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Decomposition approach for examining effects of logistic performance on exports: A case study of Vietnam

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Abstract: The study evaluates to what extent logistics performance and its components impact Vietnam's bilateral export value. The augmented Gravity model is applied on panel data in the period from 2010 to 2018. Logistics efficiency is measured by Logistic performance index (LPI) and its sub-indices developed by the World Bank. A variety of diagnostic tests and estimation methods are employed to ensure the stability of the results. The main findings confirm that all explanatory variables demonstrate the expected signs, and aggregate logistics performance and its sub-indices have positive impacts on Vietnam's export flows, with the magnitude of logistics impacts is greater than other factors in the research model. Among LPI components of Vietnam, Ease of arranging shipments index is the most influential factor on exports, followed by Infrastructure, Timeliness, and Quality of logistics services. These export's effects are also identified by partners' LPI indicators namely Quality of logistics services, Customs, Infrastructure, and Tracking and tracing.

Keywords: logistics performance index (LPI); logistics component; exports; gravity model; Vietnam
JEL classification: C2, C5, F1, F4

1. Introduction

Since implementing economic reforms in 1986, Vietnam's development over the past 30 years has been remarkable, transforming what was then one of the world's poorest nations into a lower middle-income country. In recent years, the country's economy has achieved substantial achievements with high growth rate, stable macro-economy, increased international trade, and reduced poverty rate. The above economic achievements have greatly come from the increase in exports, with opening up policy for economy leading an increase in Vietnam's trade with countries around the world. It was exports that supported the economy during the previous economic recession (Nguyen, 2013) and during the current Covid-19 pandemic. Despite being negatively affected by the pandemic as disrupted global production and supply chains, the country's exports still grew positively. That has confirmed the important role of exports to Vietnam's economy. According to data from the General Statistics Office (GSO) of Vietnam, export turnover in 2020 reached 281.5 billion USD, increased 5 per cent compared to the previous year.

Identifying exports as one of the important drivers for Vietnam's economic development, many studies have been implemented to clarify the factors that significantly affect the country's exports, in order to recommend for Vietnam's government issuing appropriate policies to encourage exports as well as promote economic growth. In the context of global trade being declined due to supply chain disruptions during the Covid 19 pandemic, effects of logistics on international trade has attracted much attention from economists, increasing studies in this research area

(Behar and Manners, 2008; Puertas et al., 2014). In 2020, the pandemic had a negative impact on the global logistics with isolation measures, blockade and many workers in this sector had to quit, resulting in almost entire logistics operation was paralyzed. The paralysis has caused difficulties in the global circulation of materials for production, as well as of goods for distribution.

The majority of studies indicate that there is a positive relation between all logistics components and foreign trade (Çelebi, 2019; Felipe and Kumar, 2012; Sy et al., 2020). In contrast, some studies concluded that there may be both negative and positive impacts of logistics components on trade, namely research by Puertas et al. (2014), Chakraborty and Mukherjee (2016), Wang and Choi (2018). Interestingly, there are researches suggesting that some logistics components to trade relations is not significant, as in the papers of Puertas et al. (2014), Zaninović et al. (2020). Even when having an impact, the importance of these components varies across studies. In Vietnam, many studies on export area have identified factors affecting trade flow, however, there are no studies synthesize factors related to logistics, especially studies using performance index of each logistics element as well as examining impacts of those elements on Vietnam's exports to main partners. Therefore, this paper intends to fill that research gap by assessing effects of the logistics components performance on exports of Vietnam with 48 major export partners. In this study, we explore the influence of logistic performance on Vietnam's export dynamics. Logistic performance refers to the efficiency and effectiveness of the processes involved in moving goods from origin to destination, encompassing aspects such as transportation infrastructure, customs procedures, service quality, and overall ease of shipment. We utilize the Logistic Performance Index (LPI) developed by the World Bank as a comprehensive measure to assess these factors. Unlike most of previous studies based on aggregate export and logistics data, this study employs bilateral export and logistic data to avoid potential issues of positive and negative impacts that offset one another at the aggregate data level. This paper also applies recently improved techniques of panel data to analyze trade effects on logistics components performance instead of focusing only on Ordinary Least Squares (OLS) estimates like most previous studies. By doing so, the study can combine cross-sectional and time series dimensions, to control both temporal effects and heterogeneity across the sample countries[1].

2. Literature review

This section delves into existing research on logistics performance and its components, particularly in the context of its impact on international trade. This section synthesizes various methodologies and findings from previous studies, providing a comprehensive overview of how logistics efficiency, as measured by the Logistics Performance Index (LPI) and its sub-indices, influences trade dynamics. The review encompasses a range of perspectives, including studies that highlight positive relationships between logistics components and trade, as well as research indicating mixed or insignificant impacts. This thorough examination of existing literature forms the foundation for our study's approach and highlights the research gap our work aims to address.

2.1. Logistics performance and its components

There are different methods to evaluate logistics efficiency and its indicators (Hausman et al., 2013) of which the logistics performance index (LPI) developed by the World Bank is the most popular used in recent studies (Martí et al., 2014). LPI ranks and compares the efficiency and capacity of logistics activities of countries. This index, from 2010, has been determined every two years, in even years. Until now, there have been 6 LPI rankings in 2007, 2010, 2012, 2014, 2016 and the latest was 2018. Vietnam's average LPI index through the last 4 rankings ranks 45th in the world. In 2018, the five countries with the highest LPI were Germany, Sweden, Belgium, Austria, and Japan. Vietnam ranked 39/160 countries participating in the survey, increasing 25 places compared to 2016 (64/160). In the Association of Southeast Asian Nations (ASEAN), Vietnam ranked behind two countries, Singapore (7th) and Thailand (32nd).

The World Bank's LPI is widely recognized by many countries as an indicator of the competitiveness and performance of the logistics industry in each country (Arvis et al., 2010). LPI has been popularly used by policymakers, trade experts, and researchers in assessing and comparing logistics performance (Puertas et al., 2014) because this index is based on the similar comparison of logistics-related criteria of various countries in the world. Thereby, LPI allows governments, businesses and stakeholders to evaluate the competitive advantage created by logistics activities and issue policies to improve logistics efficiency.

LPI is built on a five (5) point scale of six main components with the implication that a higher score (closer to 5) indicates a better logistics environment in that country. The six main components of logistics are classified into two main groups as inputs and outputs. The input indicators include criteria related to policies such as customs, infrastructure and quality of logistics service. Output criteria include areas related to time, cost and reliability, namely Timeliness, Ease of arranging shipments and tracking and tracing.

Customs: Measures the efficiency of a country's cross-border clearance operations with indicators of speed, simplicity and consistency or predictability of customs clearance procedures. In addition, this component index also shows the effectiveness of border control agencies in terms of administrative procedures and laws on global trade.

