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The impact of logistic performance on intra-ASEAN trade

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Abstract: ASEAN has gone a long way in deepening its regional economic cooperation, particularly its trade liberalization. However, ASEAN has comparatively less intraregional trade than the European Union, whose economic integration model they aspire to emulate. As reducing tariffs was no longer an efficient way to increase trade, this study analyzes logistics performance as another factor that may affect trade. Using the gravity model with bilateral trade data from 10 ASEAN member states from 2007 to 2018 with gaps, the results show that the majority of improvements in logistics performance, by both the private sector and government alike, have positive and significant impacts on export value. This finding implies that the collaboration between the private sector and government agencies to improve logistics performance in each ASEAN member state is imperative to foster ASEAN intra-regional trade further.

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Introduction

Growing studies have shown that open economies, measured using trade shares, are proven to grow faster than closed economies. Trade promotes growth through technology transfers, scale economies, and comparative advantage (Raghutla, 2020; Yanikkaya, 2003). In 2001, a vast majority of countries around the world opened their economies and focused on trade-centered reforms and outward-oriented development, in which increasing export was their main strategy. As a result, those countries are proven to have a higher annual growth of per capita GDP, physical capital investment, and GDP (Wacziarg & Welch, 2008).

In 1993, the Association of Southeast Asian Nations (ASEAN) established ASEAN Free Trade Area (AFTA). Its main goal was to foster ASEAN intra-regional trade through trade liberalization to be a competitive region facing global trade liberalization. AFTA successfully eliminated tariffs in its intra-regional trade, an important achievement in terms of ASEAN economic integration. However, AFTA has been criticized due to ASEAN's low intra-regional trade ratio, for example, to the intra-regional trade of the European Union (EU), which has been regarded as a model for economic integration (Ishikawa, 2021).

ASEAN's commitment and vision on trade should provide potential economic benefits in the future. However, ASEAN's intra-regional trade is relatively lower than its extra-regional trade, which implies that ASEAN member states have been trading more with non-member states. Table 1 shows the share of good exports to fellow ASEAN member states from 2012 to 2021. Only Lao PDR of the 10 ASEAN members has a greater intra-regional trade share than extra-regional trade share (ASEAN, 2019; Eurostats, 2021). Common Effective Preferential Tariff (CEPT), which supposedly increases ASEAN intra-regional trade, has been of relatively small impact (Debaere & Mostashari, 2010; Okabe & Urata, 2014). By contrast, the EU member states have a relatively larger intra-regional trade than their extra-regional trade, implying that they trade more with other EU member states than non-member states.

Table 1 Intra-ASEAN Export of Goods as % of Total Export in each ASEAN Member Countries

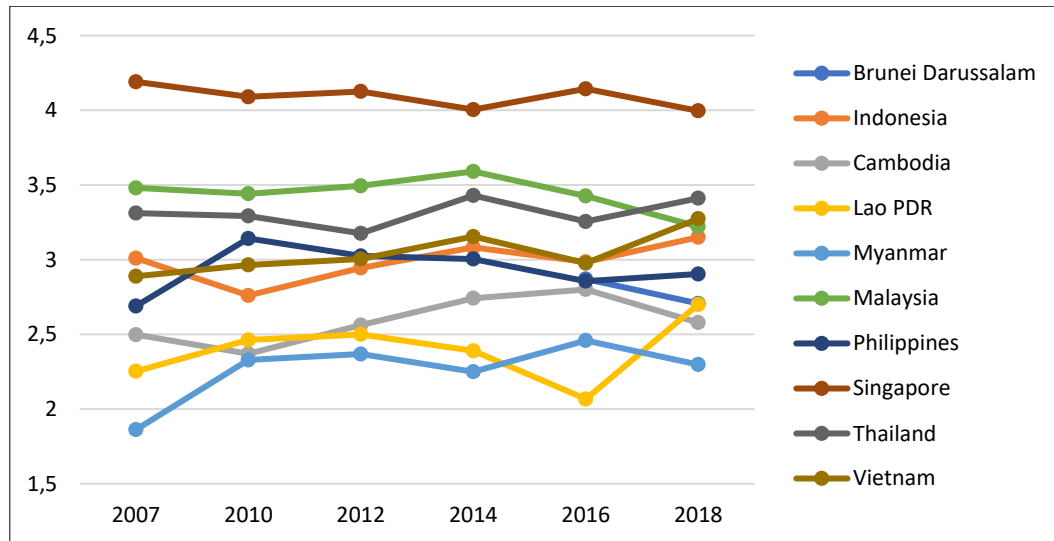
Exporters	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
ASEAN (aggregated)	26.0	26.5	25.6	24.3	23.8	23.8	24.2	23.3	21.4	21.6
Brunei Darussalam	14.7	23.2	19.8	19.5	25.7	32.1	28.2	34.3	40.2	39.6
Cambodia	8.9	7.9	5.3	9.0	8.7	10.0	7.5	9.0	21.7	6.7
Indonesia	22.0	22.3	22.5	22.3	23.0	23.3	23.4	24.7	22.4	20.6
Lao People's Democratic Republic	56.6	45.0	54.1	52.9	49.6	63.7	64.1	54.9	60.8	50.8
Malaysia	26.8	28.0	27.9	28.1	29.4	29.2	28.6	28.8	27.8	27.7
Myanmar	36.4	49.2	41.5	37.5	30.1	28.0	25.2	23.9	25.9	30.1
Philippines	18.9	15.6	14.9	14.6	14.9	15.4	16.0	15.3	16.0	16.3
Singapore	32.2	32.8	31.3	29.6	29.0	29.0	29.6	28.7	25.1	26.5
Thailand	24.7	26.0	26.1	25.7	25.3	25.2	27.1	25.5	24.0	24.0
Viet Nam	15.2	14.1	12.7	11.2	9.9	10.1	10.1	9.4	8.2	8.6

