

# The Role of Logistics in Improving Vietnam's Export Efficiency

Huy Vu Le<sup>1</sup>, Nguyen Thi Nha Trang\*<sup>2</sup>, and Nhung Nguyen Thi Cam<sup>3</sup>

**Abstract:** This paper studies the impacts of logistics performance on Vietnam's export efficiency, using the stochastic frontier gravity model (SFGM). While the existing literature focused on the relationship between logistics and exports from a cost-reduction perspective, this paper scrutinizes the efficiency perspective of international trade. The analysis utilizes bilateral export data between Vietnam and its trading partners from 2005 to 2022. Greene's True Random Effects (TRE) and True Fixed Effects (TFE) estimators are applied within the SFGM framework to address unobserved, time-invariant heterogeneity among trading pairs between Vietnam and its partners while enabling export efficiency to temporally change. The results show that both Vietnam's and partners' logistics performances significantly and positively affect export efficiency, diminishing the gap between actual bilateral export turnovers and the corresponding potential levels. The effect of Vietnam's logistics performance is higher than that of its trading partners, indicating the greater importance of export logistics capabilities. These results indicate the crucial role of logistics in reducing "behind the border" constraints and provide a new insight into the logistics-trade relationship. The robustness of the findings is confirmed using instrumental variables regression. The policy implications include the necessity of consistent investments and improvements in logistics performance to overcome implicit trade barriers, further unlock Vietnam's export potential, and facilitate its competitiveness in the international markets.

**Keywords:** Export efficiency, logistics performance, stochastic frontier gravity model, true fixed effects, true random effects, Vietnam.

## 1. INTRODUCTION

Since implementing comprehensive reforms, known as the Doi Moi policy in 1986, Vietnam has further integrated into the global economy through expanding trade and investment relations with major countries in Asia, Europe, and North America [1]. By providing an important source of foreign exchange and supporting the economy during the global recession and the COVID-19 pandemic, exports have contributed significantly to the country's economic growth [2]. Vietnam so far has successfully joined 17 free trade agreements (FTAs), facilitating its access to foreign markets. However, there are remaining challenges, likely including non-tariff barriers from importing countries, competition from other exporting countries, and domestic bottlenecks. These challenges have prevented Vietnam's exports from reaching their full potential.

These difficulties have been well recognized by practitioners, scholars, and policymakers. Recent policies have shown Vietnamese government's efforts to sustain

export and economic growth by improving the logistics efficiency. Specifically, the country has identified several logistics-related strategic objectives such as transport infrastructure improvements, warehousing system expansions and logistics cost reduction (Decision No. 493/QD-TTg, 2022). Besides, Vietnam aims at attaining an annual growth rate of 12-15% in the sector of logistics services and having at least ten international-standard logistics centers by 2050 (Decision No. 2229/QD-TTg, 2025).

There are some empirical studies having examined the relationships between logistics performance and the export growth of Vietnam, using the gravity model of trade. Huynh [2] discovered a significant relationship between logistics performance and the exports of Vietnam to 48 major importing countries from 2010 to 2018. Doan and Vu [3] investigated the effects of specific logistics components on the exports to 158 trading partners, emphasizing the importance of customs efficiency, service competence, tracking and tracing, and timeliness. Tran et al. [4] studied how green logistics

Manuscript received November 14, 2025; received in revised form December 22, 2025; accepted January 15, 2026; available online March 30, 2026.

Huy Vu Le, Nguyen Thi Nha Trang, and Nhung Nguyen Thi Cam are with the Faculty of Economics, Vietnam Maritime University, Haiphong, Vietnam (e-mails: [huy.vule@vimaru.edu.vn](mailto:huy.vule@vimaru.edu.vn), [trangntn@vimaru.edu.vn](mailto:trangntn@vimaru.edu.vn), and [nhungntc.ktb@vimaru.edu.vn](mailto:nhungntc.ktb@vimaru.edu.vn)).

\* Corresponding author.

affects the exports of Vietnam to Regional Comprehensive Economic Partnership (RCEP) members from 2012 to 2018. Using random effect models, they also found a positive relationship between emission-adjusted logistics performance and the exports. Although these papers have provided valuable insights, they mostly utilized the standard gravity framework, which primarily considers logistics as a determinant of trade costs and bypasses the potential role of logistics in reducing trade inefficiency or diminishing the gap between actual and potential trade levels.