Infrastructure: Measures the quality of infrastructure related to trade and transport. It includes the efficiency of both the transport system and the telecommunications network (infrastructure of ports, airports, railways, roads, seas, airlines, transport facilities, warehousing, IT infrastructure and IT services) within a country to ensure goods are delivered to the final consumer.

Quality of logistics services: Measures the capacity and quality of logistics service providers and their relationship with customers. This component relates to firms providing freight services of road, rail, air, sea and multimodal transportation; warehousing and distribution enterprises; quarantine agencies; specialized inspection agencies; customs authorities; customs agents; forwarding agents; related associations to trade and transport; shippers and consignees.

Ease of arranging shipments: Measures the ease and convenience in arranging

competitive freight rates for shipments that need to be transported internationally. That means how a country is able to align and participate in the global market based on competitive pricing. This component is related to costs such as agent fees, port fees, tolls, storage fees.

Timeliness: Measures the taking time for a shipment to reach the consignees within the scheduled or expected delivery times. This component is related to export and import shipments declared customs and delivered on time compared to the scheduled. Today's use of computers and the internet is considered to have positively influenced on-time deliveries.

Tracking and tracing: Measures the ability to track and trace shipments. This component plays an important role in providing the exact location of the entire movement of consignments, helping parties to control their products efficiently and reducing losses or delays.

2.2. Previous empirical evidences

Felipe and Kumar (2012) applied the augmented gravity models to study the relationship between bilateral trade flows and trade facilitation in Central Asian countries. The trade facilitation was measured by LPI and its components. Assessing trade flow as a function of GDP, GDP per capita, trade facilitation and dummy variables, their findings indicated that there had been significant gains in trade resulting from improving logistics performance in the studied countries, specifically logistics efficiency increased exports more than imports. All selected components of the LPI had a significant positive impact on trade, of which the greatest effect came from improvement in infrastructure. These authors also argued that although improving infrastructure was the most important factor for increasing trade, it took time and required large investments, thus governments had to consider factors that can improve faster and cheaper like custom.

Puertas et al. (2014) also employed gravity model to estimate impacts of logistics on imports and exports of 26 European countries in 2005 and 2010. The Logistics Performance Index (LPI) and its components were applied as proxies for trade facilitation. In this study, the two-stage model proposed by Heckman was used to avoid possible heterogeneity due to sample bias. The results indicated that logistics affects exporting countries more than importing countries in both 2005 and 2010. Moreover, in 2010, there was an increase in statistically significance of coefficients of overall LPI and its components compared to 2005. While in 2005, the aggregate LPI, Quality of logistics services, Tracking, and Timeline were insignificant, in 2010, most of the indicators all significant (except Timeline), particularly Quality of logistics services had become more important in recent years as displaying the highest coefficient.

Chakraborty and Mukherjee (2016) used panel data analysis to examine whether logistics performance and its components affected export orientation of over 140 countries in selected four years including 2007, 2010, 2012, and 2014. They modelled export orientation as a function of GDP per capita, percentage of import to GDP, share of industrial sector, inward FDI, logistic performance index and its components. They concluded that logistic performance and its components play a significant role in

influencing export orientation. Specifically, aggregate LPI, Custom, Ease of arranging shipments, Quality of logistics services and Infrastructure had a significant positive impact on export orientation on sample countries. The results were similar when the studied countries are divided into two groups: higher income countries and lower income countries.

Wang and Choi (2018) tested the sensitivity of export and import volumes of 43 economies to logistic performance by applying panel data analysis in three selected years: 2010, 2012 and 2014. This finding was similar to the that of Puertas et al. (2014) who concluded that excellent logistics performance affected trade volume in a positive way, by increasing exports more than imports although they used different datasets. Apart from Quality of logistics services, the five remaining logistics components had a statistically significant relationship with exports. These authors also argued that trade effects of logistic performance to developed countries is greater than to developing countries. While Timeliness, Ease of arranging shipments, and Tracking had a more powerful influence on developed countries' exports, Customs and Infrastructure had greater impact on export volume of developing countries.

Çelebi (2019) compared the relative impacts of different dimensions of logistics performance on trade based on various countries' income levels. The author concluded that for low- and lower-middle income economies, improvement of logistics performance increased exports more than imports, while this effect on imports were greater than exports in upper-middle and high-income countries. All six LPI sub-indices had positive and statistically significant effects on both exports and imports. Among these, Timeliness had the greatest impact on exports, while imports were largest affected by two components: Infrastructure and Ease of arranging shipments. This author also suggested that working together to improve the logistics of partner countries having more impact on exports of an upper-middle-income country than only improving its export efficiency.

Sy et al. (2020) applied the Poisson Pseudo Maximum Likelihood method, the Feasible Generalized Least Squares method, and the Heckman Two-step procedure to examine the effects of logistics performance and its components on trade flow of ASEAN countries from 2007 to 2016. Trade value was specified as a function of GDP, distance, overall LPI, LPI's components, and other control variables. The result from various estimates showed that an improvement of logistics performance caused positive effects on exports and imports of ASEAN members. All logistics components were statistically significant impact on exports and imports. The Tracking and tracing coefficient caused the greatest increase on both exports and imports, followed by Timeliness indicator for exports and Ease of arranging shipments for imports.

Kabak et al. (2020) examined the bidirectional relationship between competitive capability and logistics performance of countries, utilizing data from the Global Competitiveness Index (GCI) and the Logistics Performance Index (LPI). The findings highlighted the crucial GCI pillars that significantly influenced national logistics efficiency, including "business complexity," "financial market development," "infrastructure," "market efficiency," and "tertiary education." Moreover, the study indicated that improving the national logistics performance index had a particularly positive impact on the "market size" pillar of a country.

Explored how culture influences the efficiency of national-level logistics operations using secondary data from the World Bank's Logistics Performance Index (LPI) reports and Hofstede's cultural dimensions theory. The findings indicated that the power distance and uncertainty avoidance indexes negatively affected logistics efficiency, while individualism and long-term orientation showed a positive correlation. Thus, the research highlights the significant role of cultural factors in analyzing a country's logistics performance.

Used a combined qualitative and quantitative approach to examine how countries' strategies relate to the Logistics Performance Index (LPI) in an uncertain business environment. They gathered data from various sources, including logistics journals, scientific articles, press releases, World Bank investment reports, news outlets, publications from transportation ministries, and expert opinions. The methodological framework involved two key steps: first, analyzing the logistics strategies of countries and their influence on LPI scores, and second, proposing policies to enhance countries' LPI scores to sustain and improve their global trade performance.