(ASEANStats, 2022)

There are multiple reasons why the intra-ASEAN trade remains low. First, to a certain extent, this can be explained by the existence of other trade costs in addition to tariffs that are encountered by exporters that act as Non-Tariff Measures (NTMs), including sanitary measurement, pre-shipment inspection, and rules of origin (Ing *et al.*, 2016). Those factors contributed to high trade costs, resulting in potential drawbacks to economic growth (Anderson & van Wincoop, 2004; Cadot *et al.*, 2017; Plummer *et al.*, 2016). Second, the intra-ASEAN trade is hindered by logistics, customs procedures, and other trade facilitation issues. Okabe and Urata (2014) suggest improving both trades' hard and soft infrastructure to overcome such barriers, commonly referred to as 'trade facilitation' (Cadot *et al.*, 2017). The gains from trade facilitation were proven to be larger than those from tariff reduction (Shepherd & Wilson, 2009).

According to the World Trade Organization (WTO), trade facilitation is a simplified, modernized, and harmonized process of export and import to tackle the problem of bureaucratic delays faced by exporters and importers. Trade facilitation focuses on simplifying documents required for a trade, modernizing customs procedures required,

and reducing days and costs for exporting and importing goods across borders.¹ Figure 1 shows the World Bank’s Logistics Performance Index (LPI), one of the trade facilitation measures for the ASEAN Member States. Singapore is the leading country in ASEAN with the best logistics performance. Since LPI’s establishment in 2007, Singapore has always been in the top 10 performers in the world, with an average nearly excellent score of 4. However, the rest of the ASEAN member states barely catch up, which should raise concerns over the region’s connectivity and integration in the future.



Note: Range “very low” (1) to “very high” (5). Source: World Bank. Author’s Compilation. 2021.

Figure 1 ASEAN Member States’ LPI Score (2007–2018)

Given the background mentioned above, this study aims to investigate how logistics performance affects export value within the ASEAN region. This study mainly refers to the works by Gani (2017), Martí et al., (2014), and Sy et al., (2020) that used the gravity model to estimate the effect of logistics performance on trade in several countries, including several ASEAN countries. However, the contributions of this study are twofold. First, we added the World Bank’s four components of Trading Across Borders to the World Bank’s six components of LPI previously used by those three studies to measure logistics performance. Beyond the ASEAN context, to the best of our knowledge, our study is also the first to employ those extensive logistics performance measures in the gravity model. Second, our study also develops the analytical framework of those three main references by separating the government and private sector’s domain and role in improving logistics performance. This study, thereby, will contribute to the literature regarding ASEAN studies, international trade, and trade facilitation, while also shedding light on trade-related improvement areas prioritization for the private sector and government and explaining the magnitude of the impact of enhancing logistical performance.