Both explicit and implicit barriers can adversely influence export performance. Apart from explicit factors such as tariffs and exchange rate fluctuations, “behind the border” constraints, including inadequate infrastructure, onerous administrative procedures, and weak institutional quality can also incur inefficiencies in bilateral trade [5,6]. Traditional gravity models, although widely used, inadequately capture these unobservable barriers. Potentially, logistics can influence both explicit and implicit constraints. Agile logistics capabilities not only can reduce the trading costs in the lean approach [7] but also can lessen trade inefficiency by improving flexibility, responsiveness, and reliability, enabling exporters to adapt quickly to uncertainties and bottlenecks in their production chains and access to foreign markets [8]. However, the role of logistics is only investigated through the ‘ice-berg’ cost approach in the conventional gravity models, and has not been empirically examined, especially for the case of Vietnam.

To address these gaps, this study applies the stochastic frontier gravity model (SFGM) to estimate Vietnam’s bilateral export efficiency and to examine the impact of logistics performance on trade inefficiency reduction. In addition, the study integrates the True Random Effects (TRE) and True Fixed Effects (TFE) models [9] into the SFGM framework to control for unobserved, time-invariant heterogeneity among trading links between Vietnam and its partners while allowing export inefficiency to change temporally. This approach improves the accuracy and robustness of efficiency estimation and provides new insights into how logistics development can enhance Vietnam’s exports.

The remainder of the paper is arranged as follows. Section 2 presents the methodology and model specifications. Section 3 describes the data sources and descriptive statistics of variables. Section 4 reports and discusses the estimation results. Lastly, Section 5 concludes the study.

## 2. METHODOLOGY

### 2.1. Gravity model of trade

The gravity model is among the most successful frameworks applied to the research on international economics. The model has been widely used to study trade flows between countries [10]. Inspired by Newton’s universal law of gravitation, the model was first adopted by Tinbergen [11] to analyze international trade patterns. The basic gravity model expresses bilateral trade as a function of the trading partners’ economic sizes and the geographical distance between them, as follows:

$$X_{ij} = f(GDP_i, GDP_j, Dist_{ij}) \quad (1)$$

In Equation (1), trade between countries  $i$  and  $j$  (denoted as  $X_{ij}$ ) is positively related to their economic masses (proxied by their gross domestic products, and denoted as  $GDP_i$  and  $GDP_j$ ), but is adversely proportionate to the geographical distance ( $Dist_{ij}$ ). Conceptually, larger economies, which are equivalent to higher production and consumption capacities, tend to trade more with others. In contrast, greater distance reduces trade due to higher transport and information costs.

Originated from the Tinbergen’s pioneering work in the 1960s, the gravity model has considerably attracted attention and become the workhorse model in empirical studies on international trade [10]. Significant contributions by Anderson [12], Eaton and Kortum [13], and Anderson and van Wincoop [14] in the late 1990s and early 2000s are attributed to the establishment of concrete theoretical foundations for the model, promoting its recognition within the discipline. Gradually, additional explanatory variables have been added to the gravity model to understand the influence of social, cultural, historical, and policy-related factors on international trade. Commonly seen supplements include specified dummy variables for shared land border, common language, colonial relationship, common colonizer, and FTAs [10].

Despite the identified improvements, many factors influencing trade remain unobservable, causing potential omitted-variable bias. To tackle this issue, different approaches such as the stochastic frontier gravity model have been developed.

### 2.2. Stochastic frontier gravity model

To control for the latent trade constraints that researchers cannot fully observe and specify, Kalirajan [5] proposed the SFGM by integrating the traditional gravity model with the stochastic frontier approach [15]. The general specification is expressed as:

$$\ln X_{ij} = \ln[f(z_{ij}, \beta)] + v_{ij} - u_{ij} \quad (2)$$

In Equation (2),  $f(z_{ij}, \beta)$  stands for the trade frontier, which is a function of observable “natural” factors such as GDP and geographic distance, and “explicit beyond the border” constraints such as tariffs or trade agreements. The model generates two error components. The first term,  $v_{ij}$ , is a random error that captures statistical noise and is assumed to follow a normal distribution. The second error term,  $u_{ij}$ , is non-negative and represents “behind the border” inefficiencies that prevent trade from reaching its frontier, creating the difference between the actual and potential exports [6].

