

Logistics, trade agreements and export efficiency: evidence from Vietnam using SFA-GMM

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162

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Abstract

Purpose – This study evaluates the impact of logistics quality in importing countries on Vietnam’s export efficiency and analyzes the moderating role of free trade agreements (FTAs) in the relationship between logistics and export efficiency.

Design/methodology/approach – This study employs a quantitative methodology by utilizing Vietnam’s export data from 2000 to 2022 and applying the Stochastic Frontier Analysis (SFA) in combination with the System GMM approach.

Findings – Both logistics and FTAs have a positive and statistically significant effect on export efficiency. In particular, the interaction between logistics and FTAs demonstrates a clear moderating effect that amplifies the benefits of logistics, especially for medium- and high-tech products. Additionally, specific components of logistics, such as cargo tracking, customs efficiency, on-time delivery and infrastructure quality, play an important role in enhancing export efficiency.

Research limitations/implications – Despite offering valuable empirical insights, this study has several limitations that future research should address. First, logistics quality in importing countries is measured using the LPI. While LPI covers key aspects, such as infrastructure, customs, service quality and timeliness, it is published only every two years. It also lacks sector-specific detail. As a result, it may not fully reflect short-term changes or risks in global logistics. Second, the model treats logistics as a single, aggregated variable. It does not separate different stages such as inbound, distribution or last-mile logistics. This may obscure how each component contributes to export efficiency, limiting the design of targeted policy responses.

Practical implications – The findings reveal that Vietnam can enhance export efficiency by leveraging FTAs and improving logistics. For policymakers, a first priority is to develop a centralized “FTA Market Logistics Map” containing data on infrastructure, customs times, transport costs and supply chain risks across FTA partners to identify markets where logistics conditions match Vietnam’s trade priorities. It is also recommended to establish “Trade Logistics Satellites” in key hubs such as Singapore and Rotterdam to provide coordination, real-time updates and dispute-resolution support. A national “FTA Logistics Upgrade” program should target sectors such as agriculture, aquaculture, electronics and supporting industries by offering supply-chain consulting, training and pilot digital tools or new transport routes, while targeted logistics investment in high-potential firms can create broad spillovers. Finally, logistics should be treated as a strategic pillar in future FTAs with commitments to infrastructure development, digital traceability and mutual recognition of logistics service providers.

Social implications – For enterprises, firms should not rely only on tariff preferences but also assess logistics conditions in FTA markets. Actions should reflect sector differences with each industry focusing on its own priorities. Agriculture and aquaculture should secure carriers with temperature control and quick customs clearance, use simple real-time tracking and prepare documents for pre-arrival clearance. Low-tech industries should consolidate shipments to reduce transport costs, plan booking schedules carefully and negotiate service levels with forwarders. Medium-tech industries should strengthen documentation, seek advance customs rulings and prepare contingency plans for critical parts. High-tech electronics should diversify transport routes,

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maintain small buffer inventories near destination markets and sign guaranteed-time contracts. Across all sectors, firms should actively use FTA provisions on customs cooperation and digital certification to shorten clearance times and monitor key indicators such as clearance or on-time delivery rates.

Originality/value – The study is the first to clarify the moderating role of FTAs in the relationship between logistics and export efficiency. This study provides a comprehensive policy framework to comprehensively and sustainably optimize Vietnam's export performance in the context of increasingly deep international economic integration.

Keywords Export efficiency, Logistics performance index, FTAs, Vietnam

Paper type Research article

1. Introduction

Logistics plays a pivotal role in enhancing a nation's export efficiency by reducing costs, shortening delivery times and increasing reliability in international trade. According to the model of Melitz (2003), better logistics reduce fixed export costs such as documentation, customs clearance and domestic transport. This enables more firms to participate in trade and diversify their product offerings (Behar *et al.*, 2012; Töngür *et al.*, 2020). High transaction costs, including transportation, inventory, port handling and customs procedures, continue to pose significant barriers to trade (Hausman *et al.*, 2005, 2013; Mahmud, 2020). Efficient logistics help address these challenges by ensuring timely delivery, lowering supply chain risks and improving competitiveness (Mahpour *et al.*, 2023; Sy *et al.*, 2020; Zaninović *et al.*, 2020). In addition, modern logistics infrastructure supports deeper integration into global value chains by connecting domestic firms with international suppliers and partners (Bensassi *et al.*, 2015; Mishrif *et al.*, 2024; Zaninovic and Bugarčić, 2023).

Many scholars have examined how logistics affects export performance. They use different methods to measure this relationship. Ramaiah and Roy (2021) found that firms in regions with good logistics infrastructure are more likely to export. This is due to the lower delivery costs and better connectivity. Other studies focus on export volume. They show that logistics performance, measured by time, cost and reliability, has a significant positive effect on trade (Gani, 2017; Hausman *et al.*, 2005; Korinek and Sourdin, 2011; Siddiqui and Vita, 2019). Logistics also supports export diversification. Improvements in the Logistics Performance Index (LPI) lead to more export products and more destination markets (Olyanga *et al.*, 2022; Töngür *et al.*, 2020). Key factors such as timely delivery, shipment tracking and efficient customs help firms become more competitive. These also support integration into global value chains (Behar *et al.*, 2012; Shepherd and Hamanaka, 2015).

Although research on logistics and trade is growing, few studies examine institutional or policy-related factors. Free Trade Agreements (FTAs), in particular, may influence how logistics affects export outcomes. This gap in the literature needs attention. Some studies highlight the role of intermediary factors. Gani (2017) and Siddiqui and Vita (2019) show that weak institutions, complex procedures and informal costs can reduce the benefits of good logistics. The impact of logistics also depends on the type of goods. Time-sensitive products or intermediate inputs respond more strongly to better timeliness and traceability (Song and Lee, 2022; Zaninović *et al.*, 2020). Logistics performance in the exporting country matters more than in the importing country (Hausman *et al.*, 2005; Korinek and Sourdin, 2011). Other factors also shape the relationship. These include geography, income level, market size and trade bloc membership (Behar *et al.*, 2012; Bensassi *et al.*, 2015; Gani, 2017; Tran, 2024).

