The Impact of International Logistics Performance on ASEAN Trade

Prawpan Oruangke[1]
Faculty of International Maritime Studies, Kasetsart University, Thailand
E-mail: prawpan.o@ku.th

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Abstract

The objective of this study is to investigate the impact of international logistics performance on ASEAN trade. The gravity model is applied with an augmented Logistics Performance Index (LPI) and its six logistical components, namely customs, infrastructure, logistics competency, international shipments, tracking and tracing, and timeliness. The obtained results reveal that LPI and its components are positive and highly statistically significant to ASEAN trade, mostly exports. Improvements to logistical components have led to significant growth in trade flows, implying that efficient logistics performance contributes positively to trade. Moreover, in the area of policy regulation, the greatest increase in ASEAN trade has been shown to come primarily from improvement in logistics competency followed by customs and infrastructure. For logistics performance outcomes in terms of time, cost, and reliability, improving timeliness is found to have the greatest influence on boosting trade, followed by tracking and tracing, and international shipment. These findings can help to stimulate the governments and private sectors of ASEAN member states to improve their logistics performance and boost trade.

Keywords: ASEAN, Logistics Performance, Trade, Gravity Model
JEL Classification Codes: C50; F10; F15

[1] Lecturer, Faculty of International Maritime Studies, Kasetsart University Sri Racha Campus, Sukhumvit Road, Chonburi, 20230, Thailand. Corresponding author: E-mail: prawpan.o@ku.th.

1. Introduction

Logistics is becoming increasingly important for facilitating the trade and economic development of countries in the global economy. This is because efficiency in logistics capability helps to increase a country's competitiveness, reducing trading costs and increasing the potential for global integration. Jean-François Arvis et al. (2014) insisted that "Improving logistics performance is at the core of the economic growth and competitiveness agenda". According to Hausman, Lee, and Subramanian (2013), who examined the impact of logistics performance in terms of cost, time, and reliability on global trade flows, logistics performance has a statistically significant association with trade volume, implying that its improvement can stimulate trade. An efficient logistics performance system is a key element of sustainable economic development (Bizoi & Sipos, 2014; Havenga, 2010).

Since the World Bank first published the LPI and its indicators in 2007, these components have been widely used to study the relationship between logistics performance and trade. This is because trade performance is strongly associated with the quality of the logistics service as Hollweg and Wong (2009) suggested. For example, Felipe and Kumar (2012) studied the role of trade facilitation in Central Asia using the LPI and three logistical components, namely customs, infrastructure, and services. The findings suggested that trade facilitation improvement leads to increased trade volume in Central Asia. Martí, Puertas, and García (2014) applied the LPI and different logistical components to customs procedures, logistics cost, and the quality of infrastructure to analyze the importance of their performance on international trade. By focusing on emerging economies with maritime boundaries, they found that logistical component improvement leads to a boost in trade. Subsequently, Faria, Souza, and Vieira (2015) assessed the LPI and its components for Brazil's trade with its major trade competitors. In addition, Gani (2017) examined the effect of logistics performance on the international trade of 60 countries using the LPI and its sub-dimensions. The obtained results indicated that all aspects of logistics performance are positive and have a statistically significant association with trade, especially exports. Wang and Choi (2018) analyzed logistics performance and its effect on international trade volume by comparing developing and developed countries. They found that logistics performance has a greater influence on developed than developing countries. As previously mentioned, it can be concluded that logistics performance improvement has a positive impact on international trade and leads to economic development.

The Association of Southeast Asian Nations (ASEAN) makes a significant contribution to the global economy, particularly with the establishment of the ASEAN Economic Community (AEC) in 2015. The ASEAN comprises ten member states, namely Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. Due to its significance for global trade, and the performance and progress of trade facilitation in the region, ASEAN economies could help in supporting trade as suggested by Otsuki (2011), who stated that improving the efficiency of trade facilitation in ports, customs environment, regulatory environment, and service sector infrastructure leads to increased ASEAN trade volume. Therefore, trade facilitation is considered a key element of ASEAN connectivity for economic integration and trade improvement. However, Findlay (2009) suggested that the AEC should play a primary role in designing programs to support and monitor trade facilitation. Nevertheless, as suggested by De and Saha (2013), most countries in the ASEAN and South Asia lack sufficient knowledge of logistics and related policy development. As mentioned previously, there is no empirical evidence in relation to the assessment of the LPI impact and its six logistical components, as a proxy for trade facilitation, on ASEAN trade.

