Journal of Infrastructure, Policy and Development 2024, 8(6), 4989.
https://doi.org/10.24294/jipd.v8i6.4989

Article

Logistics' bottleneck effect and international trade: Evidence from Vietnam's imports

Huy Le Vu[1,2], Jihyun Eum[1,*]

[1] Department of International Trade, Kangwon National University, Gangwon-do 24341, Republic of Korea
[2] Department of Economics, Vietnam Maritime University, Hai Phong City 180000, Vietnam
*** Corresponding author:** Jihyun Eum, eum@kangwon.ac.kr

CITATION

Vu HL, Eum J. (2024). Logistics' bottleneck effect and international trade: Evidence from Vietnam's imports. Journal of Infrastructure, Policy and Development. 8(6): 4989. https://doi.org/10.24294/jipd.v8i6.4989

ARTICLE INFO

Received: 4 March 2024
Accepted: 9 April 2024
Available online: 13 June 2024

Abstract: This study examines the bottleneck effect of logistics performance on Vietnam's imports, utilizing bilateral trade data from 2007 to 2022. We evaluate the impact of logistics performance on imports of Vietnam using the augmented gravity model and a random effects estimator. Our findings reveal that the minimum logistics performance between Vietnam and its trading partners has a significantly positive impact on the Vietnamese imports. The magnitude of its bottleneck effects is much larger than the influence of Vietnam's individual logistics performance or deviations in performance with its trading partners. Recognizing the impact of logistics bottlenecks on international trade enables policymakers to develop more effective and efficient logistics-related policies for enhancing bilateral trade with trading partners.

Keywords: bottleneck effect; minimum logistics performance; international trade; gravity model; Vietnam
JEL Classification: C21; C23; F14

1. Introduction

International trade is one of the most important drivers of economic growth (Rahman, 2021). Following the economic reform in 1986, international trade has played a vital role in contributing to the economic growth of Vietnam. The total international trade value of Vietnam has surged by more than five times, reaching 678 million USD in 2021, compared to the value in 2007 when the country joined the World Trade Organization (WTO) (World Bank, 2021). To further facilitate international trade, Vietnam has initiated numerous free trade negotiations, with 16 agreements currently in effect (Center for WTO and International Trade, 2023). Along with these efforts to expand trading partnerships, trade facilitation strategies like development of logistics, have drawn increased attention in recent years. The WTO defines trade facilitation as the "simplification of trade procedures," while the United Nations Conference on Trade and Development (UNCTAD) and the Asia-Pacific Economic Cooperation (APEC) expand the scope of this definition, adding transport, telecommunications, business practices, banking and insurance (Moïsé and Sorescu, 2013).

Logistics is one of the crucial trade facilitation measures and it is positively associated with national competitiveness (Martí et al., 2014). It refers to the efficient movement of goods from the supply origin to the place of consumption while maintaining an acceptable service in a cost-effective manner (Rushton et al., 2017). On one hand, good logistics service quality and infrastructure strongly facilitate the

international flow of goods. On the other hand, inefficient logistics bottlenecks the movement of goods and leads to higher trade costs. Hence, both trading countries are adversely affected by poor logistics services and infrastructure (Hausman et al., 2005; Martí et al., 2014). In recent years, Vietnam has recognized the importance of logistics and has put more effort into logistics development. In February 2017, the government issued Decision 200 [1], officially approving the action plan to develop Vietnam's logistics services until 2025. This milestone affirms Vietnam's determination to pick up the logistics sector.

The imports of Vietnam and the openness of the economy are presented in **Figure 1**. Trade openness is defined as the percentage ratio of the sum of exports and imports of goods and services over GDP, reflecting the degree to which the national economy is open to foreign markets. According to the data from the World Bank, there is a close relationship between the imports and the trade openness of Vietnam. This relationship highlights the crucial role of imports in Vietnam's economy, wherein imports support exports. In other words, the exports are dependent on the imports intuitively.

Figure 1. Vietnam's imports and trade openness from 2001 to 2021.
Source: The World Bank—World Development Indicators.

This research aims to investigate the impact of logistics on Vietnam's imports, considering the bottleneck in logistics and supply chain. In our paper, we assume that the bottleneck, which refers to the minimum value of logistics performance between Vietnam and its trading partner, may influence its imports. In the related literature, the bottleneck effect is well documented, emphasizing the importance of identifying and removing the bottlenecks to improve the system performance (Li et al., 2023; Mizgier et al., 2013). The presence of bottlenecks resulting from an imbalance in logistical performance between two trading countries has the potential to impede bilateral trade. Nonetheless, studies on the relationship between logistics and international trade focus solely on the trading country's logistics performance or the deviations between logistics performances of trading countries (Behar and Manners, 2008; Bugarčić et al., 2020; Le, 2022; Puertas et al., 2014; Zaninović et al., 2021). However, these measurements overlook the bottleneck effect and may not fully explain the impacts of varied logistics performances on trade.

One of contributions of our study is to enhance the understanding of the bottleneck effect of logistics on Vietnamese imports. Unlike investigations solely focused on a nation's own logistics elements, particularly infrastructure, our study delves into the inherent weaknesses within the logistics interface between the two

trading nations by introducing bottlenecks in logistics and supply chain. These efforts may help policymakers in developing more efficient and effective logistics-related policies to enhance trade, particularly with nations where logistics bottlenecks pose significant impediments. Secondly, our study analyzes the relationship between logistics and imports in Vietnam. Although the impact of logistics on international trade is well-researched in the existing literature, most studies focus on the export side of Vietnamese trade. Since imports are also important for exporting and achieving economic development, as suggested by studies using firm-level data (Halpern et al., 2005; Pierola et al., 2018; Turco and Maggioni, 2013), research on the impact of logistics on imports may provide fruitful insights and policy implications for the Vietnam government.

Our research is structured as follows. Section 2 provides a literature review on logistics and international trade, the importance of imports, and the bottleneck effect in logistics. Section 3 explains the empirical model specifications, sampling data, and how the analysis is conducted. Section 4 presents the estimation results and a discussion of the findings. Finally, section 5 concludes the research.