Many studies confirm the positive effect of logistics on exports. However, this effect can vary depending on institutions and trade policies. FTAs may serve as key factors that influence this relationship. Yet, no empirical research has directly tested FTAs as a moderating variable. FTAs can enhance logistics through tariff cuts, simpler rules of origin (RoO) and customs reforms. Vietnam has joined 16 FTAs, including several new-generation ones. These agreements not only expand market access but also promote soft logistics, such as digital procedures and institutional harmonization (Trang, 2020). These elements may improve logistics capacity, reduce costs and strengthen supply chain performance.

This creates a clear research gap, especially in Vietnam's case [1]. Building on the above discussion, this study evaluates how importing-country logistics performance affects Vietnam's export efficiency and whether FTAs moderate this relationship. Therefore, it addresses the following questions:

- (1) To what extent does importer-country logistics performance affect Vietnam's bilateral export efficiency?
- (2) To what extent do FTAs between Vietnam and partner j improve Vietnam's bilateral export efficiency?
- (3) Do FTAs moderate the relationship between importer-country logistics performance and export efficiency; if so, in what direction and magnitude?

This study makes contributions to the existing literature in the following aspects. Theoretically, it articulates and tests an institutional-moderation mechanism in which FTAs strengthen the effect of importer-side logistics on Vietnam's export efficiency. The mechanism links structural gravity and transaction-cost arguments by mapping LPI pillars (timeliness, tracking and tracing, customs efficiency, infrastructure) to reductions in fixed and marginal export costs, while FTA disciplines (e.g. customs reform, digitalization, mutual recognition) amplify these reductions. We also discuss boundary conditions such as stringent RoO and limited digital readiness-under which the moderating effect may weaken, and we highlight heterogeneity by technology intensity.

Methodologically, it combines a stochastic-frontier gravity model to recover export efficiency with two-step System GMM to study its dynamics and the FTA \times LPI interaction, using disciplined instruments and reporting AR(1)/AR(2) and Hansen tests. Substantively, it focuses on importer-side logistics quality as an external bottleneck, decompose LPI into policy-salient pillars and document heterogeneous effects across agricultural, low-tech, medium-tech and high-tech goods.

Practically, it translates the mechanism into actionable guidance by aligning logistics upgrades with deep-integration FTAs, focusing on pillars with the largest payoffs (timeliness, tracking and tracing, customs, infrastructure) in partner markets, developing an FTA Market Logistics Map to target corridors where agreement depth and logistics conditions jointly maximize efficiency gains, streamlining rules-of-origin compliance through digital certification and prioritizing support for medium-tech and high-tech exporters whose efficiency is most sensitive to reliability and speed.

2. Hypothesis development

Export efficiency refers to a country's or firm's ability to achieve actual export value close to its maximum potential. It is often measured as the ratio of actual exports to potential exports (Doan and King, 2018). This reflects both trade opportunity realization and efficient resource use (Yenilmez, 2014). Three main factors influence export efficiency: economic conditions, infrastructure and institutions and trade integration. Studies show that the GDP and population of importing countries tend to increase export efficiency. In contrast, distance, tariffs and transport costs reduce it (Muriu *et al.*, 2024; Noviyani *et al.*, 2019). Strong institutions and modern logistics lower trade costs and boost reliability. These factors help firms compete internationally (Kaushal, 2021; Masunda and Mhonyera, 2024; Obeng *et al.*, 2023). FTAs also support export efficiency by expanding market access. However, their effectiveness depends on compliance with RoO, technical standards and the quality of domestic institutions (Doan and King, 2018; Ravishankar and Stack, 2014; Trung *et al.*, 2018). Despite these findings, few studies have proposed clear hypotheses about how logistics and FTAs interact to affect export efficiency. This remains an open area for research.

Vietnam's trade structure is characterized by high openness, diversified destinations and pronounced cross-partner variation in logistics and border procedures. This fits naturally with

a Melitz (2003) heterogeneous-firm framework and a gravity representation of bilateral frictions. First, in a Melitz setting, firms face fixed export costs and variable (iceberg) costs. For Vietnamese exporters, these costs are materially shaped by importer-side logistics (customs efficiency, timeliness, tracking and tracing, infrastructure). Improvements abroad lower the productivity threshold for selection into exporting and compress the gap between potential and realized exports. Second, a gravity-based stochastic frontier is well suited to Vietnam's multi-partner, corridor-specific landscape. The frontier pins down potential exports given economic mass and bilateral frictions, allowing export efficiency to measure the shortfall from this benchmark when destination-specific logistics frictions bind.

2.1 The effect of logistics on export efficiency

The theory of transaction costs and Melitz's (2003) model explain how logistics affects export efficiency. Logistics is not just about moving goods. It also shapes trade competitiveness by affecting cost, time, reliability and market access. First, better logistics reduce fixed export costs such as documentation, customs and domestic transport. This allows more firms to export and expands the range of products (Behar *et al.*, 2012; Hausman *et al.*, 2013; Melitz, 2003; Töngür *et al.*, 2020). Lower costs also make products more price-competitive in global markets (Bensassi *et al.*, 2015; Hausman *et al.*, 2005; Mahmud, 2020). Efficient logistics cut transaction time. They reduce inventory costs and improve response to demand, especially for time-sensitive goods like food and seasonal items (Doan and Vu Le, 2024; Olyanga *et al.*, 2022; Sy *et al.*, 2020). Reliable delivery reduces supply chain risks and supports sustainable trade (Hausman *et al.*, 2005, 2013; Zaninović *et al.*, 2020).