The objective of this study is to investigate the influence of logistical capability on ASEAN trade using the LPI and its different logistical components; first published in 2007 with the latest edition produced in 2018 (Jean-Francois Arvis, Mustra, Panzer, Ojala, & Naula, 2007; Jean-François Arvis et al., 2018). The remainder of this paper is organized as follows. Section 2 provides a description of the LPI and its ranking system and the scores for ASEAN member states including average scores for logistical capability. Section 3 contains the methodology and data while section 4 explains and discusses the results. The final section presents the conclusion.

2. The Logistics Performance Index (LPI) and ASEAN Member States

The LPI has become a key indicator for explaining the relationship between trade and transport facilitation (Martí et al., 2014). This index is an important part of the global effort to better understand logistics performance in the context of an increasingly complex supply chain which is the backbone of international trade. In addition, the LPI score reflects the perception of a country's logistics, based on efficiency in the customs clearance process, quality of trade and transport-related infrastructure, ease of arranging competitively priced shipments, quality of logistics services, ability to track and trace consignments, and the frequency with which shipments reach consignees within the scheduled or expected delivery time. The overall LPI score and its six components are used extensively, providing a more telling indicator than their rankings. This is because they are more accurate and provide a better basis for comparison over time. The score of LPI and its six components range from 1 to 5, with the higher score indicating the better logistics performance.

The LPI was first published by the World Bank in 2007, and approximately every two years thereafter; the latest edition being in 2018. Two years prior to publication, a questionnaire survey was provided by professionals on the logistics performance of trade across countries. All six editions of the LPI (2007, 2010, 2012, 2014, 2016, and 2018) contain the country's ranking with scores for the six components, namely customs, infrastructure, logistics competency, international shipments, tracking and tracing, and timeliness.

According to Jean-François Arvis et al. (2018), the LPI and its six components are divided into two main categories: policy regulation with inputs into the supply chain consisting of customs, infrastructure, and logistics services; and supply chain performance outcomes in terms of time, cost, and reliability such as timeliness, international shipments, and tracking and tracing. The six logistics components are defined as follows.

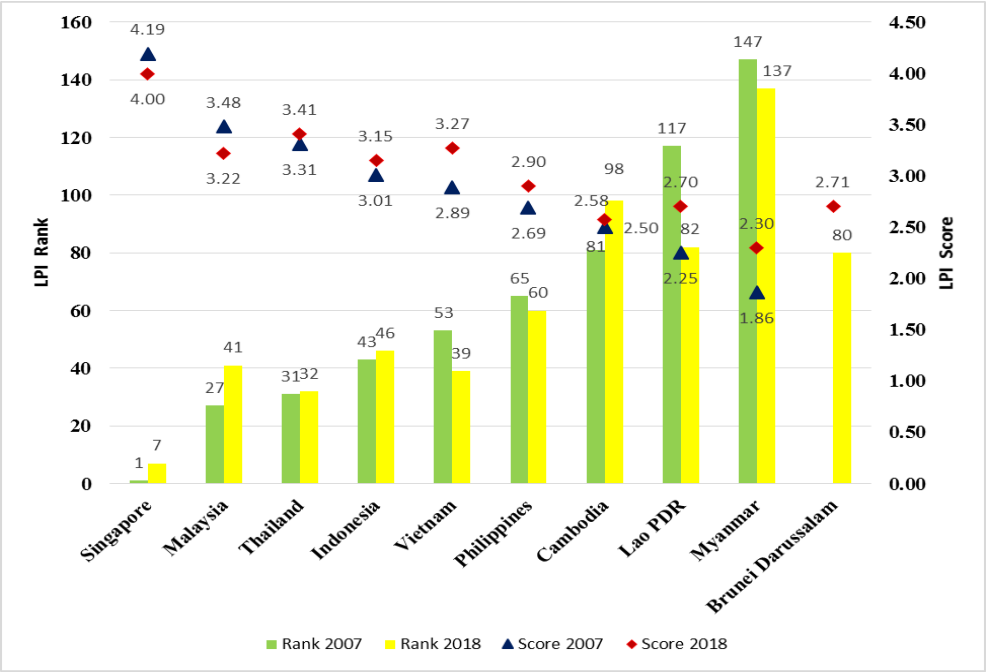
- Customs: the efficiency of customs and border management clearance
- Infrastructure: the quality of trade and transport-related infrastructure
- Competence: the competence and quality of logistics services
- International shipments: the ease with which competitive international shipments are arranged
- Tracking and tracing: the ability to track and trace consignments
- Timeliness: the frequency with which shipments reach consignees within the scheduled or expected delivery time

These components have been selected based on theoretical and empirical research, as well as the real experience of logistics experts in relation to international freight forwarding. Consequently, the LPI is constructed from an online survey of logistics professionals from multinational freight forwarders and the main express carriers, who can assess the vital aspects of a country's logistics performance. The LPI is then constructed from the six

indicators using principal component analysis (PCA); a standard statistical technique for aggregating the data into a single indicator to compare countries, regions, and income groups.