The inefficiency term  $u_{ij}$  ranges between 0 and 1. When  $u_{ij}$  equals to 0, trade is fully efficient and reaches potential frontier. If  $u_{ij}$  is larger than 0, the appearance of inefficiencies causes actual trade to fall below the frontier. These inefficiencies demonstrate domestic constraints such as poor logistics and weak institutions. Additionally, the deviation between actual and potential trade also depicts multilateral resistance effects that affect bilateral trade beyond bilateral factors [15]. The estimated parameters of the SFGM allow for the calculation of trade efficiency, which measure how close each bilateral trade flow is to its potential.

Pitt and Lee [16] and Battese and Coelli [17] extended the stochastic frontier framework to handle panel data. Nevertheless, their models assume that inefficiency does not change over time and that all cross-sectional units share the same intercept, which may lead to misspecification bias [18]. To address these shortcomings, Greene [9] proposed the True Random Effects (TRE) and True Fixed Effects (TFE) models. These models enable inefficiency to vary over time while accounting for unobserved, time-invariant heterogeneity through unit-specific intercepts.

The TRE model can be estimated using simulated maximum likelihood, whereas the TFE model requires maximum-likelihood dummy variable (MLDV) estimation. Although MLDV estimation is computationally demanding and may be affected by the incidental parameters problem, Belotti and Ilardi [19] suggest that it remains appropriate when the panel's time dimension is at least 10 periods.

### 2.3. Determinants of export efficiency

Some of previous authors have investigated the determinants of export efficiency using the stochastic frontier gravity approach. Deluna and Cruz [20] analyzed Philippine export efficiency from 2009 to 2012, incorporating institutional variables from the Heritage Foundation's Economic Freedom Index and dummy variables for APEC, ASEAN, and WTO membership, as well as shared official language with trading partners. Similarly, Noviyani et al. [21] assessed Indonesia's export efficiency to 62 trading partners during 2011-2016, using institutional quality, free trade agreements, common borders, common language, and partners' geographical characteristics such as land area and landlocked status as key determinants.

More recently, Vinh and Phuong [22] applied a one-step SFGM to examine the efficiency of Vietnam's textile and garment exports to European Union countries from 2007 to 2019. The World Economic Forum's Global Competitiveness Index components were incorporated into their model, including institutions, infrastructure, and technology, as well as the real exchange rate to understand trade efficiency (inefficiency) determinants.

While these studies identified several determinants of "behind the border" constraints, they have not fully addressed all latent factors that influence export efficiency. Moreover, the role of logistics performance in mitigating trade inefficiencies has been largely overlooked. This study fills this gap by explicitly including logistics performance as a determinant of export efficiency and applying both TRE and TFE stochastic frontier gravity models to account for unobserved, time-invariant heterogeneity.

### 2.4. Empirical specifications

Building on the methodology of Kalirajan [23] and incorporating Greene's stochastic frontier framework [9], this study specifies the following SFGM:

$$\ln EX_{jt} = \alpha_0 + \alpha_1 \ln VGDP_t + \alpha_2 \ln GDP_{jt} + \alpha_3 RTA_{jt} + \alpha_4 \ln Dist_j + \alpha_5 CB_j + \alpha_6 CC_j + v_{jt} - u_{jt} \quad (3)$$

In Equation (3), the dependent variable  $\ln EX_{jt}$  denotes the natural logarithm of Vietnam's total export value to

partner  $j$  in year  $t$ . On the right-hand side,  $\ln VGDP_t$  and  $\ln GDP_{jt}$  capture the economic sizes of Vietnam and partner  $j$  in year  $t$ , respectively, expressed in natural logarithmic form.  $RTA_{jt}$  is a dummy variable indicating whether there is a common preferential trade agreement between Vietnam and partner  $j$  in year  $t$ . The logarithm of geographical distance between Vietnam and partner  $j$  is represented by  $\ln Dist_j$ , while  $CB_j$  and  $CC_j$  are dummies for shared land border and common colonizer, respectively.