2. Literature review

2.1. Logistics and international trade

Researchers have focused on the impact of trade facilitation measures on international trade, thanks to the considerable progressed trade liberalization in recent years that have reduced transportation costs and eliminated trade barriers (Martí et al., 2014; Zaninović et al., 2021). Wilson et al. (2005) considered port infrastructure, customs, regulations, and e-business as four trade facilitation measures in gravity-based research covering 75 countries. Based on the main political areas of World Trade Organization (WTO) negotiations, Moïsé et al. (2011) developed twelve indicators that might potentially reduce trade costs by almost 10%. Enhancements to trade facilitation measures can enable the growth of international trade. Iwanow and Kirkpatrick (2007) investigated the effect of trade facilitation, regulatory quality, and infrastructure on export performance using a panel of 78 countries from 2000 to 2004. Their empirical results suggested that a 10% increase in trade facilitation would lead to a 5% increase in exports.

Many studies have used the logistics performance index (LPI) published from the World Bank since 2007 as a proxy for trade facilitation (Zaninović et al., 2021). LPI covers six logistic related measures: customs and border management clearance efficiency, infrastructure quality of trade and transport, ease of arranging competitively priced international shipments, quality of logistics services, tracking and tracing ability, and timeliness of shipments (Arvis et al., 2018). Felipe and Kumar (2012) employed all six components of the LPI in their empirical analysis of bilateral trade in Central Asian countries, using the gravity model approach. Their results showed that improvements in LPI sub-indices would lead to trade gains ranging from 28% to 63%. Among the LPI components, infrastructure was identified as having the most significant impact on bilateral trade. In the study on the effect of logistics on international trade in Central and Eastern European countries and the Western Balkans in 2007 and 2018, Bugarčić et al. (2020) used the overall LPI and its sub-indices. Their

study revealed that logistics performance significantly and positively influenced bilateral trade volume.

2.2. Importance of imports

Le (2021, 2022, 2023) provided empirical evidence of the positive impact of logistics on Vietnam's international trade. However, his studies are limited to the agriculture and aquaculture exports. The effect of logistics on Vietnam's imports remains largely unexplored in the existing literature despite its importance in enhancing productivity and serving as a driver to increase exports. By expanding variety and improving input quality, imports are positively associated with firm productivity. Halpern et al. (2005) found that imports contributed to a 30% improvement in Hungary's total factor productivity during the 1990s by advancing firm-level productivity and reallocating capital and labor to importers. According to their study, the effect of imports on productivity across all firms also enhances the competitiveness of the exporters. Turco and Maggioni (2013) provided empirical evidence that imports positively affected exports in the Italian manufacturing sector between 2000 and 2004. They showed that the growth of cheaper imported inputs resulted in a reduction in average costs, an improvement in the firms' competitiveness, and an increase in the export contingency. Similarly, in Peru, Pierola et al. (2018) found a robust and persistent relationship between imports and exports during the 2000-2012 period. According to their findings, an increase in quantity, variety, and quality of imported intermediate inputs led to a significant improvement in exports in terms of quantity, diversification, and quality.

2.3. Bottleneck effect of logistics performance on international trade

The movement of physical flows in international trade is determined by the chain of logistics activities. The overall objective of logistics management is to ensure that product flows efficiently and effectively from origin to destination (CSCMP, n.d.; Rushton et al., 2017). However, every logistics chain has bottlenecks, or particularly the slowest activities, which limit the output of the entire chain (Christopher, 2016). Bottlenecks can impede intermodal transportation and remain persistent in the European transport network (Witte et al., 2012). As a consequence of the COVID-19 outbreak, world-wide port terminal congestion hampered the transport of goods and disrupted global supply chains (Gui et al., 2022; van Battum et al., 2023).

Bottlenecks have received significant attention from researchers since the introduction of the Theory of Constraints (TOC) by Goldratt (Scholz-Reiter et al., 2011). TOC has become an important theory that views processes not as independent entities but as interconnected links in the same chain (Şimşit et al., 2014). Due to this interdependency, the overall performance is constrained by the weakest point, or the bottleneck. Sharing a similar process-based philosophy, logistics aligns closely with TOC itself. Therefore, logistics performance is determined by the bottlenecks within the logistics chain. The term 'bottleneck' has appeared in various trade logistics studies, such as Çelebi (2019), Eyob and Kahsai (2019), Hausman et al. (2013) and Zaninović et al. (2021). However, these studies only refer to deficiencies in a country's own logistics-related factors, especially infrastructure. Therefore, they do not take into

account the relatively weak points in the logistics interface between the two trading countries. In this study, based on the TOC philosophy, we target this unexplored type of logistics bottleneck in bilateral trade.

In the past literature, many researchers focused on using the logistics performance of trading countries or differences in logistics performance rather than focusing on bottleneck effects. Zaninović et al. (2021) used the difference in bilateral LPIs and Huynh (2021), Le (2021, 2022), and Martí et al. (2014) used the LPI of exporting and importing nations to measure the impact of logistics on international trade. Puertas et al. (2014) estimated, using data from 26 European Union (EU) nations, that the LPI of exporters is more relevant than that of importers in expanding bilateral trade. Zaninović et al. (2021) discovered that variations in the LPI subindices had a negative impact on trade between the EU15 and the EU members from Central and Eastern Europe (CEMS) and the rest of the world, particularly when it came to intermediate goods. Therefore, they recommended that CEMS nations raise their level of logistical performance to that of the EU 15. However, using the logistics performance of trading countries or differences in logistics performance does not fully reflect the logistics performance bottlenecks that limit the efficiency and effectiveness of the supply chain. In light of the bottleneck effect in logistics operations, the extent to which logistics affects bilateral trade may be determined by the lower bound of logistics performance between two trading countries. Therefore, we use the minimum scores of the LPI as a proxy for logistic performance bottlenecks to analyze their effects on Vietnamese bilateral imports.

3. Methodology

3.1. Research hypotheses

When two countries engage in trade, the physical movement of goods is performed through distinct logistics processes across countries. The logistics systems of these two countries are interconnected to create a logistics chain, facilitating the movement of traded goods from the exporter to the importer. Consequently, it is assumed that the minimum logistics performance, referred to as a bottleneck in the integrated logistics chain, may influence bilateral trade flows. The higher the minimum logistics performance, the larger the bilateral trade can be expected. Using the import data of Vietnam, the hypotheses of our research are defined as:

- **Hypothesis 1.** The logistics performance of Vietnam is positively correlated with Vietnam's imports.
- **Hypothesis 2.** The deviation between Vietnam and the trading partner's logistics performance is negatively correlated with Vietnam's imports.
- **Hypothesis 3.** The minimum logistics performance is positively correlated with Vietnam's imports.

To evaluate the impact of the LPIs—(1) that of the importer and (2) the differences in bilateral LPIs—in the past literature, we formulated hypotheses (1) and (2), respectively. Additionally, to estimate the bottleneck effects on Vietnamese imports, Hypothesis (3) is also established. **Table 1** provides information on variables specified in the models.