Many countries use the LPI as a key performance indicator in their national transportation or logistics strategies. This index is applied as standard reference material in many studies and policy papers on trade logistics. However, despite the LPI and its components being the most comprehensive and comparable data for a country's logistics and trade facilitation environments, they have two important limitations. Due to the limited experience of survey respondents, and for landlocked countries and small island states, their trade facilitation depends on international transit routes or the logistics of other countries.

The LPI for ASEAN member states during the period from 2007 to 2018 is shown in Figure 1. The scores indicate that the overall logistics performance slightly increased during this period for most ASEAN member states except for Singapore and Malaysia, which revealed a decrease.



Source: Compiled from the World Bank LPI Database Published in 2007 and 2018

Figure 1. Comparison of the LPI Rank and Score in ASEAN Countries for the period 2007 and 2018

Average scores for the six logistics components of ASEAN member states in all editions published by the World Bank are displayed in Table 1. The obtained results reveal that the customs procedure has the lowest performance for logistical capability in the area of policy regulation followed by infrastructure and logistics competency, respectively. Service delivery performance outcomes in terms of time, cost, and reliability, timeliness was found to be the highest, followed by tracking and tracing, and international shipments, respectively.

Table 1. Average Score of ASEAN Logistics Components in the Period from 2007 to 2018

Year	Customs	Infra structure	Logistics quality and competence	International shipments	Tracking and tracing	Timeliness
2007	2.7641	2.7043	2.8935	2.8966	2.8720	3.3334
2010	2.7022	2.7267	2.8202	3.0168	3.0391	3.5446
2012	2.7845	2.8201	2.9531	3.0178	3.1076	3.4214
2014	2.9270	2.9785	3.0004	3.0608	3.0789	3.3827
2016	2.8171	2.7868	2.8781	3.0364	2.9546	3.3939
2018	2.7851	2.8017	3.0130	3.0283	3.0883	3.4003
Average score	2.7967	2.8030	2.9264	3.0095	3.0234	3.4127

Source: Author's calculation

3. Methodology and Data

3.1 Methodology

The gravity model is widely used for investigating the relationship between international trade and influential factors. Tinbergen (1962) and Pöyhönen (1963) are considered pioneers in the use of gravity models for international trade. Subsequently, the theoretical foundation for the gravity model for use in empirical study related to international trade was proposed by Anderson (1979) and Anderson and Van Wincoop (2003). The traditional gravity model explains bilateral trade flows in relation to the size and distance of two trading partners. This model is assumed to be positive regarding the size represented by country's gross domestic product (GDP) of two countries and negative for the distance between two countries.

According to Hausman et al. (2013), the basic gravity model is expressed in logarithm form as follows:

$$S(i,j) = \beta_0 + \beta_1 GDP(i) + \beta_2 GDP(j) + \beta_3 d(i,j) + e(i,j) \qquad (1)$$

Where S(i,j) is the log value of bilateral trade from country i to country j. GDP_i (GDP_j) denotes the log of GDP in country i (j). The log of distance from country i to country j is represented as d(i,j). While e(i,j) is an error term assumed to be independent, identically distributed (i.i.d), and uncorrelated with the other variables. Theoretically, researchers add additional explanatory variables to the basic gravity model if they have the power to explain the dependent variable (Anderson, 1979). Therefore, this study applies logistics performance as an explanatory variable of trade in accordance with Martí et al. (2014) to confirm the impact of logistics performance on trade.