Modern logistics also enable shipment tracking. This helps firms control delivery, avoid losses and build trust in international markets (Bensassi *et al.*, 2015; Mahpour *et al.*, 2023; Siddiqui and Vita, 2019). High logistics quality also improves access to inputs and supports component exports. This fosters deeper integration into global value chains (Mishrif *et al.*, 2024; Shepherd and Hamanaka, 2015; Zaninovic and Bugarcic, 2023). Lastly, strong logistics systems help firms meet technical and environmental standards. This improves market access and allows full use of FTA benefits (Tran, 2024).

Grounded in the work of Melitz (2003) and transaction-cost economics, importer-country logistics performance affects Vietnam's export efficiency through three complementary channels. The first channel is fixed export costs (selection margin). Streamlined documentary requirements, pre-arrival processing and predictable destination-side customs reduce non-recoverable entry costs, allowing more Vietnam-partner product-destination pairs to clear the productivity threshold. The second channel is variable (iceberg) costs. Better transport, port capacity and last-mile connectivity in partner countries lower effective iceberg costs and transit times, which is salient for time-sensitive exports (seafood, seasonal apparel, electronics components). The third channel is information asymmetries and uncertainty. Tracking and tracing, on-time delivery and reliable schedules reduce search, monitoring and enforcement costs, curb disputes and accelerate payment cycles. Collectively, these channels reduce both the level and variance of trade costs at destination, lowering the Melitz cutoff and moving realized exports closer to the frontier (higher trade efficiency). Based on the above arguments, this study proposes the hypothesis H1 that:

- H1. Importer-country logistics performance positively affects Vietnam's bilateral export efficiency.

2.2 The effect of FTAs on export efficiency

2.2.1 FTA and export efficiency. FTAs, whether bilateral or regional, are expected to improve export efficiency. They do so by reducing tariffs, removing non-tariff barriers and simplifying trade procedures (Anderson and Yotov, 2016; Sheng *et al.*, 2015). Empirical studies support this view. For instance, Doan and Xing (2018) found that ASEAN FTAs improved Vietnam's

export efficiency, although RoO posed challenges. In India, [Kaushal \(2021\)](#) showed that SAFTA and MERCOSUR had stronger effects than APTA. Other studies in Africa ([Boadu et al., 2021](#)) and Europe ([Buch and Piazzolo, 2001](#)) also confirm that FTAs improve bilateral trade, especially when production structures are complementary.

WTO-plus trade-facilitation disciplines (customs risk management, single window, mutual recognition, transparency, electronic certification) reduce procedural opacity and policy uncertainty. For Vietnam's exporters, clearer rules and predictable timelines lower both fixed and variable frictions, improving export efficiency. Based on this evidence, the study proposes the following hypothesis:

H2. FTAs between Vietnam and its partners impact positively on export efficiency.

2.3 The effects of FTA on relationship between logistics and export efficiency

Logistics and FTAs both improve export efficiency. However, few studies explore how FTAs may moderate the effect of logistics. This combined impact is often overlooked. From an institutional and trade-integration perspective, FTAs create a rules-based environment that reduces both the level and the variance of behind-the-border trade costs by codifying WTO-plus disciplines (customs cooperation and risk management, transparency, single window, electronic certification, mutual recognition). In transaction-cost terms, such disciplines lower search, bargaining and monitoring (enforcement costs). This enhances the pass-through of physical logistics capacity into realized trade outcomes.

New trade theory and gravity models show that logistics reduce fixed and marginal export costs. This boosts trade efficiency ([Anderson and Yotov, 2016](#)). But the effectiveness of logistics depends on the trade environment. Institutions and legal frameworks matter. FTAs can serve as moderating factors. Many FTAs include WTO-plus commitments. These cover trade facilitation, customs reform, digitalization and cross-border infrastructure ([Kawai and Wignaraja, 2011](#)). When such disciplines and reforms are operational, improvements in importer-country logistics translate more fully into realized cost reductions and reliability (documentation becomes interoperable with digital processes, customs cooperation shortens dwell times and transparency curbs informal payments). Hence, the marginal effect of logistics performance on export efficiency is larger under FTAs. This strengthens the effect of logistics on export performance.

However, strict RoO can limit these benefits. If firms struggle to meet FTA criteria, they may not enjoy preferential tariffs ([Estevadeordal and Suominen, 2004](#)). In other words, where RoO are stringent or digital readiness is limited, the pass-through from logistics to efficiency is muted, weakening the moderating effect. As a result, better logistics may not translate into higher efficiency. Based on these arguments, the study proposes:

H3. FTAs may moderate the relationship between logistics and export efficiency, either positively or negatively.

3. Research methods

3.1 Estimating export efficiency

Trade efficiency is the ratio of actual exports to maximum potential exports. The potential value is estimated using a stochastic frontier gravity model ([Doan and Xing, 2018](#); [Hai and Thang, 2017](#)). This model assumes that maximum exports occur under full trade liberalization. Natural factors like GDP, distance and so on affect this potential ([Armstrong, 2007](#)). Based on the basic gravity model developed by [Tinbergen \(1962\)](#) and the studies by [Doan and Xing \(2018\)](#) and [Doanh et al. \(2020\)](#), our export efficiency model is specified as follows:

$$\ln \text{Export}_{ij,t} = \alpha + \beta_1 \ln \text{GDP}_{i,t} + \beta_2 \ln \text{GDP}_{j,t} + \beta_3 \text{POP}_{i,t} + \beta_4 \text{POP}_{j,t} + \beta_5 \text{DIST}_{ij} + \varepsilon_{ij,t} \quad (1)$$

where: \ln is logarithm, i is Vietnam, j is the Vietnam's partners and t is year t . $\text{Export}_{ij,t}$ total export value of Vietnam to country j in year t . GDP is gross domestic product. POP is total population. DIST is geographical distance between country i and country j .