Following Greene's approach [9],  $\alpha_0$  denotes the country-pair-specific intercepts capturing unobserved, time-invariant heterogeneity. The error term  $v_{jt}$  is a symmetric random disturbance ( $v_{jt} \sim N(0, \sigma_v^2)$ ) that captures statistical noise, while  $u_{jt}$  is the one-sided non-negative term ( $u_{jt} \sim N^+(0, \sigma_u^2)$ ) that represents trade inefficiency.

The TRE estimator allows the estimation of time-invariant variables on the right-hand side of Equation (3), such as geographical distance ( $\ln Dist_j$ ), common border ( $CB_j$ ), and common colonizer ( $CC_j$ ). Conversely, the TFE estimator controls for time-invariant heterogeneity by specifying trading-pair dummies. However, collinearity with the dummies omits all variables that are constant across time.

Based on the estimated parameters of Equation (3), export efficiency ( $EE_{jt}$ ) can be computed as the exponential of the negative inefficiency term [24]:

$$EE_{jt} = \exp(-u_{jt}) \quad (4)$$

A higher value of  $EE_{jt}$  indicates greater export efficiency, meaning that actual exports are closer to their potential frontier.

The determinants of Vietnam's export efficiency are then modelled as:

$$EE_{jt} = \beta_0 + \beta_1 \ln VLP_t + \beta_2 \ln LP_{jt} + \beta_3 RER_{jt} + \beta_4 Covid_t + \beta_5 INST_{jt} + \varepsilon_{jt} \quad (5)$$

In the export efficiency equation, the variables of primary interest are the logistics performance indicators:  $VLP_t$  denotes Vietnam's logistics performance, and  $LP_{jt}$  refers to that of partner country  $j$ . Both variables are measured by the World Bank's Logistics Performance Index (LPI). Among the control variables,  $RER_{jt}$  represents the real exchange rate between Vietnam and partner  $j$ 's currency, while  $Covid_t$  is a dummy variable equal to 1 for the years affected by the COVID-19 pandemic (2019 onwards) and 0 otherwise. As suggested by Vinh and Phuong (2022), Noviyani et al. (2019), and Deluna and Cruz (2014) [20–22], we control for partner's institutional quality by using variable  $INST_{jt}$ . Lastly, the term  $\varepsilon_{jt}$  denotes the stochastic disturbance.

## 3. DATA

This study employs a panel dataset covering Vietnam's bilateral exports from 2005 to 2022. The selection of this period is determined by the availability of the World Bank's LPI, which serves as the primary proxy for logistics development in Vietnam and its trading partners. Although the LPI has been criticized for relying on perception-based assessments, it remains the most comprehensive and widely accepted cross-country measure of logistics capability and performance [25,26].

Table 1. Descriptive statistics.

Variables	Mean	Std. dev.	Min	Max
$\ln EX_{jt}$	18.21	2.52	8.34	25.48
$\ln VGDP_t$	25.93	0.59	24.78	26.74
$\ln GDP_{jt}$	24.95	2.04	18.73	30.87
$RTA_{jt}$	0.13	0.34	0.00	1.00
$\ln Dist_j$	8.98	0.71	5.35	9.88
$CB_j$	0.02	0.15	0.00	1.00
$CC_j$	0.13	0.34	0.00	1.00
$\ln VLP_t$	1.13	0.05	1.06	1.19
$\ln LP_{jt}$	1.06	0.19	0.19	1.46
$RER_{jt}$	2.79E+03	1.39E+05	-8.54E+01	6.93E+06
$Covid_t$	0.14	0.35	0.00	1.00
$INST_{jt}$	0.06	0.98	-2.27	2.47

Source: The authors.

Table 2. SFGM estimations.