Recent empirical research has incorporated variables to represent logistics improvement into the model (Gani, 2017; Martí et al., 2014; Wang & Choi, 2018). However, empirical studies tend to include dummy variables to capture the effects of certain factors for supporting trade such as a common language and sharing a common border. In this study, the augmented gravity model is adjusted from Hausman et al. (2013) and Martí et al. (2014) and then expressed as follows.

$$\log(X_{ij}) = \alpha_0 + \alpha_1 \log(GDP_i) + \alpha_2 \log(GDP_j) + \alpha_3 \log(D_{ij}) + \alpha_4 \log(LPI_i) + \alpha_5 \log Z(LPI_j) + \alpha_6 CPI_i + \alpha_7 CPI_j + \alpha_8(RTA_{ij}) + \alpha_9(Border) + \alpha_{10}(Com_Lang) + \varepsilon_{ij} \ldots (2)$$

Where X_{ij} is the dependent variable representing the total value of bilateral exports from country i to country j, while i denotes the 10 ASEAN exporting member states, namely Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam, and j represents the importing country. The independent variables are defined as follows: GDP_i (GDP_j) indicates the gross domestic product of exporters (importers). D_{ij} is the transport cost measured by the distance between two trading partners expressed in kilometers. LPI_i (LPI_j) is the overall LPI of the exporting (importing) country. CPI_i (CPI_j) is the corruption perception index of the exporting (importing) country impacting on ASEAN trade as suggested by Voraveeravong (2013). The dummy variables consist of the following: the regional trade agreement (RTA_{ij}) which is equal to 1 if the trading partners have a regional trade agreement and 0 otherwise. Border is equal to 1 if the trading partners share a common border and 0 otherwise. Com_Lang is a common language which takes the value of 1 if the trading partners share a common language and 0 otherwise. The error term is represented as ε_{ij}.

According to Equation 2, exports depend on economic, geographic, logistics, and corruption perception variables. This method is based on the assumption that the variables included in the model have a significant impact on trade and signs are consistent with economic theory. Theoretically, the coefficients of the GDP exporter and importer (α_1 and α_2, respectively) should be positive due to the larger economy being expected to export and import more. The distance variable is an approximate indication of trading cost, and the expected sign of distance between countries (α_3) should be negative. In accordance with the objective of this study, the logistics variables (α_4 and α_5, respectively) should display a positive sign, representing the importance of facilitating export trade. The coefficient of the corruption perception index (α_6 and α_7, respectively) is expected to show a positive sign, indicating that lower corruption could support greater trade than higher corruption. Finally, the dummy variables such as the regional trade agreement, borders, and common language capture the similarities in societies and cultures existing in different countries.

In this study, the gravity model is estimated by the Ordinary Least Squares (OLS) method. For the heteroscedasticity problem, the robust procedure of STATA was used to correct. As suggested by Martí et al. (2014), the overall LPI is highly correlated with logistics components such as customs, infrastructure, logistics competency, international shipments, tracking and tracing, and timeliness. Therefore, to avoid the multicollinearity problem, these components should be estimated in separate equations as follows.

$$\log(X_{ij}) = \beta_0 + \beta_1 \log(GDP_i) + \beta_2 \log(GDP_j) + \beta_3 \log(D_{ij}) + \beta_4 \log(Customs_i) + \beta_5 \log(Customs_j) + \beta_6 CPI_i + \beta_7 CPI_j + \beta_8(RTA_{ij}) + \beta_9(Border) + \beta_{10}(Com_Lang) + \varepsilon_{ij} \ldots (3)$$

$$\log(X_{ij}) = \delta_0 + \delta_1 \log(GDP_i) + \delta_2 \log(GDP_j) + \delta_3 \log(D_{ij}) + \delta_4 \log(Infrastructure_i) + \delta_5 \log(Infrastructure_j) + \delta_6 CPI_i + \delta_7 CPI_j + \delta_8(RTA_{ij}) + \delta_9(Border) + \delta_{10}(Com_Lang) + \varepsilon_{ij} \ldots (4)$$

$$\log(X_{ij}) = \lambda_0 + \lambda_1 \log(GDP_i) + \lambda_2 \log(GDP_j) + \lambda_3 \log(D_{ij}) + \lambda_4 \log(Competence_i) + \lambda_5 \log(Competence_j) + \lambda_6 CPI_i + \lambda_7 CPI_j + \lambda_8(RTA_{ij}) + \lambda_9(Border) + \lambda_{10}(Com_Lang) + \varepsilon_{ij} \ldots (5)$$

$$\log(X_{ij}) = \varphi_0 + \varphi_1 \log(GDP_i) + \varphi_2 \log(GDP_j) + \varphi_3 \log(D_{ij}) + \varphi_4 \log(Intershipments_i) + \varphi_5 \log(Intershipments_j) + \varphi_6 CPI_i + \varphi_7 CPI_j + \varphi_8(RTA_{ij}) + \varphi_9(Border) + \varphi_{10}(Com_Lang) + \varepsilon_{ij} \ldots (6)$$

