunities. These measures will help Vietnam optimize trade within ASEAN and capitalize on its geographical advantages.

Similarly, when the average tariff in Vietnam as well as that of ASEAN countries

decreases, it is not an advantage for Vietnam to promote trade with ASEAN countries. Reality shows that the ASEAN Economic Community (AEC) was established on the last day of 2015. Following the achievements of the ASEAN Free Trade Area (AFTA), in the AEC environment, the tax field is committed to further enhancements to create conditions to ensure the liberalization of trade in goods and the free movement of investment capital and labor within ASEAN. Accordingly, from 1 January 2015, Vietnam has cut 1720 tax lines from the current tax rate of 5% to 0% according to ATIGA commitments. Therefore, tariffs in ASEAN are always the lowest compared to other FTAs. When the average tariff of Vietnam and ASEAN countries decreases, it means that tariffs in other FTAs of Vietnam and ASEAN countries decrease. At that time, new markets in these new FTAs will bring many new opportunities, with higher added value than promoting import and export within ASEAN. As a result, the reduction in average national tariffs will create motivation for Vietnam to boost trade with other countries in new generation FTAs, so Vietnam's trade volume with ASEAN countries will decrease significantly. Given that the reduction in average tariffs within ASEAN does not significantly enhance trade within the region but rather underscores the advantages of newer FTAs, Vietnam should consider several practical approaches. In the short term, Vietnam can leverage these new FTAs to gain access to markets offering higher value-added opportunities, thereby capitalizing on external trade benefits. Simultaneously, optimizing internal trade strategies through improved trade facilitation and reduced non-tariff barriers can help maintain competitiveness within ASEAN despite lower tariff advantages. In the long term, Vietnam should focus on strengthening strategic trade relations with countries covered by newer FTAs and diversifying its trade portfolio to include a broader range of markets and sectors. Additionally, investing in regional infrastructure and integration will enhance Vietnam's connectivity and efficiency in trade, both within ASEAN and with external markets. By adopting these strategies, Vietnam can effectively navigate the changing trade dynamics and maximize the benefits of both regional and global trade agreements.

Meanwhile, only the GDP variable of Vietnam and ASEAN countries has a positive impact on trade between Vietnam and ASEAN countries. This result is quite similar to the results of other related studies. These show that as the economic scale of Vietnam and ASEAN countries increases, the supply and demand of ASEAN countries also increases significantly, causing import and export demand to increase. As a result, when GDP increases, Vietnam's trade volume with ASEAN countries also increases as an inevitable rule. In the short term, Vietnam should focus on enhancing economic collaboration with ASEAN countries through joint projects and trade initiatives that capitalize on the growing economic scales of both parties. Additionally, promoting trade in sectors aligned with rising demand due to GDP growth can boost export opportunities. For long-term strategies, Vietnam should develop deeper economic partnerships and trade agreements within ASEAN to facilitate greater market access and integration. Investing in infrastructure that supports economic and trade growth, such as logistics networks, will also help manage and enhance trade flows. Furthermore, diversifying trade opportunities by exploring new, rapidly growing markets beyond ASEAN can reduce dependency and open additional avenues for trade expansion. By adopting these strategies, Vietnam can effectively leverage the

positive relationship between GDP growth and trade volume, enhancing its trade performance with ASEAN countries.

In summary, the research highlights the role of transportation connectivity in Vietnam's trade with ASEAN countries. Contrary to expectations, improved transport connectivity between Vietnam and ASEAN has led to a decrease in trade within the region. This suggests that better transportation links enable Vietnam to shift focus toward new, more lucrative markets outside ASEAN, such as Europe and North America, where greater business opportunities and higher value-added goods can be realized. While ASEAN is seen as a low-cost supply region for Vietnam, strong transportation links may encourage Vietnam to diversify its trade beyond the region to maximize value and economic growth. Therefore, while improved transport infrastructure is essential, its main benefit may lie in expanding trade outside of ASEAN rather than within it.

6. Limitation

The study has some limitations. It mainly focuses on transportation connectivity between Vietnam and ASEAN countries, which have similar comparative advantages. However, it does not analyze more diverse markets. The study also does not compare the border effect with other neighboring countries and does not thoroughly consider non-economic factors such as culture and politics. In addition, the study also relies too much on the traditional gravity model and does not consider enough other factors that affect trade. Therefore, in subsequent studies, the author hopes to overcome these limitations.

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

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