Variables	TRE	TFE
	(1)	(2)
$\ln VGDP_t$	0.796*** (0.0243)	0.893*** (0.0296)
$\ln GDP_{jt}$	0.722*** (0.0224)	0.433*** (0.0532)
$RTA_{jt}$	0.353*** (0.0637)	0.326*** (0.0603)
$\ln Dist_j$	-0.700*** (0.0987)	
$CB_j$	0.851*** (0.318)	
$CC_j$	0.343 (0.210)	
Usigma	-0.680*** (0.0642)	-0.606*** (0.0624)
Vsigma	-1.844*** (0.0790)	-2.157*** (0.0932)
Theta	1.321*** (0.0539)	
Observations	3123	3125
Overall fit test	$[\chi^2]$ 4326.87***	$[\chi^2]$ 2695.37***
Hausman test	$[\chi^2]$ 30.75***	

Notes: The dependent variable is  $\ln EX_{jt}$ . Standard errors are presented in parentheses. Types of test statistics are indicated in brackets. \*\*\*, \*\*, and \* indicate \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively.

Source: The authors.

Since the LPI data are not available annually, the missing values are linearly interpolated.

Bilateral trade data are obtained from the Centre d'Études Prospectives et d'Informations Internationales (CEPII)'s BACI dataset. Data on geographical distance, common border, and common colonizer are sourced from the CEPII Gravity dataset, while RTA data are sourced from the World Trade Organization (WTO) database.

Regarding other control variables, GDP for Vietnam and its trading partners, used as proxies for their economic sizes, and real exchange rates (RER) are extracted and calculated from the World Bank's World Development Indicators (WDI) database. We measure the institutional quality by the government effectiveness index, which is collected from the Worldwide Governance Indicators (WGI) dataset. These variables together ensure that the model captures both explicit economic and institutional dimensions of bilateral trade.

Table 1 shows the descriptive statistics for the variables in the SFGM and export efficiency equations.

## 4. RESULTS AND DISCUSSIONS

### 4.1. SFGM estimation

Table 2 presents the estimates using SFGM. The columns (1) and (2) show the TRE and TFE estimators, respectively. Both models indicate strong overall fit at the 1% significance level, confirming the appropriateness of the SFGM specifications.

The significant coefficients of Usigma ( $\sigma_u$ ) and Vsigma ( $\sigma_v$ ) indicate that inefficiency and random noise considerably contribute to the total error term, validating the decomposition of the actual-frontier gap into inefficiency and stochastic error components. In the TRE model, the significant Theta ( $\theta$ ) coefficient affirms the relevance of unobserved, time-invariant export inefficiency, which underpins the adoption of Greene's stochastic frontier framework [9].

In the TRE model, which allows the estimation of time-invariant variables, geographical distance ( $\ln Dist_j$ ) has a strong negative effect, confirming that greater distance increases trade costs, thereby adversely affecting exports. In contrast, the common land border ( $CB_j$ ) variable is positive and significant, indicating that Vietnam exports more intensively to neighboring countries such as China, Laos, and Cambodia. The coefficient for common colonizer ( $CC_j$ ) is not statistically significant, suggesting that historical linkages between colonies do not have a persistent impact on Vietnam's export patterns.

Trade agreements ( $RTA_{jt}$ ) exert positive and significant effects in both TRE and TFE specifications, highlighting the trade-enhancing impact of regional and bilateral trade liberalization.

### 4.2. Estimator selection and export efficiency

The Hausman test reports a chi-square statistic of 30.75, significantly rejecting the null hypothesis that favors the TRE estimator at the 1% level. According to this test result, the TFE model is more appropriate than the TRE. Therefore, we proceed to determine the level of export efficiency based on the results of the TFE model.

Table 3. Descriptive statistics of estimated Vietnam’s bilateral export efficiency from 2005 to 2022.

Mean	Std. dev.	Min	Max
0.5702926	0.2241239	0.0000072	0.9451639

Source: The authors.

Table 4. Export efficiency regressions.

Variables	OLS	GLS
	(1)	(2)
$\ln VLP_t$	0.432*** (0.107)	0.507*** (0.0752)
$\ln LP_{jt}$	0.162*** (0.0417)	0.127*** (0.0316)
$RER_{jt}$	-6.77e-08** (2.96e-08)	-7.46e-08 (5.96e-08)
$Covid_t$	-0.0259* (0.0144)	-0.0233** (0.00992)
$INST_{jt}$	0.00359 (0.00812)	-0.000814 (0.00617)
Constant	-0.0636 (0.122)	-0.0730 (0.0869)
Observations	2484	2484
Overall fit test	[F] 19.75***	[ $\chi^2$ ] 127.85***
BPCW test	[ $\chi^2$ ] 162.57***	
Max VIF	3.79	
Mean VIF	2.30	

Notes: The dependent variable is  $EE_{jt}$ . The standard errors are presented in parentheses. Types of test statistics are indicated in brackets. \*\*\*, \*\*, and \* indicate \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively.