Table 1. Variable information.

Variables	Explanations	Source	Expected sign
$\ln TR_{it}$	Log of export value from country i to Vietnam in year t	CEPII	-
$\ln LP_t$	Log of logistics performance of Vietnam in year t	WB	+
dLP_{it}	Absolute difference in logistics performance between exporter i and Vietnam in year t $dLP_{it} = \lvert XLP_{it} - LP_t \rvert$ where XLP_{it} refers to exporter i's logistics performance	WB	−
$\ln MinLP_{it}$	Log of minimum logistics performance between exporter i and Vietnam in year t $\ln MinLP_{it} = \log[\min(XLP_{it}, LP_t)]$	WB	+
$\ln DIST_i$	Log of geographical distance between country i and Vietnam	CEPII	−
$\ln GDP_{it}$	Log of GDP of exporting country i in year t	WB-WDI	+
$\ln VGDP_t$	Log of GDP of Vietnam in year t	WB-WDI	+
$POST_{it}$	Political stability of country i in year t	WGI	+
$CONTIG_i$	Common physical border between country i and Vietnam	CEPII	+
WTO_{it}	WTO membership of country i in year t	CEPII	+
RTA_{it}	Both country i and Vietnam are members of a regional trade agreement in year t	CEPII	+

3.2. Research model

Pioneered by Ravenstein (1885) and Tinbergen (1962), the gravity model has become the most widely used approach to study explanatory factors determining trade flows (Abeliansky et al., 2021; Allen et al., 2020) after the seminal paper of Anderson and van Wincoop (2003) that define structural gravity model Basically, the gravity model postulates that the volume of bilateral trade between two countries is proportional to the product of their GDPs and inversely proportional to the distance between them (Krugman et al., 2018). To estimate the effect of logistics performance on Vietnam's imports, we modify the gravity model into a structural model with Vietnam as the sole importer, as shown in the following equations.

$$\ln TR_{it} = \alpha + \beta_1 \ln LP_t + \beta_2 dLP_{it} + \gamma_1 \ln DIST_i + \gamma_2 \ln GDP_{it} + \gamma_3 \ln VGDP_t + \gamma_4 POST_{it} + \gamma_5 CONTIG_i + \gamma_6 WTO_{it} + \gamma_7 RTA_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

$$\ln TR_{it} = \alpha + \beta_1 \ln MinLP_{it} + \gamma_1 \ln DIST_i + \gamma_2 \ln GDP_{it} + \gamma_3 \ln VGDP_t + \gamma_4 POST_{it} + \gamma_5 CONTIG_i + \gamma_6 WTO_{it} + \gamma_7 RTA_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

$$\ln TR_{it} = \alpha + \beta_1 \ln MinLP_{it} + \beta_2 dLP_{it} + \gamma_1 \ln DIST_i + \gamma_2 \ln GDP_{it} + \gamma_3 \ln VGDP_t + \gamma_4 POST_{it} + \gamma_5 CONTIG_i + \gamma_6 WTO_{it} + \gamma_7 RTA_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (3)$$

Subscripts i and t indicate, respectively, the exporting country and year. ln refers to the natural logarithm. The dependent variable, TR_{it} represents the export value from the country i to Vietnam in year t. α indicates the intercept, while βs are the effects of logistics performance on Vietnam's imports. Specifically, we measure logistics performance in three ways: the logistics performance of Vietnam (LP_t, the importing country), the absolute difference between the logistics performances of the exporting country (dLP_{it}), and the minimum of the two countries' logistics performances ($MinLP_{it}$). Equation (1) includes both LP_t and dLP_{it} to estimate the effect of Vietnamese logistic performance and that of deviations in terms of logistic performances between Vietnam and its trading partners. Equation (2) only includes $MinLP_{it}$ to estimate the effect of the minimum logistics performance. Equation (3)

includes both $MinLP_{it}$ and dLP_{it} to facilitate a comparison of the marginal effects between minimum logistic performance and deviations [2].

γs are coefficients of the control variables. Motivated by related studies of Anderson and VanWincoop (2003), we include standard gravity variables. GDP_{it}, $VGDP_t$, and $DIST_i$ refer to the GDPs of the exporting countries and that of Vietnam, and the geographical distance between Vietnam and its trading partners, respectively. Additionally, we control for other factors influencing bilateral trade costs, including the political stability of exporter ($POST_{it}$), contiguity ($CONTIG_i$), WTO membership of the exporting country (WTO_{it}), and regional trade agreements (RTA_{it}). $POST_{it}$ is a proxy for the exporting country's institutional quality, affecting international trade by positively influencing the business environment and reducing business costs (Abreo et al., 2021). Hence, the higher the institutional quality, the larger the expected trade volume. $CONTIG_i$ equals 1 if the exporting country i and Vietnam share a common border, and 0 otherwise. WTO_{it} takes value 1 if country i is a member of WTO in year t, or 0 otherwise. RTA_{it} equals 1 if both country i and Vietnam are signatories of a regional trade agreement in year t, or 0 otherwise. Finally, μ_i, λ_t, and ε_{it} refer to exporter-fixed effects, year-specific effects, and stochastic disturbance terms, respectively.

3.3. Data

The primary focus of our study is the LPI obtained from the World Bank, which is measured in 2007, 2010, 2012, 2014, 2016, 2018, and 2023[3]. Throughout this period, we examine bilateral trade flows from 161 exporters to Vietnam. The key variables in this study are overall LPI scores. The World Bank conducts qualitative assessments of the LPI. Their assessments are in response to a global survey of international logistic operators and detailed, frequent data on maritime shipping and container tracking, postal, and air freight activities. Adjustment using standard statistical methods are employed to compute overall scores for each country, combining the six fundamental performance components into a single indicator. Unlike hard data on transport infrastructure, the Logistics Performance Index (LPI) is a qualitative measure of logistics that receives criticism for its perception-based nature. Despite this debatable construct, the LPI is supported by a large set of qualitative and quantitative indicators (Behar et al., 2013) and is considered one of the most comprehensive sources for analyzing cross-country logistics performance at the national level (Saslavsky and Shepherd, 2014). The LPI has become a standard reference in studies on trade logistics (Song and Lee, 2022).

The data for the dependent variable and control variables are collected from standard sources commonly used in trade gravity studies, including the World Bank—World Development Indicators (WB-WDI), the Worldwide Governance Indicators (WGI), and the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII). **Table 2** exhibits the descriptive statistics of the sample. The correlation matrix is shown in **Table 3**.