$$\log(X_{ij}) = \theta_0 + \theta_1 \log(GDP_i) + \theta_2 \log(GDP_j) + \theta_3 \log(D_{ij}) + \theta_4 \log(Tracking_i) + \theta_5 \log(Tracking_j) + \theta_6 CPI_i + \theta_7 CPI_j + \theta_8(RTA_{ij}) + \theta_9(Border) + \theta_{10}(Com_Lang) + \varepsilon_{ij} \ldots (7)$$

$$\log(X_{ij}) = \omega_0 + \omega_1 \log(GDP_i) + \omega_2 \log(GDP_j) + \omega_3 \log(D_{ij}) + \omega_4 \log(Timeliness_i) + \omega_5 \log(Timeliness_j) + \omega_6 CPI_i + \omega_7 CPI_j + \omega_8(RTA_{ij}) + \omega_9(Border) + \omega_{10}(Com_Lang) + \varepsilon_{ij} \ldots (7)$$

A significant and positive coefficient is expected for each logistics component, where a higher component value would favor international trade. By comparing the estimation results, the component with the greatest impact on trade flows can be ascertained and changes identified over the period (2005–2016).

3.2 Data

This study uses cross-sectional data on ASEAN member states for comparison between the first World Bank LPI database published in 2007 and the latest edition in 2018. The LPI and its components are of key interest in this study, since they are the benchmarks for comparing the logistics of countries, conducted every two years before publication, consisting of customs, infrastructure, logistics competency, international shipments, tracking and tracing, and timeliness. The scores for these components range from 1–5; the higher the score, the better the logistics performance. Gross domestic product (GDP) in dollars and export bilateral trade data are compiled by the World Economic Outlook database of the International Monetary Fund (IMF), while the corruption perception index (CPI) is compiled by Transparency International, with the scale range from 0 to 100; the lower the scale, the higher the country's corruption. The regional trade agreements are obtained from the World Trade Organization (WTO) database. The distance and dummy variables such as border and common language are gathered from the *Centre d'Études Prospectives et d'Informations Internationales* (CEPII) database of the French Research Center in International Economics.

4. Results and Discussion

The gravity model estimation of the influential logistics representing the LPI for ASEAN trade between 2005 and 2016 is shown in Table 2. The results of testing the variance inflation factor (VIF)[2] found that there are no multicollinearity problem among all variables. As expected, the main results accord with previous studies. The GDP of exporting and importing countries has a significantly positive impact on bilateral trade flows, slightly declining from 2005 to 2016. This indicates that efficient economies are able to export and import more. Distance has a statistically significant negative impact on trade meaning that an increase of 1% in distance reduces trade flows by approximately 1.04–1.07%, implying that the greater the distance, the lower the international trade due to the high transportation cost. The CPI was not statistically significant in 2005 on the exporter side, but highly statistically significant and revealing an unexpected negative sign in 2016. This means that higher corruption in the ASEAN could support international trade in this region. However, the CPI

[2] Variance inflation factor (VIF) indicated the presence of multicollinearity between variables if the VIF value of variables is greater than 10.

is insignificant on the importer side in both 2005 and 2016. As for the results of the dummy variables, the RTA is insignificant in 2005 but displays a statistically significant positive sign in 2016. However, the border has a positive impact on trade and is highly statistically significant in 2005 and 2016. Finally, common language is not significant for either 2005 or 2016.

The LPI variable as a proxy for logistics performance according to the gravity results is the variable interest in this study. The main results indicate that the overall LPI shows highly significant statistical and positive coefficients for bilateral trade from both the exporter and importer perspective in 2005 and 2016. This indicates that logistics performance has a greater impact on international trade. On the exporter side, the coefficient changed from 3.9511 in 2005 to 10.2971 in 2016, implying that a 1% improvement in logistics performance leads to an increase in trade value from 3.9511% in 2005 to 10.2971% in 2016. On the importer side, an increase of 1% in logistics performance could improve ASEAN trade from 3.1376 to 3.4437%. Importantly, the logistics performance of ASEAN exporting member states have a greater impact on ASEAN trade than importing.