3. Model, data and estimation method

3.1. Model specification

To analyse the impact of aggregated logistics performance and its components on the export values of Vietnam, we mainly followed Anderson and Van Wincoop (2003) and Deardorff (2011) setting up the key regression model. Let EX_{ijt} denote the export from country i to country j at time t. A common empirical formulation of the gravity model for bilateral trade includes the Gross Domestic Product (GDP) levels of the two countries, Y_{it} and Y_{jt} say, as well as D_{ij}, a variable representing for distance between two countries. This formulation of the gravity equation can be written algebraically as

$$EX_{ijt} = Y_{it}Y_{jt}D_{ij}\varepsilon_{ijt} \tag{1}$$

where ε_{ijt} is a mean zero disturbance that is independent of the regressors in Equation (1). One of the most common approaches to estimate the regression in Equation (1) is to first make it linear by taking logarithms.

The main purpose of this study is using Equation (1) to examine effects of aggregated logistics performance and its components on the export values of Vietnam to 48 major export partners on the bilateral data level. Beside key variables are LPI and its sub-dices, we include other control variables suiting the export situation of Vietnam. For example, the free trade agreement (FTA) variable is added because the current trend of participating many FTA of Vietnam with the expectation that this participation will facilitate trade between Vietnam and other member countries. The general form of models used in this study can be expressed in log linear as follows:

$$lnEX_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \beta_4 FTA_{ijt} + \beta_5 lnLPI_{it} + \beta_6 lnLPI_{jt} + \varepsilon_{ijt} \tag{2}$$

$$lnEX_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \beta_4 FTA_{ijt} + \beta_5 lnCUS_{it} + \beta_6 lnCUS_{jt} + \varepsilon_{ijt} \tag{3}$$

$$lnEX_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \beta_4 FTA_{ijt} + \beta_5 INF_{it} + \beta_6 INF_{jt} + \varepsilon_{ijt} \tag{4}$$

$$lnEX_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \beta_4 FTA_{ijt} + \beta_5 LORSERV_{it} + \beta_6 LORSERV_{jt} + \varepsilon_{ijt} \tag{5}$$

$$lnEX_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \beta_4 FTA_{ijt} + \beta_5 INTSHIP_{it} + \beta_6 INTSHIP_{jt} + \varepsilon_{ijt} \tag{6}$$

$$lnEX_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \beta_4 FTA_{ijt} + \beta_5 TIME_{it} + \beta_6 TIME_{jt} + \varepsilon_{ijt} \quad (7)$$

$$lnEX_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3 lnD_{ij} + \beta_4 FTA_{ijt} + \beta_5 TRACKTRAC_{it} + \beta_6 TRACKTRAC_{jt} + \varepsilon_{ijt} \quad (8)$$

where EX_{ijt} represents bilateral real export values of Vietnam to partner j at time t; GDP_{it} denotes market size of Vietnam; GDP_{jt} denotes market size of partner j; lnD_{ij} represents distance between Vietnam and partner j; FTA_{ijt} represents free trade agreements between Vietnam and country j (which takes a value of 1, if these two countries have mutual agreements at time t and 0 otherwise); LPI_{it}, LPI_{jt} denotes aggregated Logistics performance index at time t of Vietnam and country j respectively; CUS_{it}, CUS_{jt} represents Custom index at time t of Vietnam and country j respectively; INF_{it}, INF_{jt} denotes Infrastructure index at time t of Vietnam and country j respectively; $LORSERV_{it}$, $LORSERV_{jt}$ represents Quality of logistics services index at time t of Vietnam and country j respectively; $INTSHIP_{it}$, $INTSHIP_{jt}$ represents Ease of arranging shipments index at time t of Vietnam and country j respectively; $TIME_{it}$, $TIME_{jt}$ denotes Timeliness index at time t of Vietnam and country j respectively; $TRACKTRAC_{it}$, $TRACKTRAC_{jt}$ represents Tracking and tracing index at time t of Vietnam and country j respectively; ε_{ijt} is error term of export equations, j includes 48 major export partners of Vietnam in the export equations, t denotes time.

3.2. Data specification

The dataset consisting of 240 observations includes Vietnam and 48 major export partners. Bi-annual data for the period 2010 to 2018 are used in the export equation. The export values of Vietnam to 48 major import partners are collected from the Direction of Trade Statistics (DOTS) of the International Monetary Fund (IMF). [2]In order to generate real export variables, the export values are then deflated by the US GDP deflator, which is obtained from the International Financial Statistics (IFS) of the IMF. The GDP data series of Vietnam and partner countries are used to represent the economic size of these countries collected from the United Nations Conference on Trade and Development (UNCTAD) with data in US dollars converted to constant prices in 2015. FTAs between Vietnam and trading partners are collected from the Vietnam Chamber of Commerce and Industry (VCCI). The bilateral distance is obtained from the General Statistic Office of Vietnam (GSO). LPI and its sub-indices are collected from the World Bank. The descriptive statistics for the variables used in the bilateral export equations are described in **Table 1**.

Table 1. Summary statistics of variables of the bilateral export equations.

Variable	Obs	Mean	Std. Dev.	Min	Max
lnEX	240	9.336	1.406	6.291	13.036
lnGDPvn	240	12.117	0.170	11.884	12.366
lnGDP	240	13.071	1.455	9.200	16.791
lnDIS	240	8.650	0.894	6.175	9.830
FTA	240	0.291	0.455	0.000	1.000
lnLPIvn	240	1.122	0.038	1.086	1.186

Table 1. (*Continued*).

Variable	Obs	Mean	Std. Dev.	Min	Max
lnLPI	240	1.204	0.161	0.726	1.441
lnCUSvn	240	1.017	0.038	0.974	1.081
lnCUS	240	1.125	0.197	0.613	1.430
lnINFvn	240	1.030	0.074	0.940	1.135
lnINF	240	1.180	0.211	0.566	1.490
lnLOGSERVvn	240	1.091	0.079	0.986	1.223
lnLOGSERV	240	1.193	0.176	0.700	1.461
lnINTSHIPvn	240	1.142	0.018	1.112	1.168
lnINTSHIP	240	1.172	0.139	0.761	1.429
lnTIMEvn	240	1.266	0.026	1.234	1.300
lnTIME	240	1.314	0.134	0.951	1.509
lnTRACKTRACvn	240	1.145	0.062	1.044	1.238
lnTRACKTRAC	240	1.220	0.170	0.566	1.476

Source: Compiled by authors.

3.3. Estimation method

As a panel dataset is used, panel estimators, such as pooled ordinary least squares (pooled OLS), fixed effects (FE), and random effects (RE) methods can be employed. In order to account for heteroskedasticity of an unknown form in the error term, we applied the robust option in Stata to correct for this issue (Wooldridge, 2002). In addition, we also correct all standard errors for clustering within each country using a generalisation of the White method. We then tested the statistical significance of the estimated coefficients using their standard errors based on this robust variance matrix. Then, we performed the variance inflation factor (VIF) procedure to detect possible multicollinearity in the regressors. According to Wooldridge (2009), if VIF exceeds the value of 10, one may conclude that there could be potential multicollinearity in the estimated regression. From the VIF results in Appendix, there is not enough evidence to conclude that multicollinearity presents a problem in our regression. Finally, we utilise the Hausman's specification test (FE vs. RE) to determine the preferred estimator for each model. Furthermore, an essential aspect of our econometric analysis involves the careful consideration of the time series properties of the data utilized in this study. Prior to our main regression analyses, we conducted a series of unit root tests to assess the stationarity of the variables. These tests, including the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron (PP) test, indicated that most variables were stationary at their level or first difference, thus mitigating concerns regarding spurious regression results due to non-stationarity.