Source: The authors.

Table 5. IV-GMM analysis.

Variables	Coefficients	Robust SEs
$\ln VLP_t$	0.424***	0.0448
$\ln LP_{jt}$	0.181***	0.0470
$RER_{jt}$	-6.87e-08***	1.55e-09
$Covid_t$	-0.0269**	0.0123
$INST_{jt}$	3.27e-05	0.00898
Observations	2292	
Kleibergen-Paap rk Wald	[F] 3902.210	
Hansen p-value	0.6181	

Notes: The dependent variable is  $EE_{jt}$ . Types of test statistics are indicated in brackets. \*\*\*, \*\*, and \* indicate \*\*\*, \*\*, and \* denote significance at the 1%, 5%, and 10% levels, respectively.

Source: The authors.

Table 3 presents the descriptive statistics of export

efficiency, showing that the average value for Vietnam is around 0.57. This implies that Vietnam has exploited only about 57 percent of the optimal export capacity predicted by the model. The lowest efficiency level is almost zero, while the highest level is close to 0.94, reflecting the significant difference in efficiency levels among partner countries.

According to the estimated efficiency, although Vietnam has achieved better export performance over time, a considerable part of its potential remains untapped. For example, the average efficiency of Vietnam’s exports to major partners, including the United States, China, South Korea and Japan, has not exceeded 0.67. This shows that Vietnam still needs to continue to improve in many aspects to fully exploit its export potential.

### 4.3. Determinants of export efficiency

As presented in Eq. (5), Vietnam’s export efficiency model is estimated to examine the effect of logistics performance and other factors. Ordinary Least Squares (OLS) method is used and shown in Column (1) of Table 4, while Column (2) presents Generalized Least Squares (GLS) results. The Breusch–Pagan/Cook–Weisberg (BPCW) test results indicate the presence of heteroscedasticity, affecting the reliability of OLS estimation. Thus, the GLS model can performance better with correction for non-constant variance of the error term.

The specification tests show the appropriateness of our regressions. Both the F-test in the OLS model and the Chi-square test in the GLS model are statistically significant at the 1% level. These tests reject the null hypothesis that all regressor coefficients simultaneously equal to zero, thereby confirming that our set of explanatory variables can jointly explain the export efficiency. In addition, the Variance Inflation Factors (VIF) also validate the estimation results. The maximum VIF value of 3.79 and the mean value of 2.30 are well below the generally accepted threshold of 10, indicating that multicollinearity does not affect the estimations.

The GLS estimation results reaffirm the findings obtained by using the OLS estimator, emphasizing the important role of logistics efficiency in improving Vietnam's export performance. Both Vietnam’s logistics performance ( $\ln VLP_t$ ) and its trading partners’ ( $\ln LP_{jt}$ ) are positive and highly significant. This suggests that as the logistics system improves, Vietnam's ability to approach its optimal export level will increase. The estimated coefficient for Vietnam’s logistics performance (0.507) is greater than that of its trading partners (0.127), reporting that logistics activities in the exporting country are more impactful to enhancing trade efficiency.

The real exchange rate ( $RER_{jt}$ ) has a negative coefficient, suggesting that the appreciation of the Vietnamese Dong against the partner’s currencies may weaken Vietnam’s export competitiveness. However, the coefficient becomes insignificant in the GLS estimation, which is consistent with the empirical findings of Vinh and Phuong [16]. The COVID-19 pandemic dummy ( $Covid_t$ ) remains negative and significant, reflecting the disruptions to production and logistics chains that exert more inefficiencies to trade operations. In contrast,

institutional quality ( $INST_{jt}$ ) is not statistically significant in both models, implying that the level of partners' governance efficiency plays a limited role when considering the impact of logistics efficiency.