¹ https://www.wto.org/english/news_e/brief_tradefa_e.htm

The remainder of this article is organized as follows. The next section discusses the extant literature on the gravity model, trade costs, and logistics performance. The third section explains the research methodology, including the data and estimation strategy. The fourth section discusses the results, and the final section concludes.

Many studies have used gravity models to capture trade patterns and development. The gravity model was pioneered by Tinbergen in 1962, followed by Anderson and van Wincoop (2003), who developed the estimation method for the gravity equation. The idea of the gravity model is that bilateral trade is proportional to the economic size of two countries, which GDP and the inverse of the geographical distance between them show. In its basic form, the larger the economic size of both exporter and importer countries, the more significant the impact on the increase of trade is, and *vice versa*. As for distance, the greater the distance between two countries, the lower their trade.

The reason why ASEAN intra-trade is lower than extra-trade can be explained by one component of the gravity model, which is their member states' differences in economic size and income level. ASEAN has low similarity in terms of economic sizes within member states, as it has a combination of high, upper, and lower-middle-income member states. By contrast, in the case of the EU, most of its member states are in the high-income group. The distance component of the gravity model can be widely interpreted. For example, geographical distance between two countries can take the form of either traditional or physical approaches. Hence, the other proxy for distance can also refer to non-physical barriers such as differences in language, borders, or colonizers. All of the variables mentioned above are then used as control variables before adding variables of interest, to control for changes in trade due to other usual factors rather than the variable of interest (Anderson & van Wincoop, 2003; Moïse & Le Bris, 2013).

Therefore, distance can also refer to all factors contributing to trade costs. However, measuring real trade costs from one country to another is hard (Anderson & van Wincoop, 2004). Khan and Kalirajan (2011) help to define those costs into 'behind the border costs' and 'beyond the border costs. Behind-the-border costs are something that an exporting country can change, while beyond-the-border costs are something that an exporting country has no control to change. This study focuses on the former, behind-the-border barriers for the exporting side, which are cost factors that affect goods before they reach the border, including institutional inefficiency, poor informational institutions, poor infrastructure, and bureaucratic problems. These issues are considered more important than direct policy instruments such as tariffs. Improving convergency among ASEAN member states in those areas is expected to improve connectivity and shorten distance barriers. Summarizing, efficient connectivity, improved logistics performance, and effective trade policy are expected to reduce fixed trade costs between two trading countries (Anderson & van Wincoop, 2004; Khan & Kalirajan, 2011; Lawless, 2010; Moïse & Le Bris, 2013).

Figure 2 illustrates the channel of improvement in logistics performance based on the gravity model. The highlight of studies in logistics performance is that each country differs in terms of which component is more significantly affecting trade, but the overall

improvement in any component should lead to an increase in export performance (Felipe & Kumar, 2012; Portugal-Perez & Wilson, 2012; Feenstra & Ma, 2014; Martí et al., 2014; Halaszovich & Kinra, 2020).

The private sector performs most of the operational work in logistics in a country. Meanwhile, institutional, or regulatory support is mostly a supporting factor and is performed by the government. The whole process is defined by supply chain connectivity, where both the private sector and government work together to move goods across borders, starting from producers in one country until they safely arrive at the consumer in another (Gani, 2017; Arvis et al., 2018).

The government area is prone to change and requires excessive agency coordination. In addition, customs, infrastructure, and compliances are policy and stimulus sensitive. Customs are usually time-consuming, need unnecessary paperwork, and require coordination among several customs agencies (Gani, 2017). These problems result in long transit delays that can significantly lower exports of goods in a country (Hummels & Schaur, 2013). Typically, developing countries have higher trade costs than developed countries, a part of which is prone to corruption. Unexpected costs such as bribery or corruption are quite a problem in trade cost regulation, resulting in a welfare loss that can reduce trade (Gani, 2017; Hornok & Koren, 2015).