$CONTIG_i$, WTO_{it}, and RTA_{it} are binary variables; therefore, they are not included in **Table 2**. We transform all non-binary variables into natural logarithm form, except $POST_{it}$, as this variable typically ranges from −2.5 to 2.5 (Teeramungcalanon

et al., 2020). Higher values refer to more stable political systems in host countries. In some extreme cases, $POST_{it}$ may exceed the upper or lower bounds (Kaufmann et al., 2009) as shown in **Table 2**. The political stability scores below −2.5 are of Afghanistan, the Central African Republic, Iraq, Pakistan, Somalia, Syria, and Yemen.

Table 2. Descriptive statistics.

Variables	Observations	Mean	Std.Dev	Min	Max
TR_{it}	936	1217010	6461864	0.015	1.24×10^{8}
LP_t	1041	3.076962	0.1480609	2.89	3.3
dLP_{it}	1041	0.5390773	0.3138019	0	1.68
$MinLP_{it}$	1041	2.709028	0.3588959	1.21	3.3
$DIST_i$	1041	8887.68	4310.794	480	19076
GDP_{it}	1041	4.85×10^{11}	1.82×10^{12}	2.18×10^{8}	2.10×10^{13}
$VGDP_t$	1041	2.35×10^{11}	6.48×10^{10}	1.50×10^{11}	3.59×10^{11}
$POST_{it}$	1041	−0.1568581	0.9449216	−2.996031	1.512161

Source: The authors' calculations based on the WB, the WGI, and the CEPII data.

Table 3. Pairwise correlation matrix.

	$\ln TR_{it}$	$\ln LP_t$	dLP_{it}	$\ln MinLP_{it}$	$\ln DIST_i$	$\ln GDP_{it}$	$\ln VGDP_t$	$POST_{it}$
$\ln TR_{it}$	1	-	-	-	-	-	-	-
$\ln LP_t$	0.124***	1	-	-	-	-	-	-
dLP_{it}	-0.0293	0.043	1	-	-	-	-	-
$\ln MinLP_{it}$	0.563***	0.259***	-0.464***	1	-	-	-	-
$\ln DIST_i$	-0.275***	-0.00589	-0.0611	-0.0436	1	-	-	-
$\ln GDP_{it}$	0.753***	0.0649*	-0.0193	0.614***	-0.115***	1	-	-
$\ln VGDP_t$	0.135***	0.855***	0.0387	0.240***	-0.00136	0.0690*	1	-
$POST_{it}$	0.247***	0.0222	0.0377	0.459***	0.0535	0.158***	0.0209	1

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Source: The authors' calculations based on the WB, the WGI, and the CEPII data.

Figure 2 illustrates the positive correlation between the minimum logistics performance and Vietnam's imports. All control variables follow the theoretical expectations, exhibiting positive correlations, except for geographical distance, which reflects a negative correlation. The correlation matrix in **Table 3** shows a positive relationship between Vietnam's logistics performance, the minimum logistics performance, and bilateral trade value. In contrast, the absolute difference in logistics performance is negatively correlated with bilateral trade. This simple measure also indicates that the correlation of the minimum logistics performance with Vietnam's imports is higher than that of Vietnam's logistics performance or the absolute difference in logistics performance.

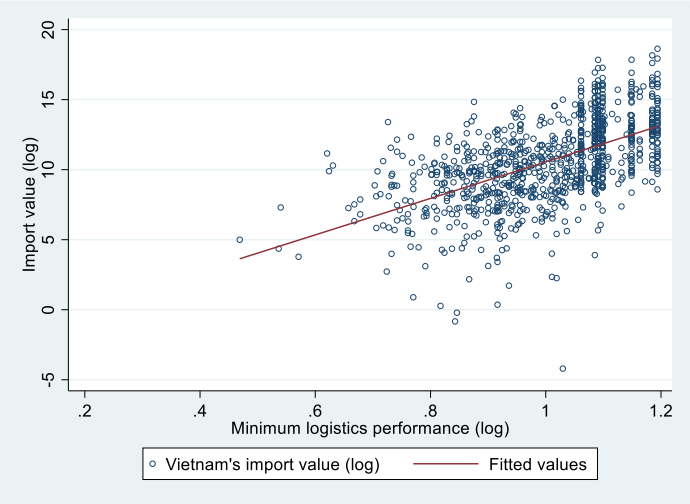

Figure 2. The minimum logistics performance and Vietnam's imports from 2007 to 2022[4].

Source: The authors' demonstration based on the CEPII and the WB data.

3.4. Analysis strategy

Equations (1)–(3) are estimated by using Pooled Ordinary Least Squares (POLS). While this standard estimator is known for providing the most efficient and unbiased estimates when the unobserved exporting countries' time-invariant effects are absent, our research suggests a likelihood of presence of time-invariant effects. Therefore, we opt to employ the Random Effects (RE) estimator to control the unobserved country-specific effects. One significant advantage of the RE models is the ability to estimate time-invariant variables, while the Fixed Effects (FE) models cannot. The appropriateness of RE applications in our research is supported by a set of specification tests. The Breusch and Pagan Lagrangian multiplier (BPLM) test (Breusch and Pagan, 1980) favors RE over POLS, whereas Hausman's test (J. A. Hausman and Taylor, 1981; Kaiser, 2015) confirms RE estimator is better than FE at 5% level. In addition, the inclusion of the dedicated year dummies helps to control for year-specific effects. Robust standard errors are applied to all our estimations to address potential presence of heteroscedasticity.

4. Empirical results

4.1. Baseline estimations

Table 4 presents the estimation results of Equations (1)–(3) in the corresponding column numbers. We find that both Vietnam's logistics performance (ln LP_t) and the difference in logistics performance (dLP_{it}) do not have significant impacts on bilateral trade, according to the results in column (1). In contrast, the coefficient of the minimum logistics performance (ln $MinLP_{it}$) is statistically significant at the 5% significance levels in columns (2) and (3), respectively. The absolute difference in logistics performance remains insignificant in column (3). All the control variables exhibit the expected signs and are found statistically significant at the 1% or 5% significance level. The calculated Variance Inflation Factors (VIFs) suggest that

multicollinearity is not a concern in our estimation models, as all the values are less than 10 (Wooldridge, 2020).

Table 4. POLS estimates.