Recently, dynamic panel Generalized method of moments (GMM) is increasingly applied to studies with panel dataset on the basis that it optimally exploits all linear moment restrictions specified by the model through the use of internal instruments derived from the orthogonal conditions between the lagged dependent variable and the idiosyncratic error term (Ahn & Schmidt, 1997; Arellano & Bond, 1991; Baum & Schaffer, 2003; Blundell & Bond, 1998). Despite its robustness, we have determined that GMM is not suitable for our study. This decision stems from a critical assessment

of the data against GMM's stringent prerequisites. Specifically, a fundamental prerequisite for system-GMM estimators is that the error terms should not exhibit serial correlation. In essence, these error terms must conform to a Moving Average process of order one (MA(1)), characterized by non-zero first-order autocorrelations and zero autocorrelations of second order or higher. Our empirical tests, however, do not reject the null hypothesis of no first-order serial correlation in error terms, thus violating this essential requirement. Given this, employing a GMM estimator for our panel data would be methodologically inappropriate and could compromise the validity of our results.

4. Results

4.1. Main results

The main results of the impacts of logistics performance on Vietnam's bilateral exports from the Ordinary Least Squares (OLS), Fixed Effects (FE) and Random Effects (RE) regressions for the period from 2010 to 2018 are presented in **Tables 2–4**, respectively.

When considering whether to use FE or RE for estimation, this study used Hausman test to check. The test results reported in **Tables 3** and **4** indicate that the estimation by RE is more appropriate in the models (2), (3), (4), (5), and (8), whereas FE is more suitable in the models (6), and (7). Therefore, the discussion of the results will mainly be based on FE in the models (6), and (7), and based on RE in the models (2), (3), (4), (5), and (8), in comparison with the results from OLS estimation reported in **Table 2**.

Table 2. Export estimation result by ordinary least squares.

	lnEX						
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
lnGDPvn	1.525***	1.491***	1.414***	1.230***	1.220***	1.711***	1.774***
	(4.29)	(2.73)	(4.56)	(2.80)	(4.29)	(5.60)	(6.46)
lnGDP	0.589***	0.624***	0.579***	0.578***	0.627***	0.631***	0.585***
	(15.87)	(14.68)	(12.90)	(12.36)	(14.39)	(14.19)	(12.88)
lnDIS	−0.639***	−0.637***	−0.646***	−0.638***	−0.607***	−0.660***	−0.655***
	(−10.26)	(−11.56)	(−11.84)	(−11.62)	(−10.96)	(−12.06)	(−12.16)
FTA	0.520***	0.474***	0.520***	0.545***	0.540***	0.491***	0.513***
	(4.35)	(4.50)	(4.90)	(5.15)	(5.38)	(4.72)	(5.02)
lnLPIvn	1.346	-	-	-	-	-	-
	(0.87)	-	-	-	-	-	-
lnLPI	2.448***	-	-	-	-	-	-
	(7.47)	-	-	-	-	-	-
lnCUSvn	-	0.977	-	-	-	-	-
	-	(0.40)	-	-	-	-	-
lnCUS	-	1.853***	-	-	-	-	-
	-	(7.60)	-	-	-	-	-

Table 2. (*Continued*).

| | **lnEX** | | | | | | |
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
lnINFvn	-	-	1.206*	-	-	-	-
	-	-	(1.78)	-	-	-	-
lnINF	-	-	1.895***	-	-	-	-
	-	-	(7.63)	-	-	-	-
lnLOGSERVvn	-	-	-	1.224	-	-	-
	-	-	-	(1.31)	-	-	-
lnLOGSERV	-	-	-	2.319***	-	-	-
	-	-	-	(7.49)	-	-	-
lnINTSHIPvn	-	-	-	-	7.300***	-	-
	-	-	-	-	(2.61)	-	-
lnINTSHIP	-	-	-	-	2.405***	-	-
	-	-	-	-	(6.58)	-	-
lnTIMEvn	-	-	-	-	-	2.365	-
	-	-	-	-	-	(1.21)	-
lnTIME	-	-	-	-	-	2.266***	-
	-	-	-	-	-	(5.49)	-
lnTRACKTRACvn	-	-	-	-	-	-	0.268
	-	-	-	-	-	-	(0.38)
lnTRACKTRAC	-	-	-	-	-	-	2.334***
	-	-	-	-	-	-	(7.65)
_cons	−15.92***	−14.59***	−13.42***	−11.86**	−19.71***	−20.04***	−17.45***
	(−4.74)	(−3.12)	(−3.81)	(−2.56)	(−5.26)	(−5.45)	(−5.23)
N	240	240	240	240	240	240	240
adj. R^2	0.774	0.773	0.775	0.776	0.770	0.752	0.772

Source: Compiled by authors. Notes: The figures in parentheses are standard errors for coefficients; ***, **, and * in the table denote statistical significant coefficient at 1 per cent, 5 per cent and 10 per cent level respectively.

The estimation results show that logistics performance and its components have positive and mostly significant effects on Vietnam's exports. There are more equations with OLS- and RE-derived estimation measures than those equations with FE-derived estimation measures (9 and 10 vs 6) in which logistics indicators have statistically significant impacts on export flows. The Adjusted R Squared in all estimates shows that the mode's variables can explain approximately 63–77 per cent of the fluctuations in the export flow of Vietnam and its 48 main trading partners in the period 2010–2018.