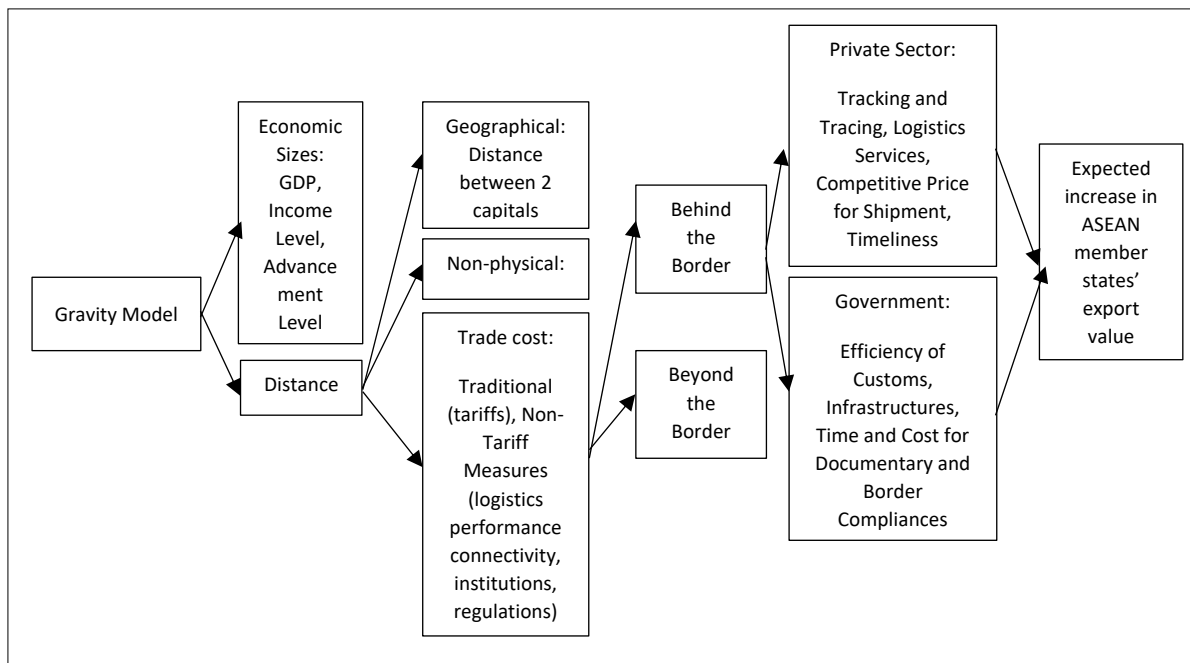


Figure 2 Conceptual Framework of the Study

Customs is one of the cores of the government’s area of logistics performance and is considered a necessity. Further, it may fall to a short-term policy because cutting down on custom procedures is considered fast relative to infrastructure improvement. Therefore, the modernization of customs procedures starts with good governance. A

modernized customs procedure makes delivering goods across borders more efficient in both cost and time. Improving cost efficiency and time to trade can directly impact exports, thus creating a more competitive business to participate in the global value chain (Shujie & Shilu, 2009).

The last but equally and usually considered the most important factor in increasing export value in the government's area of improvement is infrastructure (Feenstra & Ma, 2014; Felipe & Kumar, 2012; Halaszovich & Kinra, 2020; Martí et al., 2014; Portugal-Perez & Wilson, 2012). Infrastructure is more of a long-term investment. It is also prone to change since it depends on the budget the government is willing to spend in a given period on infrastructure. Infrastructure is a huge constraint in developing countries, but lately, it has been improving (Arvis et al., 2018). As a supporting role, good infrastructure should affect all components in the private sector's area of improvement, such as services, prices, and timeliness. For example, if a toll road in a country is in bad condition or cannot be used, exports will be delayed as a connectivity problem. An inadequate infrastructure shows a country's isolation from the international market (Gani, 2017). The conclusion for the government's area of improvement is that, in the short term, improving customs efficiency is easier and cheaper than improving infrastructure. While in the long term, improving infrastructure will have a greater and more significant impact on trade (Feenstra & Ma, 2014).

Although the government's role is important, the private sector is the key player who actually does the operations. Private sector areas include the ability to track and trace, logistics services, competitive prices for shipment, and timeliness. The business players include shippers, forwarders, trucking companies, terminal operators, and rail companies. Hummels and Schaur (2013) show that fast but expensive air cargo has risen 2.6 times faster than slow but cheap ocean ships. This shows how products to be exported are time-sensitive, where any delays in transporting goods will cause a decrease in exports. In addition, the increase in export prices paid to ship companies will lower exports. A competitive price and a wide choice of export transportation options are needed. However, it can be done if only the transportation infrastructure is in good condition (Gani, 2017; Jiang et al., 2018). Overall, the flow of transporting goods from one country to another involves parties, both from the private sector and government agencies. For example, the availability to track and trace goods is a combination of work between shipping companies and a country's single window in trade. Each party has its own but interdependent role; hence good coordination is needed to make export easier (Sholihah et al., 2018).