#### 4.4. Instrumental variables regression for robustness checks

To assess the consistency of our previous findings, we utilize an instrumental variables regression using the two-step generalized method of moments estimator (IV-GMM). This approach allows us to mitigate potential endogeneity arising from omitted confounders that may jointly affect logistics performance and export flows but are not explicitly controlled for in Equation (5).

The two endogenous variables,  $VLP_t$  and  $LP_{jt}$ , are instrumented using their respective lagged values and Vietnam's number of fixed telephone subscriptions per 100 people. The physical movement of exports from Vietnam is primarily driven by the contemporaneous efficiency of Vietnam's and partners' logistics activities. In contrast, past levels of logistics performance are not expected to influence current export flows.

Regarding the use of fixed telephone subscriptions as an instrument, contemporary exports are driven by advanced communication technologies, such as the Internet. Consequently, the number of fixed telephone subscriptions is unlikely to be directly correlated with the export flows from Vietnam. However, fixed telephone lines provided a vital infrastructure for the early development of Internet connectivity, facilitating the progress of logistics information systems, which are essential for modern logistics operations. Therefore, this variable only has an indirect correlation with Vietnam's exports through the endogenous logistics performance variable.

As shown in Table 5, the IV-GMM estimation results confirm our previous findings, reporting the positive and significant effects of both Vietnam's and partners' logistics performance on the exports. In comparison with the results presented in Table 4, the estimated coefficients of the key variables change only marginally, consistently showing the greater importance of the export logistics performance.

The diagnostic tests validate our instrumental variables in the overidentified specification. The Kleibergen-Paap rk Wald F statistic, which measures instrument strength, is over 3902. This value is substantially above the conventional threshold of 10, indicating that the instruments are sufficiently correlated with the endogenous variables and are unlikely to suffer from weak instrument problems. In addition, the Hansen overidentification test gives a p-value of 0.618, failing to reject the null hypothesis of instrument exogeneity. Therefore, our instrumental variables meet both relevance and orthogonality conditions.

## 5. CONCLUSION

This paper offers insights into the significant impact of logistics on enhancing export efficiency. The results show that logistics performances of both Vietnam and importing countries have significant and positive impacts on the export efficiency, demonstrating that well-

developed logistics systems can facilitate trade by reducing "behind-the-border" constraints. Moreover, the impact of Vietnam's logistics performance is consistently stronger, being at least 2.3 times greater than that of its trading partners, depending on the estimator employed. These findings suggest that sustained investment and reform in the logistics services and infrastructure sector are essential for Vietnam to fully leverage its export potential and enhance its integration into global value chains.

Methodologically, this paper advances the empirical analysis of trade efficiency by applying Greene's TRE and TFE models within the stochastic frontier gravity framework. This approach enables the separation of time-invariant heterogeneity from time-varying inefficiency, producing more reliable and consistent efficiency estimates. It therefore provides a useful refinement over conventional SFGM applications.

While the construction of the key variables in this paper is based on the overall LPI, which provides a comprehensive assessment of national logistics performance, this approach does not allow for an explicit examination of the effects of individual LPI components. Future research could therefore decompose logistics performance into its dimensions to assess their differential impacts on trade efficiency, providing more insights and detailed policy implications.

## ACKNOWLEDGEMENT

This research is funded by Vietnam Maritime University under grant number: DT25-26.134.

## REFERENCES

- [1] T. N. Kien and Y. Heo, "Doi Moi policy and socio-economic development in Vietnam, 1986–2005," *International Area Review*, vol. 11, no. 1, pp. 205–232, 2008.
- [2] T. D. L. Huỳnh, "Tầm quan trọng của logistics đối với xuất khẩu của Việt Nam," *Kinh tế và Phát triển*, vol. 290, pp. 23–33, 2021.
- [3] T. H. Doan and L. H. Vu, "Effects of logistics performance on Vietnam's exports: a quantitative analysis using the PPML method," *Journal of International Economics and Management*, vol. 24, no. 1, pp. 1–16, 2024.
- [4] M. N. Tran, L. T. K. Cao, H. T. Quach, and V. T. T. Phan, "Impact of green logistics performance on Vietnam's export trade to regional comprehensive economic partnership countries," *Journal of Trade Science*, vol. 178, pp. 31–39, 2023.
- [5] K. Kalirajan, "Regional cooperation and bilateral trade flows: an empirical measurement of resistance," *The International Trade Journal*, vol. 21, no. 2, pp. 85–107, 2007.
- [6] K. Kalirajan and R. Paudel, "India's trade deficit with China: will free trade agreement (FTA) work for India?," *Global Economy Journal*, vol. 15, no. 4, pp. 485–505, 2015.
- [7] L. Martí and R. Puertas, "The importance of export logistics and trade costs in emerging economies," *Maritime Economics & Logistics*, vol. 19, no. 2, pp. 315–