Table 3. Export estimation results by fixed effects.

	lnEX						
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
lnGDPvn	1.789***	1.754***	1.639***	1.498***	1.624***	1.891***	1.966***
	(6.18)	(5.59)	(6.19)	(5.24)	(6.01)	(6.90)	(7.15)
lnGDP	0.353	0.367	0.260	0.304	0.235	0.307	0.358
	(0.73)	(0.77)	(0.55)	(0.64)	(0.50)	(0.64)	(0.75)
lnDIS	-	-	-	-	-	-	-
	-	-	-	-	-	-	-
FTA	0.352	0.337	0.354	0.355	0.372	0.383	0.359
	(0.79)	(0.75)	(0.83)	(0.79)	(0.91)	(0.82)	(0.80)
lnLPIvn	1.035***	-	-	-	-	-	-
	(3.17)	-	-	-	-	-	-
lnLPI	0.653	-	-	-	-	-	-
	(1.08)	-	-	-	-	-	-
lnCUSvn	-	0.821	-	-	-	-	-
	-	(1.54)	-	-	-	-	-
lnCUS	-	0.734**	-	-	-	-	-
	-	(2.65)	-	-	-	-	-
lnINFvn	-	-	1.347***	-	-	-	-
	-	-	(8.19)	-	-	-	-
lnINF	-	-	0.549	-	-	-	-
	-	-	(1.53)	-	-	-	-
lnLOGSERVvn	-	-	-	1.191***	-	-	-
	-	-	-	(5.10)	-	-	-
lnLOGSERV	-	-	-	0.677	-	-	-
	-	-	-	(1.62)	-	-	-
lnINTSHIPvn	-	-	-	-	8.091***	-	-
	-	-	-	-	(8.75)	-	-
lnINTSHIP	-	-	-	-	−0.200	-	-
	-	-	-	-	(−0.50)	-	-
lnTIMEvn	-	-	-	-	-	1.241**	-
	-	-	-	-	-	(2.15)	-
lnTIME	-	-	-	-	-	−0.498	-
	-	-	-	-	-	(−0.98)	-
lnTRACKTRACvn	-	-	-	-	-	-	0.0656
	-	-	-	-	-	-	(0.36)
lnTRACKTRAC	-	-	-	-	-	-	0.347
	-	-	-	-	-	-	(0.97)
_cons	−19.01***	−18.47***	−16.06***	−15.00***	−22.53***	−18.63***	−19.77***
	(−4.31)	(−4.22)	(−3.74)	(−3.30)	(−5.20)	(−4.27)	(−4.60)
N	240	240	240	240	240	240	240
adj. R^2	0.625	0.629	0.655	0.636	0.693	0.627	0.622
Hausman test (p-value)	-	-	-	-	0.000	0.022	-

Source: Compiled by authors. Notes: The figures in parentheses are standard errors for coefficients; ***, **, and * in the table denote statistically significant coefficient at 1 per cent, 5 per cent and 10 per cent level respectively.

As predicted by the gravity model, both the economic size of Vietnam and the partner country have a positive impact on Vietnam's exports, regardless of which estimation method was used. The impacts of Vietnam's GDP on exports are positive and significant at 1 per cent in all models. With magnitude of effects from 1.22 to 1.78, given that the GDP variables are expressed in logarithms, it can be interpreted that a 1 per cent grow in Vietnam's GDP will increase bilateral exports of Vietnam by 1.22 to 1.78 per cent depending on the model and estimation measure used. This result is consistent with economic theory in that an increase in GDP means the size of Vietnam's economy becomes larger, thus Vietnam is not only able to increase production's scale but also able to diversify production activities, as well as improve the products' quality. At that time, Vietnam can produce many different goods with increasing quantity and quality to serve various demands of partners, so it will encourage exports from Vietnam to the partners. Regarding the GDP coefficient of the partner countries, while this impact from the pooled OLS and RE-derived model is significant at 1 per cent levels, the effect from the FE-derived model is insignificant. The estimated coefficient of the OLS and RE model is between 0.58 and 0.66 per cent implying that a 1 per cent increase in a Vietnam counterpart's GDP is linked with a 0.58–0.66 per cent increase in the exports of the country. This is because when the economic size of the partner country increases, it is likely to people's income in this country increases, encouraging ability to spend, leading to grow in consumer demand, including goods from Vietnam, hence it will increase commodities exported from the country.

Since time invariant variables are not reported in the FE model, the coefficients of Distance are only significant in the OLS and RE models at 1 per cent of significance level. The estimation results show that the longer the distance between Vietnam and her partner, the less Vietnam's products are exported to the counterpart. The estimation results suggest that exports from Vietnam will decline approximately 0.61–0.66 per cent, associated with a further 1 per cent increase in distance between two countries. The results make economic sense, as increasing geographical distance costing more transportation fees creating more trade costs for exports, reducing competitive advantages of Vietnam's commodities, as a result, it may reduce trade from Vietnam to partners.

Table 4. Export estimation results by random effects.

	lnEX						
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
lnGDPvn	1.581***	1.558***	1.429***	1.287***	1.351***	1.682***	1.784***
	(8.27)	(7.24)	(8.29)	(6.18)	(7.55)	(8.93)	(9.79)
lnGDP	0.641***	0.660***	0.638***	0.641***	0.707***	0.717***	0.670***
	(7.27)	(7.63)	(7.43)	(7.19)	(8.03)	(7.97)	(7.23)
lnDIS	−0.662***	−0.658***	−0.661***	−0.662***	−0.647***	−0.657***	−0.661***
	(−5.32)	(−5.21)	(−5.17)	(−5.14)	(−4.95)	(−4.73)	(−5.16)
FTA	0.415	0.395	0.418	0.420	0.419	0.412	0.426
	(1.54)	(1.44)	(1.51)	(1.50)	(1.64)	(1.38)	(1.57)

Table 4. (*Continued*).

	lnEX						
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
lnLPIvn	1.170***	-	-	-	-	-	-
	(3.35)	-	-	-	-	-	-
lnLPI	1.467***	-	-	-	-	-	-
	(3.24)	-	-	-	-	-	-
lnCUSvn	-	0.876	-	-	-	-	-
	-	(1.52)	-	-	-	-	-
lnCUS	-	1.137***	-	-	-	-	-
	-	(4.46)	-	-	-	-	-
lnINFvn	-	-	1.285***	-	-	-	-
	-	-	(7.38)	-	-	-	-
lnINF	-	-	1.024***	-	-	-	-
	-	-	(3.26)	-	-	-	-
lnLOGSERVvn	-	-	-	1.194***	-	-	-
	-	-	-	(4.72)	-	-	-
lnLOGSERV	-	-	-	1.244***	-	-	-
	-	-	-	(3.43)	-	-	-
lnINTSHIPvn	-	-	-	-	7.834***	-	-
	-	-	-	-	(8.19)	-	-
lnINTSHIP	-	-	-	-	0.297	-	-
	-	-	-	-	(0.83)	-	-
lnTIMEvn	-	-	-	-	-	1.529***	-
	-	-	-	-	-	(2.68)	-
lnTIME	-	-	-	-	-	0.244	-
	-	-	-	-	-	(0.50)	-
lnTRACKTRACvn	-	-	-	-	-	-	0.126
	-	-	-	-	-	-	(0.67)
lnTRACKTRAC	-	-	-	-	-	-	0.921**
	-	-	-	-	-	-	(2.46)
_cons	−15.67***	−14.76***	−13.25***	−11.83***	−20.11***	−17.11***	−16.71***
	(−5.44)	(−5.00)	(−4.80)	(−3.78)	(−6.82)	(−5.83)	(−5.99)
N	240	240	240	240	240	240	240
adj. R^2	0.790	0.789	0.785	0.787	0.699	0.635	0.777
Hausman test (p-value)	0.361	0.469	0.697	0.616	-	-	0.071

Source: Compiled by authors. Notes: The figures in parentheses are standard errors for coefficients; ***, **, and * in the table denote statistical significant coefficient at 1 per cent, 5 per cent and 10 per cent level respectively.