In theory, GDP of both countries has a positive effect on exports. It reflects supply from the exporter and demand from the importer (Ayesu, 2023; Behar et al., 2012; Doan and Vu Le, 2024). Population is also expected to boost trade. More people mean greater production or consumption (Mahpour et al., 2023; Tran, 2024). Distance has a negative effect. It raises transport costs and reduces trade flow (Behar et al., 2012; Doan and Vu Le, 2024). According to Battese and Coelli (1988), the error term ($\varepsilon_{ij,t}$) in Eq (1) includes random error ($v_{ij,t}$) and technical inefficiency ($u_{ij,t}$), which represents the degree of inefficiency in export performance. When $u_{ij,t} = 0$, the country is fully efficient. Therefore, export efficiency ($TE_{ij,t}$) can be calculated as the exponential function of the one-sided error term:

$$TE_{ij,t} = \exp(-u_{ij,t}) \in (0, 1) \quad (2)$$

3.2 Analyzing the drivers of export efficiency

After estimating TE from Eq (1) and Eq (2), we assess the effects of logistics and FTAs. The model follows Doanh et al. (2020) and is specified as follows:

$$TE_{ij,t} = \delta_0 + \delta_1 TE_{ij,t-1} + \delta_2 LPI_{j,t} + \delta_3 FTA_{ij,t} + \delta_4 (FTA_{ij,t} \times LPI_{j,t}) + \epsilon_{ij,t} \quad (3)$$

where: $TE_{ij,t-1}$ is the export efficiency between country i and country j in the previous year. $FTA_{ij,t}$ is a dummy variable that equals 1 if a FTA between country i and country j is in effect in year t , and 0 otherwise. $\epsilon_{ij,t}$ is the error term.

$LPI_{j,t}$ is logistics performance of country j . The Logistics Performance Index (LPI), developed by the World Bank, is a summary indicator of logistics sector performance, combining data on six core performance components into a single aggregate measure [2]. The six core components are:

- (1) *Customs*: The efficiency of customs and border management clearance, rated from very low (1) to very high (5).
- (2) *Infrastructure*: The quality of trade and transport infrastructure, rated from very low (1) to very high (5).
- (3) *Ease of arranging shipments*: The ease of arranging competitively priced shipments, rated from very difficult (1) to very easy (5).
- (4) *Quality of logistics services*: The competence and quality of logistics services, rated from very low (1) to very high (5).
- (5) *Tracking and tracing*: The ability to track and trace consignments, rated from very low (1) to very high (5).
- (6) *Timeless*: The frequency with which shipments reach consignees within scheduled or expected delivery times, rated from hardly ever (1) to nearly always (5).

The overall LPI score is constructed from these six indicators using principal component analysis, a standard statistical technique used to reduce the dimensionality of a dataset. The LPI is survey-based and released infrequently, which can introduce measurement error and limit within-country variation; it is not sector-specific and may mask subnational differences and methodology changes across waves can affect strict comparability. To mitigate these

issues, we analyze both the composite index and each dimension within a dynamic System GMM framework.

Because the independent variable ($TE_{ij,t-1}$) is time-lagged, it may be endogenous. Traditional models like OLS or Fixed Effects (FE) can lead to bias. These models struggle with autocorrelation, heteroskedasticity and unobserved effects (Khan *et al.*, 2022a, b). The FE model also performs poorly when lagged variables correlate with the error term or when regressors are not strictly exogenous (Sharma and Mishra, 2022).

Given these limitations, following Xaisongkham and Liu (2022), we employ the System Generalized Method of Moments (System GMM). This method was developed by Arellano and Bover (1995) and Blundell and Bond (1998). It combines level and differenced equations and uses lagged variables as instruments (Roodman, 2009). System GMM is suitable for panel data with short time periods and many cross sections. This fits our dataset. To test model validity, we apply the Hansen test and the Arellano–Bond second-order autocorrelation test – AR(2) (Khan *et al.*, 2022a, b).

3.3 Data

This study employs panel data covering the period from 2000 to 2022. Bilateral export values, expressed in million USD, are sourced from the UN Comtrade Database (see Appendix 2). Information on GDP in billion USD and population for each country is sourced from the World Bank. Geographical distances between country pairs, measured in kilometers, are obtained from CEPII. The Logistics Performance Index (LPI), updated biennially and rated on a 1 (low) to 5 (high) scale, is collected from the World Bank. Data on active FTAs are compiled from the WTO Regional Trade Agreements Database. Additional logistics dimensions, including tracking and tracing, logistics quality, shipment arrangement ease, customs efficiency, on-time delivery and infrastructure quality – each assessed on a 1 to 5 scale are also derived from the World Bank.

The empirical panel is organized at the bilateral partner-year level with Vietnam as the exporter i partner country j . Each observation corresponds to (i, j, t) for $t = 2000, \dots, 2022$. In the frontier (SFA) stage, the dependent variable is $\ln Export_{ij,t}$. The resulting efficiency scores $TE_{ij,t}$ feed the second-stage models. Explanatory variables are indexed, including: $LPI_{j,t}$ (importer-side logistics for partner j), $FTA_{ij,t}$ ($i - j$ agreement in force) and $TE_{ij,t-1}$ (lagged efficiency). For product-group analyses, the unit becomes (i, j, g, t) , where g includes agricultural material, low-tech, medium-tech or high-tech products.