Variables	POLS	POLS	POLS
	(1)	(2)	(3)
$\ln LP_t$	0.199	-	-
	(2.330)	-	-
dLP_{it}	−0.174	-	0.222
	(0.159)	-	(0.222)
$\ln MinLP_{it}$	-	1.401**	1.962**
	-	(0.678)	(0.959)
$\ln DIST_i$	−0.485***	−0.470***	−0.455***
	(0.105)	(0.103)	(0.104)
$\ln GDP_{i,t}$	1.001***	0.953***	0.934***
	(0.0318)	(0.0393)	(0.0498)
$\ln VGDP_t$	0.376	0.270	0.203
	(0.432)	(0.246)	(0.248)
$POST_{it}$	0.300***	0.227***	0.195**
	(0.0601)	(0.0667)	(0.0829)
$CONTIG_i$	1.639***	1.728***	1.759***
	(0.287)	(0.289)	(0.289)
WTO_{it}	1.555***	1.519***	1.509***
	(0.248)	(0.247)	(0.248)
RTA_{it}	1.237***	1.234***	1.250***
	(0.164)	(0.162)	(0.164)
Max VIF	3.79	2.27	4.63
Observations	936	936	936

Note: Dependent variable: $\ln TR_{it}$; Robust standard errors in parentheses; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Due to the potential presence of the unobserved time-invariant effects in exporters, which can lead to biased POLS estimates, our analysis continues with the application of the RE models. The inclusion of year dummies in these estimations helps control for two-way error component disturbances (Baltagi, 2021). **Table 5** exhibits the results of the RE estimates.

As presented in columns (2) and (3) of **Table 5**, after controlling the exporting countries' unobserved time-invariant effects and year-specific effects, the coefficient of the minimum logistics performance remains statistically significant and positive. However, the effect of Vietnam's logistics performance ($\ln LP_t$) is found to be insignificant, a result consistent with the POLS estimate. The absolute difference in logistics performance (dLP_{it}) is found to have a negative effect on Vietnam's imports at the 5% level in column (1), and it becomes insignificant in column (3) when specified in the same model with the minimum logistics performance ($\ln MinLP_{it}$). Furthermore, the magnitudes of the effect of minimum logistics performance on

Vietnam's imports are also much larger than those of Vietnam's logistics performance and the absolute difference in logistics performance. These results indicate that the bottleneck effect of logistics performance significantly influences Vietnam's imports more than the other two proxies of logistics performance [5].

Table 5. RE estimates.

Variables	RE	RE	RE
	(1)	(2)	(3)
$\ln LP_t$	2.765	-	-
	(2.518)	-	-
dLP_{it}	−0.333**	-	0.151
	(0.167)	-	(0.248)
$\ln MinLP_{it}$	-	1.600***	1.981**
	-	(0.618)	(0.952)
$\ln DIST_i$	−0.411	−0.394	−0.386
	(0.254)	(0.250)	(0.249)
$\ln GDP_{i,t}$	1.066***	1.009***	0.996***
	(0.0687)	(0.0733)	(0.0803)
$\ln VGDP_t$	−1.429	−1.439	−1.473
	(1.202)	(1.099)	(1.106)
$POST_{it}$	0.384***	0.340***	0.330***
	(0.103)	(0.102)	(0.106)
$CONTIG_i$	2.362***	2.443***	2.461***
	(0.769)	(0.754)	(0.752)
WTO_{it}	0.101	0.0727	0.0588
	(0.659)	(0.653)	(0.657)
RTA_{it}	0.594***	0.604***	0.616***
	(0.213)	(0.212)	(0.214)
BPML test	BPML test	[0.0000]	[0.0000]
Hausman tests	Hausman tests	[0.1337]	[0.0832]
Year-specific effects	Year-specific effects	YES	YES
Country-fixed effects	Country-fixed effects	YES	YES
Observations	Observations	936	936
No. of exporters	No. of exporters	161	161

Note: Dependent variable: $\ln TR_{it}$; Robust standard errors in parentheses; *P*-values in square brackets; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Using the RE estimation method and incorporating year dummies leads to changes in the estimates of control variables compared to the POLS. Only the effects of geographical distance, GDPs and political stability of the exporting countries, common border, and regional trade agreements remain significant, while Vietnam's economic size and the WTO membership of the exporting countries become insignificant. The signs and significances of the control variables are consistent across **Table 5**. The economic size and political stability of all exporters, along with the presence of common border, have positive impacts on Vietnam's imports at the 1%

level, significantly facilitating Vietnam's imports. Common membership in regional trade agreements also show positive and significant effects at the 1% level, contributing to the increase in exports from other members to Vietnam.

4.2. Robustness check with extended model

The robustness of our estimates is verified by changing the model specifications. Two variables, economic similarity ($SIML_{it}$), and the number of cellular phone subscriptions per 100 people in the exporting country i ($CELL_{it}$), are added to the baseline equations to investigate whether our estimates remain consistent. $SIML_{it}$ refers to the degree of similarity between the GDP of the exporting country i and Vietnam in year t (Kahouli, 2016). The variable is calculated as follows:

$$SIML_{it} = 1 - \left(\frac{GDP_{it}}{GDP_{it} + VGDP_t}\right)^2 - \left(\frac{VGDP_t}{GDP_{it} + VGDP_t}\right)^2 \quad (4)$$

The exporting country i and Vietnam are considered very different if $SIML_{it}$ takes a value close to 0. If the value is close to ½, it indicates that the two countries are very similar in terms of the size of GDP. The number of cell phone subscriptions per 100 people is among the proxies for the development of information and communication technologies (ICTs) and is believed to have a positive impact on international trade (Abeliansky et al., 2021; Xing, 2018).

Table 6. Robustness check.

Variables	RE	RE	RE
	(1)	(2)	(3)
$\ln LP_t$	2.354	-	-
	(2.470)	-	-
dLP_{it}	−0.280	-	0.206
	(0.171)	-	(0.250)
$\ln MinLP_{it}$	-	1.455**	1.968**
	-	(0.655)	(0.999)
$\ln DIST_i$	−0.449*	−0.434*	−0.420*
	(0.245)	(0.241)	(0.240)
$\ln GDP_{i,t}$	1.088***	1.036***	1.014***
	(0.0631)	(0.0654)	(0.0743)
$\ln VGDP_t$	−1.057	−1.060	−1.093
	(1.204)	(1.100)	(1.102)
$POST_{it}$	0.347***	0.312***	0.299***
	(0.105)	(0.104)	(0.109)
$CONTIG_i$	2.351***	2.435***	2.489***
	(0.811)	(0.796)	(0.786)
WTO_{it}	0.269	0.244	0.230
	(0.539)	(0.535)	(0.537)
RTA_{it}	0.488**	0.487**	0.500***
	(0.193)	(0.192)	(0.192)

Table 6. (*Continued*).