The estimated results of the FTA variables show that participation in free trade agreements has a positive impact on Vietnam's exports as this coefficient is positive, however, apart from OLS model, this positive result is not significant. Because of statistical insignificance, this study does not pay more attention to analyze the effect

of the FTA variables. Despite their insignificance in FE and RE estimates, the variables of FTA were not removed from the models, as removing them may have distorted the signs and explanatory power of the other variables.

In general, the estimated results of Model (2) in both OLS and RE methods are almost unchanged in both magnitudes and levels of statistical significance. The coefficients of aggregate logistics performance of Vietnam and of her partners with positive and statistically significant values at 1 per cent levels in both estimation methods indicate that the overall logistics excellent of both Vietnam and its partners has a positive impact on Vietnam's exports. The magnitudes of the effects are 1.17 and 1.47, implying that a 1 per cent increase in logistics efficiencies of the country and its counterparts lead to a growth in exports of Vietnam about 1.17 and 1.47 per cent respectively. These coefficients yield the preliminary expectations of signs and significance, indicating the importance of logistics performance to trade flows, as improving the quality of logistics operations is considered as trade facilitation.

Regarding custom performance, the empirical results show that an improvement in custom efficiency of Vietnam and its partners has a positive effect on Vietnam's bilateral exports. However, the level of significance for the two coefficients is different, while the impact from the custom performance of the partner is significant at 1 per cent levels, the effect from Vietnam's custom fulfillment is insignificant. With magnitude of effects at 1.14, it can be interpreted that a 1 per cent improvement in the counterpart's custom performance will increase bilateral exports of Vietnam by 1.14 per cent. For exported commodities, customs clearance is more important in the purchasing country compared to the exporting country because these goods must meet administrative and legal requirements of importing country to cross the customs border, whereas in Vietnam, the government had already reduced and simplified many customs clearance procedures to encourage exports.

The positive and significant coefficients of Infrastructure measure of Vietnam and its partners denote that developing infrastructure increase the bilateral exports of the country. The impacts of the two mentioned LPI sub-indices on exports are significant at the 1 per cent level. The estimated coefficient is 1.29 and 1.02. It can be interpreted that an increase in bilateral exports of Vietnam by 1.29 and 1.02 per cent are associated with developing 1 per cent the infrastructure in Vietnam and its trading partners respectively. Since improvement in quality and quantity transport infrastructure, such as road density and road network, air transport, railways, and ports, helping transportation of goods and materials is easier and more convenient thereby encouraging the movement of goods and promoting international trade. Furthermore, the availability and quality of infrastructure also impacts location decisions of multinational enterprises (MNEs). Those MNEs produce and distribute exported commodities for international markets, hence, increase exports of their host economies. It worth to note that Vietnam has been recognized as one of the most attractive host countries in the Asia.

The estimation results of Logistics services quality variables of Vietnam and of its exporting partner show the expected positive signs and statistically significant at conventional level. The estimation results suggest that a 1 per cent improvement in quality of logistics services leads to an expansion in exports by 1.19 and 1.24 per cent, respectively. The impacts of logistics service quality on bilateral exports are

significant at the 1 per cent level. The quality of logistics services is important to both the exporting and the importing country because of improving the quality of freight services of multimodal transportation; warehousing and distribution enterprises; quarantine agencies; customs authorities; customs agents; forwarding agents… facilitate the movement of goods, thereby promoting international trade.

A progression in Ease of arranging shipments of Vietnam and of its exporting partners have a positive impact on the country's exports. However, while this impact from the competitively priced shipments of Vietnam is significant at 1 per cent levels, the effect from the component of export partner is insignificant. The estimated coefficient of the Ease of arranging shipments of Vietnam is 8.09, which indicates that 1 per cent increase in competitively priced shipments of Vietnam lead to an expansion in its exports by 8.09 per cent. Regarding to Vietnam's exports, this LPI component is the most important because domestic enterprises have not yet accounted for a large market share of international shipping and logistics in Vietnam. Freight rates and schedules almost depend on foreign enterprises, that has reduced proactively plans and reduced competitiveness of Vietnamese commodities because it is difficult to negotiate competitive freight rates, and convenient delivery schedules with foreign shipping lines. Therefore, if this indicator can be improved, it will further encourage the country's exports.

Although the estimation results of the Timeliness of Vietnam and of its counterpart variables yield the expected signs, the significant level of the two variables are completely different. While the export effects of Vietnam's Timeliness are positive and statistically significant at 5 per cent, the positive impacts from the partner's logistic component are insignificant. With magnitude of effects at 1.24, given that the variable is expressed in logarithms, indicating that a 1 per cent improvement in Timeliness of Vietnam rise bilateral exports of Vietnam by 1.24 per cent. In Vietnam, the country's shipping fleet is only about 7 per cent of the international shipping market share compared to 93 per cent of foreign shipping lines (GSO), which has negatively affected on-time delivery. Therefore, if this index can be improved, it will have a great impact on encouraging exports from Vietnam.

Finally, the empirical results show that the coefficients of Tracking and tracing of Vietnam and its counterpart have the expected signs as they have a significant positive effect on bilateral exports. However, the Vietnam's partners-derived tracking and tracing performance is significant at 5 per cent level whereas the country-derived component is insignificant. The magnitude of the coefficient is 0.92 which reflect that an additional 1 per cent enhancement in tracking and tracing performance of Vietnam's partner, leads to an enlargement by 0.92 per cent in exports of Vietnam. This LPI component has greater impacts for the purchasing country as intermediaries and customers tend to track and trace commodities after the goods have arrived in the importing country.

4.2. Robustness checks

In this section, we undertake several robustness checks to validate the reliability of our findings. Firstly, we employ an alternative measure for market size to ascertain the consistency of our results. This approach allows us to verify the robustness of our

conclusions against different metrics and perspectives on market size. Specifically, we use alternative measure of market size, per capita income of the partner country j (PPP_j), to replace the size of economy of the partner country j (GDPj) used so far. The results of estimating Equations (2)–(8) with the new measure of market size by the both FE and RE estimation methods are presented in **Table 5**.

Table 5 indicates that the use of the new proxy variable, which is the partner country's income per capita instead of the partner country's economic size variable, does not significantly change the estimated results. The coefficients of all explanatory variables in **Tables 2–4** compared to **Table 5** are in the same signs and of almost the same magnitudes. This further confirmed the sustainability of the research results. In all cases, the main variable to be studied in this paper the logistics performance and its components variables also provide similar results to the previous estimates. Thus, it can be concluded that that our results are not sensitive to the way in which market size are measured.