Table 2. Estimates of Gravity Model using LPI for the period 2005 and 2016

	2005	**2016**
Constant	-5.0623***	-45.6707***
	(1.2483)	(1.5489)
GDP export	1.3173***	0.9418***
	(0.0757)	(0.0552)
GDP import	0.8628***	0.8126***
	(0.0407)	(0.0382)
Distance	-1.0377***	-1.0738***
	(0.1221)	(0.0854)
LPI export	3.9511***	10.2971***
	(0.7843)	(0.6575)
LPI import	3.1376***	3.4437***
	(0.5372)	(0.5982)
CPI export	0.0547	-0.0391***
	(0.0554)	(0.0045)
CPI import	-0.0258	-0.0050
	(0.0431)	(0.0046)
RTA	0.4538	1.0723***
	(0.3682)	(0.2211)
Border	1.9901***	1.4569***
	(0.7713)	(0.3921)
Common language	0.2728	0.0547
	(0.2508)	(0.2007)
Number of observations	1341	1439
Adjusted R-squared	0.7699	0.7330

Notes: *** indicates the statistical significant at 1% level. Robust standard errors are in parentheses. All variables are in the log with exception CPI and dummy variables.

According to the objective of this study, gravity estimation is applied to investigate the impact of logistical components, namely customs, infrastructure, logistics competency, international shipments, tracking and tracing, and timeliness on ASEAN trade in 2005 and 2016, as revealed in Table 3. The main results indicate that each logistical component has a positive and statistically significant impact on both exporters and importers. However, the logistical components of ASEAN exporting members have more influence on trade than their trading partners.

Table 3. Coefficient of LPI and its Components for the periods 2005 and 2016

	2005		**2016**	
	Export	**Import**	**Export**	**Import**
LPI	3.9511***	3.1376***	10.2971***	3.4437***
	(0.7843)	(0.5372)	(0.6575)	(0.5982)
Customs	7.5168***	2.1678***	9.5705***	3.4257***
	(1.2598)	(0.4950)	(0.5855)	(0.4907)
Infrastructure	4.0650***	2.6399***	9.2674***	2.5798***
	(0.6765)	(0.4615)	(0.5992)	(0.5012)
Competence	6.0191***	2.4361***	10.4567***	1.9332***
	(1.0281)	(0.4362)	(0.5721)	(0.5238)
International shipments	2.4649***	2.4842***	5.6251***	2.0297***
	(0.6344)	(0.4583)	(0.5936)	(0.5004)
Tracking and tracing	1.7379***	2.4937***	6.2971***	2.4888***
	(0.5040)	(0.4245)	(0.5386)	(0.4827)
Timeliness	2.6054***	1.5668***	9.5044***	2.1327***
	(0.6228)	(0.4914)	(0.6814)	(0.5470)

Notes: *** indicates the statistical significant at 1% level. Robust standard errors are in parentheses.

Focusing on logistical components in the area of policy regulation such as customs, infrastructure and logistics competency, the results obtained from the exporter perspective found that these components had a greater impact on ASEAN trade and were highly statistically significant during the period from 2005 to 2016. A customs performance improvement of 1% could enhance trade by about 7.5168% in 2005 and 9.5705% in 2016. As for infrastructure, a 1% improvement in performance could support ASEAN trade by approximately 4.0650% in 2005 and 9.2674% in 2016. An improvement in logistics competency of 1% could promote trade by about 6.0191% in 2005 and 10.4567% in 2016. Comparison of these logistical components in 2016 indicated that a performance improvement in logistics competency had the greatest impact on ASEAN trade, followed by customs and infrastructure, respectively. From the importer perspective, the results show that three logistics components are also highly statistically significant with positive values for both 2005 and 2016.

In terms of time, cost, and reliability, timeliness, international shipments, and tracking and tracing in particular also had a greater impact on ASEAN trade from the exporter perspective for the period from 2005 to 2014. The results indicate that a 1% performance improvement in international shipments could promote trade by about 2.4649% in 2005 and 5.6251% in 2016. A performance improvement of 1% for tracking and tracing supported an increase in trade of approximately 1.7379% in 2005 and 6.2971% in 2016. A 1% performance improvement in timeliness could enhance trade by about 2.6054% in 2005 and 9.5044% in 2016. In 2016, timeliness had the greatest impact on ASEAN trade, followed by tracking and tracing, and international shipments, respectively. In contrast to the importer side, the results indicate that the performance of international shipments and timeliness had less impact on trade than tracking and tracing during the period from 2005 to 2016. Comparing these logistical components for the most recent year of 2016, tracking and tracing is shown to have the greatest impact on trade followed by timeliness, and international shipments, respectively.