Variables	RE	RE	RE
	(1)	**(2)**	**(3)**
$SIML_{it}$	−0.0208	0.0395	0.154
	(0.716)	(0.696)	(0.702)
$\ln CELL_{it}$	−0.0324	−0.0589	−0.0657
	(0.118)	(0.117)	(0.117)
BPLM test	[0.0000]	[0.0000]	[0.0000]
Hausman test	[0.4551]	[0.2415]	[0.3147]
Year-specific effects	YES	YES	YES
Country-fixed effects	YES	YES	YES
Observations	918	918	918
No. of exporters	161	161	161

Note: Dependent variable: $\ln TR_{it}$; Robust standard errors in parentheses; *P*-values in square brackets; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The robustness of our estimates is confirmed as presented in **Table 6**. The RE models are applied based on the results of the Hausman's specification test, as the null hypothesis cannot be rejected at the 1% significance level. The BPLM test also indicates that the RE models are more appropriate than the POLS. According to the estimated results, the changes in model specifications do not affect our findings. All the estimates are consistent with the previous results presented in **Table 5**. The effect of minimum logistics performance remains positive and statistically significant at the 5% level; however, Vietnam's logistics performance and the absolute difference in logistics performance, on the contrary, are found to be insignificant. Therefore, we can strongly confirm the research hypothesis of the positive effect of minimum logistics performance on Vietnam's imports. Neither Vietnam's logistics performance nor the absolute difference in logistics performance have significant effects to confirm hypotheses (1) and (2). On the other hand, their estimates are much lower than that of minimum logistics performance. In general, we find a consistent and significant effect of logistics performance bottleneck on Vietnam's imports.

5. Conclusions

This research aims to investigating the bottleneck effect of logistics performance on Vietnam's imports in comparison to Vietnam's own logistics performance and the deviations between Vietnam's and trading countries' logistics performance. Using a sample of Vietnam's bilateral trade with 161 partners from 2007 to 2022 and applying RE models, we find that the minimum logistics performance has a significant and robustly positive impact on Vietnam's imports. Its effect is much larger than the two other alternative measures from the existing literature. Therefore, these findings confirm that the logistics performance bottleneck constrains the bilateral trade from the trading countries to Vietnam. Increasing the minimum logistics performance, or, in other words, the lower bound of the two trading countries' logistics performance, can facilitates bilateral trade.

Our first contribution in this research is the identification of a new aspect of the relationship between logistics and international trade: the bottleneck in logistics performance between the bilateral trading countries. Specifically, the minimum value of logistic performance between trading partners creates a bottleneck, thus being negatively associated with bilateral trade value The improvement in minimum logistics performance can facilitate greater bilateral trade. Based on these findings, policymakers can develop more effective and efficient logistics-related policies to improve bilateral trade by identifying specific logistics bottlenecks in trade with the targeted partners.

However, it is important to note some limitations in our study. Focusing solely on the case of Vietnam is a pronounced limitation. Another likely shortcoming is our use of the overall score of logistics performance and leave all six subindices unexplored. Additionally, we utilize a non-continuous value in relation to the time span of the LPIs to estimate the effects. Although we acknowledge that the Logistics Performance Index (LPI) receives criticism for its perception-based nature as a qualitative measure of logistics, we use it because it is the most comprehensive source that allows for cross-country analysis of national logistics performance. Future studies could provide more insights by covering a larger set of bilateral trading partners and incorporating the components of LPI. Furthermore, in today's context, the environmental aspects of logistics have gained increasing importance. While we were unable to address these dimensions in this paper, we aim to investigate carbon emissions and power generation in future empirical studies.

Author contributions: Conceptualization, HLV; Methodology, HLV and JE; Software, HLV; Validation, HLV; Formal Analysis, HLV; Investigation, HLV; Resources, HLV; Data Curation, HLV; Writing-Original Draft Preparation, HLV; Writing-Review & Editing, JE; Supervision, JE. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare no conflict of interest.

Notes

1. Decision no. 200/QD-TTg was issued by Vietnam's prime minister on 14th February 2017, approving the action plan for the improvement of competitiveness and development of Vietnam's logistics services by 2025
2. We cannot include Vietnam's logistics performance LP_t in Equation (3) because, in some observations, the value of $MinLP_{it}$ is equivalent to LP_t causing an omitted variable issue.
3. Due to the COVID-19 pandemic, the WB's LPI survey was postponed until 2022. Given that the LPI 2023 edition was surveyed in late 2022, we are concerned regarding data bias from exogenous macroeconomic factors such as Covid-19. Thus, we present the estimated results excluding the LPI 2023 using data up to 2018 in Table A2 in the appendix. The findings remain the same.
4. The countries identified as bottlenecks due to lower logistic efficiency, where their LPI is lower than that of Vietnam, include Timor-Leste, Haiti, Rwanda, and Myanmar. Specifically, the five small circles located on the left side of **Figure 2** also represent trade flows from Syria in 2016, Timor-Leste in 2007, Haiti in 2016, Rwanda in 2007, and Myanmar in 2007. Therefore, we can conclude that these countries, with lower LPIs than Vietnam, exhibit the lowest value of imports.
5. We include **Table A1** in the appendix to present the estimates without controlling for year-specific effects. The additional results do not alternate our findings regarding the logistics measures.

References

Abeliansky, A. L., Barbero, J., & Rodriguez-Crespo, E. (2021). ICTs quality and quantity and the margins of trade. Telecommunications Policy, 45(1), 102056. https://doi.org/10.1016/j.telpol.2020.102056

Abreo, C., Bustillo, R., & Rodriguez, C. (2021). The role of institutional quality in the international trade of a Latin American country: evidence from Colombian export performance. Journal of Economic Structures, 10(1). https://doi.org/10.1186/s40008-021-00253-5

Allen, T., Arkolakis, C., & Takahashi, Y. (2020). Universal Gravity. Journal of Political Economy, 128(2), 393–433. https://doi.org/10.1086/704385

Anderson, J. E., & van Wincoop, E. (2003). Gravity with Gravitas: A Solution to the Border Puzzle. American Economic Review, 93(1), 170–192. https://doi.org/10.1257/000282803321455214

Arvis, J.-F., Ojala, L., Wiederer, C., et al. (2018). Connecting to Compete 2018. World Bank, Washington, DC. https://doi.org/10.1596/29971

Baltagi, B. H. (2021). Econometric Analysis of Panel Data. In Springer Texts in Business and Economics. Springer International Publishing. https://doi.org/10.1007/978-3-030-53953-5

Behar, A., & Manners, P. (2008). Logistics and Exports. Centre for the Study of African Economies, University of Oxford.