Table 5. Export estimation results using PPP variables.

	lnEX						
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
lnGDPvn	1.756***	1.747***	1.590***	1.453***	1.538***	1.823***	1.944***
	(9.17)	(8.17)	(9.31)	(7.06)	(6.11)	(7.03)	(10.74)
lnPPP	0.458***	0.487***	0.444***	0.452***	0.586	0.632	0.514***
	(3.07)	(3.49)	(3.18)	(3.33)	(1.01)	(1.06)	(3.61)
lnDIS	−0.598***	−0.600***	−0.595***	−0.597***	-	-	−0.608***
	(−3.51)	(−3.33)	(−3.49)	(−3.46)	-	-	(−3.56)
FTA	0.411	0.389	0.420	0.418	0.384	0.391	0.432
	(1.21)	(1.08)	(1.25)	(1.21)	(0.95)	(0.85)	(1.27)
lnLPIvn	1.135***	-	-	-	-	-	-
	(3.32)	-	-	-	-	-	-
lnLPI	1.261**	-	-	-	-	-	-
	(2.36)	-	-	-	-	-	-
lnCUSvn	-	0.834	-	-	-	-	-
	-	(1.52)	-	-	-	-	-
lnCUS	-	0.887***	-	-	-	-	-
	-	(3.39)	-	-	-	-	-
lnINFvn	-	-	1.303***	-	-	-	-
	-	-	(7.37)	-	-	-	-
lnINF	-	-	0.993***	-	-	-	-
	-	-	(2.80)	-	-	-	-
lnLOGSERVvn	-	-	-	1.199***	-	-	-
	-	-	-	(4.81)	-	-	-
lnLOGSERV	-	-	-	1.156***	-	-	-
	-	-	-	(3.08)	-	-	-
lnINTSHIPvn	-	-	-	-	8.059***	-	-
	-	-	-	-	(8.79)	-	-

Table 5. (*Continued*).

	lnEX						
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
lnINTSHIP	-	-	-	-	−0.222	-	-
	-	-	-	-	(−0.55)	-	-
lnTIMEvn	-	-	-	-	-	1.236**	-
	-	-	-	-	-	(2.14)	-
lnTIME	-	-	-	-	-	−0.465	-
	-	-	-	-	-	(−0.91)	-
lnTRACKTRACvn	-	-	-	-	-	-	0.104
	-	-	-	-	-	-	(0.55)
lnTRACKTRAC	-	-	-	-	-	-	0.753**
	-	-	-	-	-	-	(2.19)
_cons	−14.01***	−13.19***	−11.61***	−10.19***	−23.89***	−19.80***	−14.99***
	(−4.77)	(−4.24)	(−4.11)	(−3.20)	(−5.93)	(−4.90)	(−5.31)
N	240	240	240	240	240	240	240
adj. R2	0.634	0.639	0.662	0.644	0.697	0.631	0.631

Source: Compiled by authors. Notes: The figures in parentheses are standard errors for coefficients; ***, **, and * in the table denote statistical significant coefficient at 1 per cent, 5 per cent and 10 per cent level respectively.

Secondly, we include the variable multilateral resistance terms, Multilateral Resistance Terms (MRT), in our analysis (Anderson and Van Wincoop, 2003)[3]. The MRT is crucial for capturing the resistance to trade that countries face due to factors other than bilateral trade costs. By incorporating MRT into our model, we address potential biases and provide a more comprehensive understanding of the factors influencing Vietnam's export performance. The inclusion of MRT in our analysis, as depicted in the **Table 6**, reaffirms the robustness of our previous findings. The results indicate that the introduction of MRT variables does not significantly alter the magnitude or direction of the estimated coefficients compared to those presented in **Tables 2–5**. Specifically, key variables such as lnGDPvn, lnPPP, and lnDIS maintain their statistical significance and directional influence. This consistency underlines the stability of our model and supports the reliability of our conclusions, even with the addition of the MRT variables. The MRT's inclusion, therefore, enhances the model's comprehensiveness without deviating from the established understanding of the factors influencing Vietnam's export performance.

Table 6. Inclusion of the multilateral resistance terms.

	lnEX						
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
lnGDPvn	1.893***	1.899***	1.650***	1.570***	1.531***	1.909***	2.091***
	(0.153)	(0.162)	(0.139)	(0.167)	(0.203)	(0.219)	(0.144)
lnPPP	0.228**	0.260***	0.224**	0.220**	0.463	0.536	0.315***
	(0.103)	(0.095)	(0.100)	(0.092)	(0.507)	(0.515)	(0.097)

Table 6. (*Continued*).

	lnEX						
	(2)	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
MRT	0.275***	0.272***	0.281***	0.277***	0.264***	0.231***	0.279***
	(0.046)	(0.048)	(0.046)	(0.045)	(0.057)	(0.065)	(0.047)
lnDIS	−0.321***	−0.322**	−0.315***	−0.320***	0.000	0.000	−0.338***
	(0.115)	(0.125)	(0.116)	(0.117)	-	-	(0.121)
FTA	0.275	0.268	0.283	0.278	0.363	0.371	0.275
	(0.258)	(0.277)	(0.256)	(0.261)	(0.337)	(0.415)	(0.264)
lnLPIvn	1.091***	-	-	-	-	-	-
	(0.282)	-	-	-	-	-	-
lnLPI	1.255***	-	-	-	-	-	-
	(0.455)	-	-	-	-	-	-
lnCUSvn	-	0.712	-	-	-	-	-
	-	(0.447)	-	-	-	-	-
lnCUS	-	0.878***	-	-	-	-	-
	-	(0.240)	-	-	-	-	-
lnINFvn	-	-	1.575***	-	-	-	-
	-	-	(0.145)	-	-	-	-
lnINF	-	-	0.924***	-	-	-	-
	-	-	(0.306)	-	-	-	-
lnLOGSERVvn	-	-	-	1.232***	-	-	-
	-	-	-	(0.217)	-	-	-
lnLOGSERV	-	-	-	1.193***	-	-	-
	-	-	-	(0.318)	-	-	-
lnINTSHIPvn	-	-	-	-	9.427***	-	-
	-	-	-	-	(0.782)	-	-
lnINTSHIP	-	-	-	-	−0.088	-	-
	-	-	-	-	(0.302)	-	-
lnTIMEvn	-	-	-	-	-	0.923*	-
	-	-	-	-	-	(0.478)	-
lnTIME	-	-	-	-	-	−0.598	-
	-	-	-	-	-	(0.388)	-
lnTRACKTRACvn	-	-	-	-	-	-	−0.088
	-	-	-	-	-	-	(0.140)
lnTRACKTRAC	-	-	-	-	-	-	0.481*
	-	-	-	-	-	-	(0.261)
_cons	−16.353***	−15.667***	−13.40***	−12.391***	−24.893***	−19.812***	−17.166***
	(2.203)	(2.286)	(2.160)	(2.369)	(3.444)	(3.344)	(2.174)

Source: Compiled by authors. Notes: The figures in parentheses are standard errors for coefficients; ***, **, and * in the table denote statistical significant coefficient at 1 per cent, 5 per cent and 10 per cent level respectively.