In summary, from the ASEAN exporter perspective, the overall logistics performance and its six components are important for trade enhancement. Moreover, the performance of logistics components has a greater impact on exporting countries than importing. In the area of policy regulation, logistics competency has the highest impact on ASEAN trade, followed by customs and infrastructure, respectively. Additionally, in terms of logistics performance outcomes, timeliness is found to have the greatest impact on ASEAN trade followed by tracking and tracing, and international shipments. Subsequently, ASEAN policymakers should focus on improving the quality of logistics providers while the private sector needs to improve the transportation of commodities in a timely manner to enhance ASEAN trade.

5. Conclusions

Logistics has become important for a country's competitiveness, trade enhancement, and the economic development of the global economy. Recently, many researchers have focused on logistics performance to facilitate international trade. This study aims to investigate the impact of logistics performance on ASEAN trade since this region is becoming significant for global trade.

In accordance with the objective of this study, the LPI and its components: customs, infrastructure, logistics competency, international shipments, tracking and tracing, and timeliness, are used as a proxy for logistics in the investigation of its influence on ASEAN international trade. These logistical components were first published by the World Bank in 2007, with the most recent edition produced in 2018. The augmented gravity model is applied to estimate the influence of logistics on ASEAN trade. The obtained results indicate that the LPI and each logistical component are significant and provide positive coefficients, implying that an improvement in logistics performance can increase the volume of ASEAN exports. Moreover, the logistics performance of an exporting country has a greater impact on international trade than an importing country. Comparison of logistical components in the area of policy regulation indicates that logistics competency has the largest impact on ASEAN trade followed by customs and infrastructure. As for service delivery performance outcomes in terms of time, cost, and reliability, the highest increase in ASEAN trade comes from timeliness, followed by tracking and tracing, and international shipments.

The results of this study confirm that improvement in logistics performance and each of its components is strongly associated with ASEAN trade enhancement. Therefore, the ASEAN member countries should focus on improving the quality of logistics services such as trucking, forwarding agent, and customs brokerage. Moreover, customs clearing processes

should be improved for better logistical performance and efficient policy regulation and monitoring. In terms of time, the private sector should transport the commodity from origin to destination within the scheduled or expected delivery time to boost trade. Further study should be investigated the influence of logistics performance on ASEAN trade in terms of time-sensitive products such as agricultural products compared to manufactured products.

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Appendix

Table 1. Estimates of Gravity Model using Customs, Infrastructure and Competence for the period 2005 and 2016 (area of policy regulation). Dependent variable: log of ASEAN total exports

	2005			2016		
	Customs	**Infra structure**	**Competence**	**Customs**	**Infra structure**	**Competence**
Constant	-6.0708***	-3.9395***	-5.9521***	-51.8661***	-39.7937***	-43.9159***
	(1.3356)	(1.1784)	(1.2964)	(1.4932)	(1.6696)	(1.5281)
GDP export	1.0500***	1.2844***	1.2179***	1.2237***	0.8511***	0.8820***
	(0.1062)	(0.0721)	(0.0824)	(0.0443)	(0.0596)	(0.0532)
GDP import	0.9137***	0.8711***	0.8781***	0.8598***	0.8135***	0.8671***
	(0.0376)	(0.0404)	(0.0398)	(0.0327)	(0.0402)	(0.0372)
Distance	-1.0101***	-1.0181***	-1.0215***	-1.0339***	-1.0856***	-1.0780***
	(0.1226)	(0.1217)	(0.1217)	(0.0845)	(0.0856)	(0.0836)
Customs export	7.5168***			9.5705***		
	(1.2598)			(0.5855)		
Customs import	2.1678***			3.4257***		
	(0.4950)			(0.4907)		
Infrastructure export		4.0650***			9.2674***	
		(0.6765)			(0.5992)	
Infrastructure import		2.6399***			2.5798***	
		(0.4615)			(0.5012)	
Competence export			6.0191***			10.4567***
			(1.0281)			(0.5721)
Competence import			2.4361***			1.9332***
			(0.4362)			(0.5238)

Table 1. Estimates of Gravity Model using Customs, Infrastructure and Competence for the period 2005 and 2016 (area of policy regulation). Dependent variable: log of ASEAN total exports (Continued)