Behar, A., Manners, P., & Nelson, B. D. (2013). Exports and International Logistics*. Oxford Bulletin of Economics and Statistics, 75(6), 855–886. Portico. https://doi.org/10.1111/j.1468-0084.2012.00715.x

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. The Review of Economic Studies, 47(1), 239. https://doi.org/10.2307/2297111

Bugarčić, F. Ž., Skvarciany, V., & Stanišić, N. (2020). Logistics performance index in international trade: case of central and eastern European and western Balkans countries. Business: Theory and Practice, 21(2), 452–459. https://doi.org/10.3846/btp.2020.12802

Çelebi, D. (2017). The role of logistics performance in promoting trade. Maritime Economics & Logistics, 21(3), 307–323. https://doi.org/10.1057/s41278-017-0094-4

Center for WTO and International Trade. (2023). Vietnam's FTAs as of August 2023. Available online: https://wtocenter.vn/thong-ke/13814-vietnams-ftas-summary-as-of-april-2019 (accessed on 2 January 2024).

Christopher, M. (2016). Logistics and Supply Chain Management, 5th ed. Pearson.

CSCMP. (n.d.). Definition of Logistics Management. Available online: https://cscmp.org/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx (accessed on 2 January 2024).

Eyob, E., & Kahsai, M. S. (2019). Relationships of Selected Key Logistics Factors and Logistics Performance Index of Sub-Saharan African Countries. Journal of Applied Business and Economics, 21(6). https://doi.org/10.33423/jabe.v21i6.2401

Felipe, J., & Kumar, U. (2012). The Role of Trade Facilitation in Central Asia. Eastern European Economics, 50(4), 5–20. https://doi.org/10.2753/eee0012-8775500401

Gui, D., Wang, H., & Yu, M. (2022). Risk Assessment of Port Congestion Risk during the COVID-19 Pandemic. Journal of Marine Science and Engineering, 10(2), 150. https://doi.org/10.3390/jmse10020150

Halpern, L., Koren, M., & Szeidl, A. (2005). Import and Productivity (Issue MT-DP-2005/9). Hungarian Academy of Sciences, Institute of Economics. http://hdl.handle.net/10419/108083

Hausman, J. A., & Taylor, W. E. (1981). Panel Data and Unobservable Individual Effects. Econometrica, 49(6), 1377. https://doi.org/10.2307/1911406

Hausman, W. H., Lee, H. L., & Subramanian, U. (2005). Global Logistics Indicators, Supply Chain Metrics, And Bilateral Trade Patterns. The World Bank. https://doi.org/10.1596/1813-9450-3773

Hausman, W. H., Lee, H. L., & Subramanian, U. (2013). The Impact of Logistics Performance on Trade. Production and Operations Management, 22(2), 236–252. https://doi.org/10.1111/j.1937-5956.2011.01312.x

Huynh, L. T. D. (2021). The Importance of Logistics to Vietnam's Exports. Kinh Te va Phat Trien, 290, 23–33.

Iwanow, T., & Kirkpatrick, C. (2007). Trade facilitation, regulatory quality and export performance. Journal of International Development, 19(6), 735–753. https://doi.org/10.1002/jid.1399

Kahouli, B. (2016). Regional Integration Agreements, Trade Flows and Economic Crisis: A Static and Dynamic Gravity Model. International Economic Journal, 30(4), 450–475. https://doi.org/10.1080/10168737.2016.1204338

Kaiser, B. (2015). RHAUSMAN: Stata module to perform Robust Hausman Specification Test. Statistical Software Components.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2009). Governance matters VII: aggregate and individual governance indicators 1996–2007. In: Non-State Actors as Standard Setters. Cambridge University Press. https://doi.org/10.1017/CBO9780511635519.007

Krugman, P. R., Maurice, O., & Melitz, M. J. (2018). International Economics: Theory and Policy. In: Syria Studies, 11th ed. Pearson.

Le, D. N. (2021). Globalisation, Logistics and Food Supply: Evidence from Vietnam. Malaysian Journal of Economic Studies, 58(2), 267–291. https://doi.org/10.22452/MJES.vol58no2.5

Le, D. N. (2022). Export, Logistics Performance, and Regional Economic Integration: Sectoral and Sub-Sectoral Evidence from Vietnam. Journal of International Logistics and Trade, 20(1), 37–56. https://doi.org/10.24006/jilt.2022.20.1.037

Lê, Đ. N. (2023). Gender equality, institutions, logistics efficiency, International Trade: The case of agriculture in Vietnam (Vietnamese). Journal of International Economics and Management. https://doi.org/10.38203/jiem.vi.082022.1001

Li, C.-Y., Shinde, T., He, W., et al. (2023). Unveiling Bottlenecks in Logistics: A Case Study on Process Mining for Root Cause Identification and Diagnostics in an Air Cargo Terminal. In: Lecture Notes in Computer Science. Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-48424-7_21

Martí, L., Puertas, R., & García, L. (2014). The importance of the Logistics Performance Index in international trade. Applied Economics, 46(24). https://doi.org/10.1080/00036846.2014.916394

Mizgier, K. J., Jüttner, M. P., & Wagner, S. M. (2013). Bottleneck identification in supply chain networks. International Journal of Production Research, 51(5), 1477–1490. https://doi.org/10.1080/00207543.2012.695878

Moïsé, E., Orliac, T., & Minor, P. (2011). Trade Facilitation Indicators: The Impact on Trade Costs. In: OECD Trade Policy Papers. OECD.

Moïsé, E., & Sorescu, S. (2013). Trade Facilitation Indicators: The Potential Impact of Trade Facilitation on Developing Countries' Trade. In: OECD Trade Policy Papers. OECD.