4. Results and discussion

4.1 Main findings

Table 1 reports the results of unit-root tests for all time-series variables used in the analysis. The findings indicate that all variables exhibit highly negative unadjusted and adjusted

Table 1. The results of unit-root test

Variable	Unadjusted t	Adjusted t*	p-value
$\ln Export_{ij,t}$	-15.118	-12.864	0.000
$\ln GDP_{i,t}$	-30.297	-28.176	0.000
$\ln GDP_{j,t}$	-15.946	-14.473	0.000
$\ln POP_{i,t}$	-8.631	-7.368	0.000
$\ln POP_{j,t}$	-12.836	-12.582	0.000
$LPI_{j,t}$	-27.622	-21.967	0.000

Source(s): Authors' own elaboration

t-statistics with p -values of 0.000, far exceeding conventional significance thresholds. This strong evidence allows for a decisive rejection of the null hypothesis of a unit root and confirms that all series are stationary at their levels.

The SFA model results (Table 2) confirm that key gravity variables significantly affect bilateral exports. GDP of both the exporting and importing countries has a strong positive effect. This aligns with theory and past studies (Behar *et al.*, 2012; Doan and Vu Le, 2024; Mahpour *et al.*, 2023). Larger economies have more production capacity and greater demand diversity. The exporter's population has no significant effect. The importer's population shows a weak positive impact. This suggests that market size helps but is not a key driver. Distance has a strong negative effect. It reflects higher transport costs and delivery risks. These remain major barriers, especially for developing countries.

Based on the SFA model, export efficiency was calculated and shown in Figure 1. From 2000 to 2007, Vietnam's export efficiency was stable at around 0.78. This was the pre-integration phase when trade commitments were still developing. After 2007, efficiency declined, reaching a low of 0.755 in 2010. This drop likely reflects the impact of the 2008–2009 global financial crisis.

Since 2011, export efficiency has gradually improved. From 2015 to 2019, progress was slow and uneven. After 2020, efficiency increased more steadily, reaching about 0.77 by 2022. This recovery aligns with the launch of new FTAs like CPTPP (2019) and EVFTA (2020). It also reflects global supply chain shifts after the COVID-19 pandemic. Overall, Vietnam's export efficiency is sensitive to global shocks and trade policy. The recent upward trend signals the positive effects of reform and deeper integration.

Before interpreting the results, model diagnostics are reported in Table 3. Both AR(2) and Hansen test p -values are above 0.05. AR(2) values range from 0.520 to 0.853. This shows no second-order autocorrelation, supporting the consistency of System GMM. Hansen test p -values range from 0.089 to 0.315. These values do not reject the null hypothesis of instrument validity. Therefore, the estimates are statistically robust.

Table 3 shows the effects of logistics and FTAs on export efficiency. The lagged variable ($TE_{ij,t-1}$) is positive and significant in all models. This suggests that past export efficiency tends to persist. The result supports theories of sustained trade performance and confirms findings by Doanh *et al.* (2020). Logistics performance also has a positive effect on export efficiency, supporting H1. A 1% rise in the importing country's logistics quality increases Vietnam's export efficiency by 0.010%. This confirms that logistics is central to trade

Table 2. The results of SFA

Variable	β	SE	z	$P > z$
$\ln GDP_{i,t}$	0.921	0.195	4.731	0.000
$\ln GDP_{j,t}$	0.883	0.019	47.181	0.000
$\ln POP_{i,t}$	0.142	2.041	0.069	0.945
$\ln POP_{j,t}$	0.046	0.021	2.132	0.033
$\ln DIST_{ij}$	-0.997	0.033	-30.238	0.000
Constant	-28.662	32.408	-0.884	0.376
μ				
Constant	-19.618	31.121	-0.630	0.528
$U\sigma$				
Constant	2.013	1.539	1.309	0.191
$V\sigma$				
Constant	-0.002	0.071	-0.029	0.977
σ_u	2.736	2.105	1.30	0.194
σ_v	0.999	0.036	28.4	0.000
Λ	2.739	2.111	1.30	0.195

Source(s): Authors' calculation

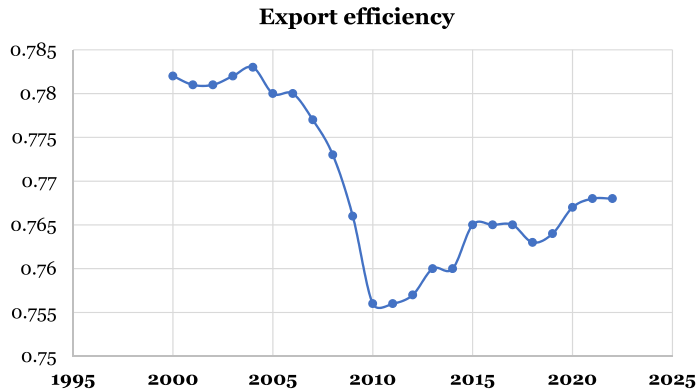


Figure 1. The export efficiency of Vietnam from 2000 to 2022. *Source:* Created by authors

competitiveness. The result matches previous studies, such as those by [Töngür et al. \(2020\)](#) and [Hausman et al. \(2013\)](#). In comparative perspective, this confirms time-cost-reliability channels documented by [Hausman et al. \(2005\)](#), [Korinek and Sourdin \(2011\)](#) and [Gani \(2017\)](#), while extending prior work by focusing on export efficiency (TE) and on importer-side logistics quality.

The above finding is especially relevant for Vietnam. The country relies on time-sensitive exports such as seafood, textiles and agricultural goods. Better logistics in partner countries help reduce delivery time, lower costs and minimize informal payments. Improved logistics also enhance supply chain stability. This allows Vietnamese firms to meet demand quickly, expand exports and build trust in international markets. These results reflect real business efforts to deepen participation in global value chains. Logistics supports this process by easing market access, cutting technical barriers and leveraging FTA benefits like CPTPP and EVFTA.