These robustness checks reinforce the validity of our results, confirming that our

findings are not sensitive to the specific measures of market size used and are robust to the inclusion of additional relevant variables like MRT. This strengthens the credibility and generalizability of our study, ensuring that our conclusions are well-founded and reliable.

5. Conclusion and policy implication

The empirical results have shown a positive relationship between logistics performance and Vietnam's exports. This study's results have confirmed the importance of logistics performance in facilitating this country's exports as overall LPI surpasses other variables such as the GDP of the partner country or the FTA in terms of magnitude and statistically significant level. In addition, the results also show that all LPI sub-indices have positive impacts on Vietnam's exports. These export's effects are identified in order of importance by Vietnam's LPI components such as Ease of arranging shipments, Infrastructure, Timeliness, and Quality of logistics services, and by partners' LPI indicators namely Quality of logistics services, Customs, Infrastructure, and Tracking and tracing. Therefore, to continue promoting exports, besides solutions implemented in the country, the Vietnamese government needs to cooperate and propose arguments to trading partners for improving their logistics efficiency. The government also needs to disseminate the importance of logistics to Vietnam' exporters, orienting these enterprises focus on markets with high LPI to be more favorable in promoting exports.

Based on the insights garnered from our study, it is evident that Vietnam's export sector can greatly benefit from a series of strategic actions aimed at enhancing logistic efficiency. Firstly, the Vietnamese government should proactively engage in dialogue with international trading partners to foster improvements in logistics efficiency. Such international cooperation is crucial for creating an environment conducive to export growth. By working collaboratively with other nations, Vietnam can leverage shared expertise and resources to elevate its logistic capabilities, ultimately facilitating smoother export processes and broadening market access.

Simultaneously, there is a need to emphasize the significance of logistics to Vietnamese exporters. By understanding the impact of high Logistic Performance Index (LPI) scores, exporters can strategically target markets where logistic processes are more efficient, thereby easing export procedures and expanding their global footprint. This market-oriented approach is essential for navigating the complexities of international trade and maximizing export potential.

Furthermore, the development of a national container fleet stands as a pivotal element in reducing logistics costs and bolstering the competitiveness of Vietnamese exports. Policymakers should advocate for the establishment and expansion of this fleet, tapping into private investments, Foreign Direct Investment (FDI), and public-private partnerships. This diversified investment approach is key to ensuring the financial viability of the project while minimizing the burden on the national budget.

Enhancing the logistics infrastructure is another critical step. By focusing on the development and modernization of warehouses, distribution centers, and transport networks, Vietnam can facilitate more efficient multimodal transport solutions. This infrastructural advancement is not only about cost reduction but also about

diversifying export commodities, thereby strengthening the resilience and adaptability of Vietnam's export sector.

The digital transformation of the logistics sector is an imperative stride towards keeping pace with global trends. Accelerating the adoption of information technology and digital solutions in logistics operations will streamline processes, enhance overall efficiency, and ensure that Vietnam remains competitive in the international logistics arena.

Lastly, the development of human resources in logistics is paramount. By promoting both short-term training programs and comprehensive university courses, Vietnam can cultivate a skilled workforce adept in contemporary logistic practices. This focus on education and training is essential for equipping professionals with the skills and knowledge necessary to meet the ever-evolving demands of the logistics industry.

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

Notes

[1.] It is crucial to note that our analysis uses data up to the year 2018. This decision was made in light of the significant disruptions caused by the Covid-19 pandemic on international trade activities. The pandemic, which began in late 2019, led to widespread cancellations and severe interruptions in global trade, rendering data from 2019 to 2021 anomalous and not reflective of typical trade patterns. To maintain the integrity and consistency of our analysis, we have chosen to exclude this period, acknowledging that this limitation restricts our study's ability to capture the pandemic's full impact on Vietnam's export sector.

[2.] In this study, we have focused on a selected sample of 48 trading partners for Vietnam. This selection is not arbitrary but is instead based on a strategic assessment of trade volume. These 48 countries collectively account for over 95% of Vietnam's total trade volume, making them the most significant contributors to the nation's export and import activities. This high percentage of coverage ensures that our analysis captures the majority of Vietnam's trade dynamics, providing a comprehensive understanding of the logistic performance's impact on exports. The inclusion of these countries, therefore, offers a robust representation of Vietnam's global trade interactions, underpinning the relevance and validity of our findings in the context of Vietnam's international trade.

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Appendix

VIF calculation for selected variables

Table A1. Model (2).

Variable	VIF	1/VIF
lnGDPvn	1.95	0.511
lnLPIvn	1.95	0.513
lnDIS	1.66	0.603
FTA	1.58	0.632
lnGDP	1.56	0.642
lnLPI	1.5	0.668
Mean VIF	1.7	-

Table A2. Model (3).

Variable	VIF	1/VIF
lnGDPvn	5.17	0.193
lnLPIvn	5.16	0.193
lnDIS	1.66	0.602
FTA	1.57	0.636
lnGDP	1.37	0.732
lnLPI	1.29	0.777
Mean VIF	2.7	-

Table A3. Model (4).

Variable	VIF	1/VIF
lnGDPvn	1.66	0.603
lnLPIvn	1.64	0.611
lnDIS	1.59	0.630
FTA	1.58	0.631
lnGDP	1.58	0.632
lnLPI	1.58	0.632
Mean VIF	1.6	-

Table A4. Model (5).

Variable	VIF	1/VIF
lnGDPvn	3.37	0.296
lnLPIvn	3.36	0.297
lnDIS	1.66	0.602
FTA	1.62	0.618
lnGDP	1.59	0.629
lnLPI	1.57	0.637
Mean VIF	2.19	-

Table A5. Model (6).

Variable	VIF	1/VIF
lnGDPvn	1.67	0.597
lnLPIvn	1.59	0.628
lnDIS	1.41	0.707
FTA	1.35	0.741
lnGDP	1.35	0.742
lnLPI	1.34	0.747
Mean VIF	1.45	-

Table A6. Model (7).

Variable	VIF	1/VIF
lnGDPvn	1.66	0.602
lnLPIvn	1.58	0.634
lnDIS	1.5	0.668
FTA	1.46	0.683
lnGDP	1.36	0.735
lnLPI	1.36	0.736
Mean VIF	1.49	-

Table A7. Model (8).

Variable	VIF	1/VIF
lnGDPvn	1.66	0.603
lnLPIvn	1.59	0.628
lnDIS	1.58	0.633
FTA	1.55	0.647
lnGDP	1.08	0.925
lnLPI	1.08	0.928
Mean VIF	1.42	-