- 333, 2017.
- [8] A. Mehrsai, K. D. Thoben, and B. Scholz-Reiter, "Bridging lean to agile production logistics using autonomous carriers in pull flow," *International Journal of Production Research*, vol. 52, no. 16, pp. 4711–4730, 2014.
- [9] W. Greene, "Fixed and random effects in stochastic frontier models," *Journal of Productivity Analysis*, vol. 23, no. 1, pp. 7–32, 2005.
- [10] Y. V. Yotov, R. Piermartini, J. A. Monteiro, and M. Larch, *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model*. WTO, 2016.
- [11] J. Tinbergen, *Shaping the World Economy, Suggestions for an International Economic Policy*. The Twentieth Century Fund, 1962.
- [12] J. E. Anderson, "A theoretical foundation for the gravity equation," *American Economic Review*, vol. 69, no. 1, pp. 106–116, 1979.
- [13] J. Eaton and S. Kortum, "Technology, geography, and trade," *Econometrica*, vol. 70, no. 5, pp. 1741–1779, 2002.
- [14] J. E. Anderson and E. van Wincoop, "Gravity with gravitas: A solution to the border puzzle," *American Economic Review*, vol. 93, no. 1, pp. 170–192, 2003.
- [15] E. M. Ebaidalla and M. E. M. Ali, "Assessing Intra-Arab trade integration and potential: Evidence from the stochastic frontier gravity model," *The International Trade Journal*, vol. 37, no. 2, pp. 221–239, 2023.
- [16] M. M. Pitt and L. F. Lee, "The measurement and sources of technical inefficiency in the Indonesian weaving industry," *Journal of Development Economics*, vol. 9, no. 1, pp. 43–64, 1981.
- [17] G. E. Battese and T. J. Coelli, "Prediction of firm-level technical efficiencies with a generalized frontier production function and panel data," *Journal of Economics*, vol. 38, no. 3, pp. 387–399, 1988.
- [18] F. Belotti, S. Daidone, G. Ilardi, and V. Atella, "Stochastic frontier analysis using Stata," *SSRN Electronic Journal*, 2012.
- [19] F. Belotti and G. Ilardi, "Consistent estimation of the 'true' fixed-effects stochastic frontier model," *SSRN Electronic Journal*, 2012.
- [20] R. Deluna Jr and E. Cruz, "Philippine export efficiency and potential: an application of stochastic frontier gravity model," University Library of Munich, Germany, 2014.
- [21] D. S. Noviyani, Widyastutik, and T. Irawan, "Indonesian export efficiency: a stochastic frontier gravity model approach," *International Journal of Scientific Research in Science, Engineering and Technology*, pp. 488–497, 2019.
- [22] V. Q. Dang and P. H. Le, "Determinants of the export efficiency of Vietnam's textiles and garments to EU countries – a stochastic frontier gravity approach," *Asian Economic and Financial Review*, vol. 12, no. 8, pp. 722–730, 2022.
- [23] K. Kalirajan, "Gravity model specification and estimation: revisited," *Applied Economics Letters*, vol. 15, no. 13, pp. 1037–1039, 2008.
- [24] S. Masunda and G. Mhonyera, "Effects of free trade on export efficiency of COMESA member-states," *Journal of Shipping and Trade*, vol. 9, no. 1, pp. 5, 2024.
- [25] A. Gani, "The logistics performance effect in international trade," *The Asian Journal of Shipping and Logistics*, vol. 33, no. 4, pp. 279–288, 2017.
- [26] A. Behar, P. Manners, and B. D. Nelson, "Exports and International Logistics," *Oxford Bulletin of Economics and Statistics*, vol. 75, no. 6, pp. 855–886, 2013.