Overall is the overall quality of logistics performance; *Tracking and Tracing*: Ability to track and trace consignments; *Logistics Quality*: Competence and quality of logistics services; *Shipment Arrangement Ease*: Ease of arranging competitively priced shipments; *Customs Efficiency*: Efficiency of customs clearance process; *On-time Delivery*: Frequency with which shipments reach consignee within scheduled or expected time and *Infrastructure Quality*: Quality of trade and transport-related infrastructure.

Several logistics components significantly improve Vietnam's export efficiency. First, tracking and tracing systems in importing countries increase transparency and reliability. When partners use modern tracking tools, Vietnamese firms can deliver on time, reduce disputes and speed up payment cycles. This boosts productivity and lowers trade risks. Second, the overall quality of logistics services matters. Professional transport, warehousing and freight services ensure smooth delivery. This is vital for products like seafood and agricultural goods that require careful handling. Third, the ease of arranging shipments also plays a role. Low-cost and flexible transport options reduce total supply chain costs. This improves the price competitiveness of Vietnamese exports. Fourth, customs efficiency is critical. Fast, transparent clearance procedures help avoid delays. They allow firms to meet delivery schedules and maintain long-term contracts. Fifth, on-time delivery in importing countries supports timely access to end consumers. This improves brand reputation and opens new markets with similar logistics profiles. Finally, good infrastructure in partner countries (such as ports, roads and bonded warehouses) reduces costs and delays. Strong infrastructure, especially at borders or transshipment hubs, helps Vietnam access global markets more efficiently. Our findings support [H1](#). This pattern is also consistent with evidence on product variety and market diversification gains from logistics improvements ([Töngür et al., 2020](#); [Olyanga et al., 2022](#); [Bensassi et al., 2015](#)).

Table 3. The effect of logistics on export efficiency

Variables	Overall	Tracking and tracing	Logistics quality	Shipment arrangement ease	Customs efficiency	On-time delivery	Infrastructure quality
TE _{ij,t-1}	0.486** (0.129)	0.466** (0.145)	0.598** (0.124)	0.592** (0.109)	0.483** (0.101)	0.829** (0.112)	0.501** (0.110)
LPI _{ij,t}	0.010* (0.005)	0.011** (0.004)	0.012** (0.003)	0.012** (0.003)	0.008* (0.003)	0.016** (0.005)	0.012** (0.002)
FTA _{ij,t}	0.018* (0.008)	0.014** (0.005)	0.044** (0.007)	0.076** (0.014)	0.019* (0.009)	0.050** (0.017)	0.009* (0.004)
LPI _{jt} *FTA _{ij,t}	0.002* (0.001)	0.003* (0.001)	0.002* (0.001)	0.000 (0.001)	0.002 (0.001)	0.003* (0.001)	0.001* (0.001)
Constant	0.284** (0.105)	0.311** (0.113)	0.118 (0.098)	0.023 (0.094)	0.304** (0.086)	-0.110 (0.105)	0.301** (0.083)
No of observation	340	340	340	340	340	340	340
AR(2) Z	0.49	0.006	0.18	0.64	0.56	0.34	0.61
Pr > z	0.626	0.809	0.853	0.520	0.577	0.731	0.544
Hansen χ^2	7.26	7.06	7.11	16.37	16.19	4.88	13.31
Prob > χ^2	0.297	0.315	0.311	0.089	0.134	0.300	0.102

Note(s): Standard errors in parentheses. * Significant at the 0.05 level; ** significant at the 0.01 level
Source(s): Authors' calculations

The findings show that FTAs have a positive and statistically significant effect on Vietnam’s export efficiency, consistent with H_2 . This supports the theory that FTAs reduce trade barriers, cut costs and improve market access. As a result, trade becomes more efficient. Vietnam’s participation in multiple FTAs, including CPTPP and EVFTA, has helped exports move closer to their full potential. FTAs also reflect improvements in firms’ ability to meet technical standards, operate transparently and manage supply chains more professionally. These results align with [Doan and Xing \(2018\)](#) and [Kaushal \(2021\)](#). Comparatively, our H_2 result accords with Vietnam/ASEAN evidence ([Doan and Xing, 2018](#)) and findings for India ([Kaushal, 2021](#)).

Beyond direct effects, FTAs also play a moderating role. The interaction term (FTA \times Logistics) is positive and significant in all models. This means FTAs help enhance the impact of logistics quality in partner countries on Vietnam’s export efficiency. Trade theory and gravity models emphasize the role of logistics in lowering costs and improving competitiveness. However, logistics alone is not enough. Institutional support is needed. FTAs provide this support. They often come with WTO-plus commitments like customs reform, border modernization, digitalization and improved logistics infrastructure. In line with H_3 , the positive and significant interaction terms show that FTAs amplify the effect of logistics on export efficiency. The moderation results align with a wide range of evidence. Studies show that improvements in trade facilitation and logistics raise export performance and expand export variety. When these upgrades are combined with FTA frameworks, trade gains become even stronger ([Mishrif et al., 2024](#)).

Taken together, these moderation results are consistent with a broad evidence base showing that trade-facilitation and logistics upgrades systematically raise export performance and export variety and, when implemented alongside FTA frameworks, further magnify trade gains (e.g. [Tongür et al., 2020](#); [Hausman et al., 2013](#); [Gani, 2017](#); [Siddiqui and Vita, 2019](#); [Shepherd and Hamanaka, 2015](#); [Mishrif et al., 2024](#)), with heterogeneous amplification across pillars, sectors and partner types.

These reforms reduce delays, lower delivery costs and make supply chains more reliable. They help firms export more efficiently. In short, FTAs allow Vietnamese exporters to better leverage partner countries’ logistics systems. Vietnam is benefiting not only from market access but also from a more supportive trade environment. This is critical for local firms that face cost and capacity constraints.