Pierola, M. D., Fernandes, A. M., & Farole, T. (2018). The role of imports for exporter performance in Peru. The World Economy, 41(2), 550–572. https://doi.org/10.1111/twec.12524

Puertas, R., Martí, L., & García, L. (2014). Logistics performance and export competitiveness: European experience. Empirica, 41(3), 467–480. https://doi.org/10.1007/s10663-013-9241-z

Rahman, M. M. (2021). The dynamic nexus of energy consumption, international trade and economic growth in BRICS and ASEAN countries: A panel causality test. Energy, 229, 120679. https://doi.org/10.1016/j.energy.2021.120679

Ravenstein, E. G. (1885). The Laws of Migration. Journal of the Statistical Society of London, 48(2), 167. https://doi.org/10.2307/2979181

Rushton, A., Croucher, P., & Baker, P. (2017). The Handbook of Logistics and Distribution Management, 6th ed. Kogan Page Limited.

Scholz-Reiter, B., Windt, K., & Liu, H. (2011). Modelling dynamic bottlenecks in production networks. International Journal of Computer Integrated Manufacturing, 24(5), 391–404. https://doi.org/10.1080/0951192X.2010.511655

Şimşit, Z. T., Günay, N. S., & Vayvay, Ö. (2014). Theory of Constraints: A Literature Review. Procedia–Social and Behavioral Sciences, 150, 930–936. https://doi.org/10.1016/j.sbspro.2014.09.104

Song, M.-J., & Lee, H.-Y. (2022). The relationship between international trade and logistics performance: A focus on the South Korean industrial sector. Research in Transportation Business & Management, 44, 100786. https://doi.org/10.1016/j.rtbm.2022.100786

Teeramungcalanon, M., Chiu, E. M. P., & Kim, Y. (2020). Importance of Political Elements to Attract FDI for ASEAN and Korean Economy. Journal of Korea Trade, 24(8), 63–80. https://doi.org/10.35611/jkt.2020.24.8.63

Tinbergen, J. (1962). Shaping the World Economy, Suggestions for an International Economic Policy. The Twentieth Century Fund.

Turco, A. Lo, & Maggioni, D. (2013). On the Role of Imports in Enhancing Manufacturing Exports. World Economy, 36(1). https://doi.org/10.1111/twec.12020

van Battum, C. H. H., Wiegmans, B., Atasoy, B., et al. (2023). Performance improvements in container terminals through the bottleneck mitigation cycle. Maritime Economics & Logistics, 25(1), 174–195. https://doi.org/10.1057/s41278-022-00245-7

Wilson, J. S., Mann, C. L., & Otsuki, T. (2005). Assessing the Benefits of Trade Facilitation: A Global Perspective. The World Economy, 28(6), 841–871. https://doi.org/10.1111/j.1467-9701.2005.00709.x

Witte, P. A., Wiegmans, B. W., van Oort, F. G., & Spit, T. J. M. (2012). Chokepoints in corridors: Perspectives on bottlenecks in the European transport network. Research in Transportation Business & Management, 5, 57–66. https://doi.org/10.1016/j.rtbm.2012.10.001

Wooldridge, J. M. (2020). Introductory Econometrics: A Modern Approach, 7th ed. Cengage.

World Bank. (2021). World development indicators. Available online: https://databank.worldbank.org/source/world-development-indicators?# (accessed on 2 January 2024).

Xing, Z. (2018). The impacts of Information and Communications Technology (ICT) and E-commerce on bilateral trade flows. International Economics and Economic Policy, 15(3), 565–586. https://doi.org/10.1007/s10368-017-0375-5

Zaninović, P. A., Zaninović, V., & Skender, H. P. (2021). The effects of logistics performance on international trade: EU15 vs CEMS. Economic Research-Ekonomska Istraživanja, 34(1), 1566–1582. https://doi.org/10.1080/1331677X.2020.1844582

Appendix

Table A1. Baseline regressions without year dummies for the period 2007–2023.

Variables	RE	RE	RE
	(1)	(2)	(3)
$\ln LP_t$	0.482		
	(1.255)		
dLP_{it}	−0.469***		0.0871
	(0.168)		(0.251)
$\ln MinLP_{it}$		2.038***	2.248**
		(0.606)	(0.935)
$\ln DIST_i$	−0.484*	−0.461*	−0.457*
	(0.250)	(0.246)	(0.245)
$\ln GDP_{i,t}$	1.070***	0.998***	0.991***
	(0.0695)	(0.0728)	(0.0781)
$\ln VGDP_t$	0.864***	0.723***	0.698***
	(0.292)	(0.221)	(0.232)
$POST_{it}$	0.378***	0.321***	0.315***
	(0.102)	(0.102)	(0.106)
$CONTIG_i$	2.469***	2.573***	2.583***
	(0.774)	(0.757)	(0.756)
WTO_{it}	0.190	0.147	0.141
	(0.654)	(0.648)	(0.652)
RTA_{it}	0.283*	0.295**	0.302**
	(0.148)	(0.146)	(0.148)
Year-specific effects	NO	NO	NO
Country-fixed effects	YES	YES	YES
Observations	936	936	936

Note: Dependent variable: $\ln TR_{it}$; Robust standard errors in parentheses; *P*-values in square brackets; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A2. Regressions for the period 2007–2018.

Variables	RE	RE	RE
	(1)	(2)	(3)
$\ln LP_t$	0.612	-	-
	(1.303)	-	-
dLP_{it}	−0.308*	-	0.315
	(0.165)	-	(0.255)
$\ln MinLP_{it}$	-	1.726***	2.509**
	-	(0.610)	(0.984)
$\ln DIST_i$	−0.432*	−0.418*	−0.402*
	(0.239)	(0.234)	(0.233)
$\ln GDP_{i,t}$	1.045***	0.982***	0.954***
	(0.0664)	(0.0702)	(0.0770)

Table A2. (*Continued*).

Variables	RE	RE	RE
	(1)	(2)	(3)
$\ln VGDP_t$	0.0533	−0.0895	−0.403
	(0.408)	(0.823)	(0.773)
$POST_{it}$	0.353***	0.307***	0.285***
	(0.102)	(0.0995)	(0.105)
$CONTIG_i$	2.306***	2.378***	2.420***
	(0.747)	(0.729)	(0.723)
WTO_{it}	0.434	0.406	0.384
	(0.516)	(0.509)	(0.511)
RTA_{it}	0.529**	0.539**	0.553**
	(0.233)	(0.230)	(0.231)
BPML test	[0.0000]	[0.0000]	[0.0000]
Hausman tests	[0.0701]	[0.0694]	[0.1514]
Year-specific effects	YES	YES	YES
Country-fixed effects	YES	YES	YES
Observations	829	829	829
No. of exporters	161	161	161

Note: Dependent variable: $\ln TR_{it}$; Robust standard errors in parentheses; *P*-values in square brackets; *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.