	2005			2016		
	Customs	**Infra structure**	**Competence**	**Customs**	**Infra structure**	**Competence**
CPI export	-0.1346*	-0.0278	-0.0844	-0.0500***	-0.0539***	-0.0488***
	(0.0775)	(0.0604)	(0.0710)	(0.0049)	(0.0053)	(0.0045)
CPI import	0.0006	-0.0326	0.0188	-0.0100**	-0.0028	0.0031
	(0.0456)	(0.0442)	(0.0388)	(0.0047)	(0.0047)	(0.0045)
RTA	0.4826	0.5009	0.3774	0.9542***	1.0484***	1.0847***
	(0.3687)	(0.3671)	(0.3670)	(0.2192)	(0.2220)	(0.2164)
Border	1.9468**	1.9931***	2.1108***	1.4271***	1.5277***	1.4262***
	(0.7695)	(0.7665)	(0.7682)	(0.3878)	(0.3939)	(0.3839)
Official language	0.2620	0.4729*	0.3876	0.0528	-0.0031	0.0990
	(0.2507)	(0.2544)	(0.2513)	(0.1981)	(0.2017)	(0.1963)
Observations	1341	1341	1341	1439	1439	1439
Adjusted R-squared	0.7665	0.7694	0.7690	0.7367	0.7287	0.7421

Notes: ***,**,* indicates the statistical significant at 1%, 5% and10% level. Robust standard errors are in parentheses. All variables are in the log with exception CPI and dummy variables.

Table 2. Estimates of Gravity Model using International Shipments, Tracking and Tracing, and Timeliness for the period 2005 and 2016 (Logistics performance outcomes in terms of time, cost and reliability). Dependent variable: log of ASEAN total exports

	2005			**2016**		
	International shipments	**Tracking and tracing**	**Timeliness**	**International shipments**	**Tracking and tracing**	**Timeliness**
Constant	-3.9935***	-2.8898**	-4.3428***	-46.5819***	-46.7664***	-50.8344***
	(1.2255)	(1.1687)	(1.3144)	(1.6733)	(1.6137)	(1.5507)
GDP export	1.4426***	1.4296***	1.4714***	1.1304***	1.1312***	1.0828***
	(0.0657)	(0.0731)	(0.0576)	(0.0601)	(0.0543)	(0.0524)
GDP import	0.8972***	0.8780***	0.9331***	0.8627***	0.8403***	0.8738***
	(0.0385)	(0.0394)	(0.0402)	(0.0379)	(0.0370)	(0.0362)
Distance	-1.0442***	-1.0663***	-1.0357***	-1.1516***	-1.1078***	-1.0883***
	(0.1231)	(0.1230)	(0.1242)	(0.0899)	(0.0884)	(0.0871)
International shipments export	2.4649***			5.6251***		
	(0.6344)			(0.5936)		
International shipments import	2.4842***			2.0297***		
	(0.4583)			(0.5004)		
Tracking and tracing export		1.7379***			6.2971***	9.5044***
		(0.5040)			(0.5386)	(0.6814)
Tracking and tracing import		2.4937***			2.4888***	2.1327***
		(0.4245)			(0.4827)	(0.5470)
Timeliness export			2.6054***			
			(0.6228)			
Timeliness import			1.5668***			
			(0.4914)			
CPI export	0.1628***	0.1924***	0.1469***	0.0004	-0.0174***	-0.0257***
	(0.0446)	(0.0408)	(0.0452)	(0.0035)	(0.0041)	(0.0042)

Table 2. Estimates of Gravity Model using International Shipments, Tracking and Tracing, and Timeliness for the period 2005 and 2016 (Logistics performance outcomes in terms of time, cost and reliability). Dependent variable: log of ASEAN total exports (Continued)

	2005			**2016**		
	Inter national shipments	**Tracking and tracing**	**Timeliness**	**Inter national shipments**	**Tracking And tracing**	**Timeliness**
CPI import	0.0281	0.0019	0.0808**	0.0074**	0.0007	0.0050
	(0.0382)	(0.0398)	(0.0379)	(0.0038)	(0.0042)	(0.0041)
RTA	0.3972	0.4747	0.4881	1.1403***	1.0911***	1.0966***
	(0.3711)	(0.3706)	(0.3746)	(0.2351)	(0.2299)	(0.2263)
Border	1.9281**	1.8567**	2.0224***	1.4512***	1.4734***	1.4328***
	(0.7767)	(0.7754)	(0.7851)	(0.4165)	(0.4078)	(0.4014)
Official language	0.1373	0.1718	0.2373	-0.1068	-0.0538	0.3815*
	(0.2513)	(0.2514)	(0.2544)	(0.2133)	(0.2089)	(0.2071)
Observations	1341	1341	1341	1439	1439	1439
Adjusted R-squared	0.7637	0.7643	0.7595	0.6966	0.7089	0.7180

Notes: ***,**,* indicates the statistical significant at 1%, 5% and10% level. Robust standard errors are in parentheses. All variables are in the log with exception CPI and dummy variables.