To explore further, the study analyzed logistics effects by product category. [Table 4](#) shows that logistics quality in the importing country positively affects Vietnam’s export efficiency across all four groups: agricultural, high-tech, medium-tech and low-tech goods. The

Table 4. The effects of logistics, FTA on export efficiency across type of products

Variables	Agricultural materials	High-tech	Medium-tech	Low-tech	
TE _{ij,t-1}	0.724** (0.049)	0.939** (0.042)	0.261* (0.121)	0.668** (0.087)	
LPI _{ij,t}	0.025* (0.012)	0.065* (0.032)	0.062* (0.028)	0.032* (0.016)	
FTA _{ij,t}	0.022** (0.008)	0.024* (0.012)	0.027* (0.013)	0.009* (0.004)	
LPI _{ij,t} *FTA _{ij,t}	0.004* (0.002)	0.010* (0.010)	0.007* (0.004)	0.003* (0.002)	
Constant	-0.009 (0.042)	-0.295* (0.115)	0.153 (0.158)	0.074 (0.063)	
No of obs	325	245	275	310	
AR(2)	z	1.01	1.64	-1.20	0.22
	Pr > z	0.310	0.102	0.231	0.829
Hansen	χ^2	27.39	16.13	12.34	0.030
	Prob > χ^2	0.072	0.136	0.338	0.710

Note(s): Standard errors in parentheses. * Significant at the 0.05 level; ** significant at the 0.01 level

Source(s): Authors’ calculations

estimated coefficients are 0.025* for agriculture, 0.065** for high-tech, 0.062* for medium-tech and 0.032* for low-tech products. The effect is strongest and most significant for high-tech exports (at the 1% level). Though the coefficients are modest, the results confirm the critical role of partner-country logistics in supporting Vietnam's trade performance (across both traditional and advanced product categories). The above finding supports **H1** across product categories. This is consistent with evidence that time-sensitive and complex goods respond more to timeliness and reliability (Korinek and Sourdin, 2011; Song and Lee, 2022; Olyanga *et al.*, 2022).

The strong influence of logistics quality in importing countries shows that transport, customs and distribution conditions directly shape market access for Vietnamese firms. High-tech and medium-tech products have higher coefficients. This is expected, as these goods require precise handling, fast delivery and coordinated logistics. The moderating role of FTAs is also evident across product types. The interaction term ($FTA \times Logistics$) is positive and statistically significant in all categories: 0.004* for agriculture, 0.010* for high-tech, 0.007* for medium-tech and 0.003* for low-tech products. All effects are significant at the 5% level. In line with **H3**, the moderation effect holds across technology groups. Taken together, the heterogeneity results extend prior studies by quantifying an FTA-enabled amplification of logistics for medium-tech and high-tech exports within an efficiency framework (see Figure 2).

The largest effect is observed in the high-tech group. This suggests that FTAs not only reduce tariffs but also strengthen institutional support for logistics. This is critical for goods with high value-added and complex supply chains. Although smaller, the coefficients for other product types remain significant. This confirms that FTAs enhance the positive effect of logistics quality across sectors, including those with lower technological intensity. Supporting

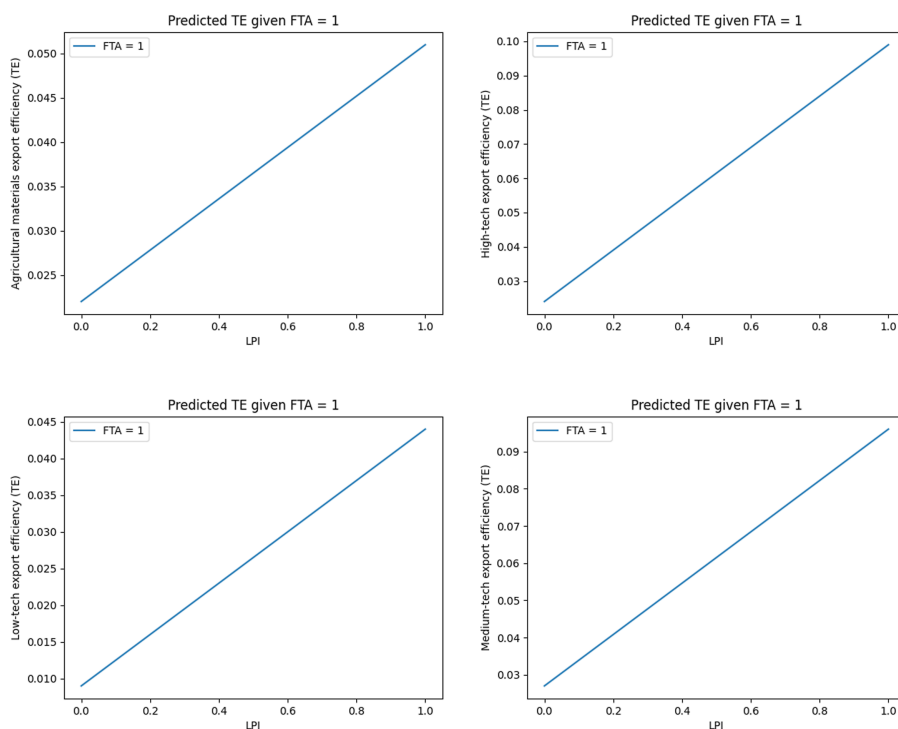


Figure 2. The effects of LPI on export efficiency of Vietnam according to type of products. *Source:* Created by authors

H2 and in line with H3, these heterogeneous effects point to stronger FTA-enabled amplification where reliability and regulatory predictability matter most (high-tech). Overall, our findings confirm core mechanisms in the logistics-trade literature and add the moderating role of FTAs, using an efficiency-based outcome rather than trade levels.

4.2 Implications

The findings reveal that Vietnam can enhance export efficiency by leveraging FTAs and improving logistics. For policymakers, a first priority is to develop a centralized “FTA Market Logistics Map” containing data on infrastructure, customs times, transport costs and supply chain risks across FTA partners to identify markets where logistics conditions match Vietnam’s trade priorities. It is also recommended to establish “Trade Logistics Satellites” in key hubs such as Singapore and Rotterdam to provide coordination, real-time updates and dispute-resolution support. A national “FTA Logistics Upgrade” program should target sectors such as agriculture, aquaculture, electronics and supporting industries by offering supply-chain consulting, training and pilot digital tools or new transport routes, while targeted logistics investment in high-potential firms can create broad spillovers. Finally, logistics should be treated as a strategic pillar in future FTAs with commitments to infrastructure development, digital traceability and mutual recognition of logistics service providers.

For enterprises, firms should not rely only on tariff preferences but also assess logistics conditions in FTA markets. Actions should reflect sector differences with each industry focusing on its own priorities. Agriculture and aquaculture should secure carriers with temperature control and quick customs clearance, use simple real-time tracking and prepare documents for pre-arrival clearance. Low-tech industries should consolidate shipments to reduce transport costs, plan booking schedules carefully and negotiate service levels with forwarders. Medium-tech industries should strengthen documentation, seek advance customs rulings and prepare contingency plans for critical parts. High-tech electronics should diversify transport routes, maintain small buffer inventories near destination markets and sign guaranteed-time contracts. Across all sectors, firms should actively use FTA provisions on customs cooperation and digital certification to shorten clearance times and monitor key indicators such as clearance or on-time delivery rates.

For academic researchers, this study opens a new research direction by highlighting the moderating role of FTAs in the logistics-export efficiency relationship. Future work can examine how different FTA types affect this interaction across industries or institutional settings and should explore firm-level data for richer insights.

4.3 Contributions

This study contributes to the literature by being one of the first to empirically examine the moderating role of FTAs in the link between logistics and export efficiency. At the theoretical level, we conceptualize FTAs as institutional moderators of logistics pass-through from importer-side logistics quality to export efficiency, formally $\frac{\partial TE_{ij,t}}{\partial LPI_{j,t}} = \delta_2 + \delta_4 \cdot FTA_{ij,t}$ with $\delta_4 > 0$, subject to boundary conditions such as rules-of-origin stringency and digital readiness. Unlike previous research that treated logistics and FTAs as independent drivers of trade, this paper highlights their complementary relationship and the conditional effects of institutional arrangements. This articulation moves beyond additive treatments by specifying how WTO-plus disciplines (e.g. customs risk management, single window, transparency, electronic certification, mutual recognition) lower both the level and the variance of behind-the-border trade costs, thereby increasing the pass-through from logistics to efficiency. By applying a two-stage empirical strategy using SFA and System GMM, this research offers a better understanding of the mechanisms through which infrastructure and policy interact to shape export performance. Methodologically, the design distinguishes potential from realized exports and identifies the $(LPI_{j,t} \times FTA_{ij,t})$ interaction. The decomposition of LPI pillars provides logistics-salient levers for intervention.

These findings extend the scope of existing theories by integrating insights from structural gravity models with institutional trade governance. Empirically, we provide Vietnam-wide evidence that FTAs amplify importer-side logistics effects on efficiency, with stronger impacts for medium-tech and high-tech products that are more sensitive to timeliness and reliability. The study also contributes practical value by identifying that logistics investments are most effective when complemented by coherent trade policies under FTAs. For policy, the framework implies prioritizing deep FTAs and RoO simplification to raise pass-through, and targeting high-payoff pillars (on-time delivery, tracking and tracing, customs, infrastructure) in partner markets.

4.4 Limitations

Despite offering valuable empirical insights, this study has several limitations that future research should address. First, logistics quality in importing countries is measured using the LPI. While LPI covers key aspects, such as infrastructure, customs, service quality and timeliness, it is published only every two years. It also lacks sector-specific detail. As a result, it may not fully reflect short-term changes or risks in global logistics. Second, the model treats logistics as a single, aggregated variable. It does not separate different stages such as inbound, distribution or last-mile logistics. This may obscure how each component contributes to export efficiency, limiting the design of targeted policy responses.

Future research should use more granular and frequently updated data. High-frequency logistics indicators, disaggregated by industry or product type, would offer deeper insights. Moreover, separating logistics by supply chain stages can help assess specific impacts and better capture how FTAs interact with each stage. Concretely, future work should construct industry or product-level quarterly indicators (e.g. dwell times, on-time performance) and estimate stage-specific models of the $FTA \times logistics$ interaction to pinpoint which stages and provisions deliver the largest efficiency gains.

5. Conclusion

This study examines the relationship between logistics, FTAs and Vietnam's export efficiency from 2000 to 2022. The results show that (1) importer-country logistics quality and FTAs each have a positive, statistically significant effect on export efficiency; (2) FTAs play a key moderating role, amplifying the marginal impact of logistics on efficiency and (3) this amplification is strongest for high-tech products, which rely on speed, precision and regulatory certainty. This highlights the essential role of FTAs and modern logistics in promoting value-added trade.

These findings help fill a research gap on the moderating role of FTAs in logistics and trade. They also offer concrete policy directions. Recommendations include creating logistics maps for each FTA market, establishing logistics satellites in key international hubs, launching targeted support programs for export logistics, promoting cross-border data corridors and integrating logistics as a strategic pillar in future FTAs. Overall, the study bridges theory and practice. It offers a foundation for evidence-based trade policies that aim to boost Vietnam's export efficiency in an increasingly integrated global economy.

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Notes

1. Literature matrix is presented in [Appendix 1](#).
2. <https://lpi.worldbank.org/index.php/international>

Supplementary material

The supplementary material for this article can be found online.

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