Research Method

This study aims to estimate the impact of logistics performance on intra-ASEAN trade. In doing so, this study replicates the works Marti et al. (2014), Gani (2017), and Sy et al., (2020) that performed such estimation using the gravity model, and applying their approach in the context of ASEAN. The basic gravity model is proposed by Tinbergen (1962) and expressed in equation (1) as follows:

$$Trade_{ij} = \frac{\alpha GDP_i GDP_j}{Distance_{ij}} \dots\dots\dots (1)$$

In the gravity model shown in equation (1), trade is supposedly proportional to the economic size of two trading countries (represented by GDP) and the inverse of the geographical distance between them. However, previous studies argued that the distance could be widely interpreted by all types of costs and barriers that may hinder trade. For example, other than physical distance (geographical location), trade can also be influenced by psychological distance (e.g., culture and language differences, and colonization history) (Portugal-Perez & Wilson, 2012; Luthfianto et al., 2016; Halaszovich & Kinra, 2020). Further, trade can also be hampered by technical and administrative distance, including trade barriers and logistics costs (Marti et al., 2014; Gani, 2017; Sy et al., 2020). Accordingly, those three studies employed the World Bank's LPI components as proxies to measure the last type of distance.

Considering that extended gravity model, our study constructs the variables with the description provided in Tables 2 and 3. The dependent variable ($Trade_{ij}$) is represented by the export value of the bilateral trade data of 10 ASEAN member states in country pairs, including Singapore, Thailand, Vietnam, Malaysia, Indonesia, Philippines, Brunei, Laos, Cambodia, and Myanmar.

The economic size of the exporting and importing countries are used as control variables, represented by GDP_i and GDP_j , respectively. The other control variables include geographical distance and psychological distance, represented by a common language and borders. Finally, the technical distance is represented by six components of the World Bank's LPI and trade facilitation measurement data using the four components of the World Bank's Trading Across Border. There are a total of 90 country pairs from the periods 2007, 2010, 2012, 2014, 2016, and 2018. The period is chosen following World Bank's LPI data availability.

The World Bank's LPI consists of worldwide surveys on trade operators (global freight forwarders and express carriers). They filled in the survey online and were required to rate eight countries on the six most important logistics components. Countries are chosen based on the most important export and import markets of the country where the respondents are located. As for the World Bank's Trading Across Borders, border compliance includes customs regulations and other related inspections for shipments by customs agencies. Documentary compliance includes documents required for government agencies in the exporter country, the importer country, and even every transit. It includes requirements from government agencies, starting from getting the document issued and stamped, completing a customs declaration or certificate of origin, waiting time for the issued certificate, showing the documents to port authorities, and submitting the customs declaration (which can be in person or electronically). Hence, logistics performance can also be classified into two groups based on improvement responsibility: areas for improvement for the private sector and government.

Table 2 Description of Variables: Gravity

No	Variables	Measurement	Data Sources	Years	Expected Signs
Dependent Variable					
1	Export value	In million current USD	CEPII based on UNcomtrade	2007, 2010, 2012, 2014, 2016, and 2018	
Control Variable					
2	GDP (origin, destination)	In million current USD	CEPII	2007,	(+)
3	Geographical Distance	In kilometer		2010,	(-)
4	Common language	Dummy variable 1= have common language, 0 = otherwise		2012, 2014, 2016, and 2018	(+)
5	Common borders	Dummy variable 1= have common borders, 0 = otherwise		2018	Uncertain

Table 3 Description of Variables: Logistics Performance

No	Classification	Variables of Interest	Data Sources and Measurement	Years	Expected Signs
1	Private Sectors	Tracking and tracing	World Bank's	2007, 2012,	(+)
2		Competence of Logistics Services	Logistic Performance Index	2014, 2016, and 2018	(+)
3		Competitive Price of Shipment	"very low" (1) to		(+)
4		Frequency on Scheduled Time	"very high" (5)		(+)
5	Government	Efficiency of Customs	World Bank's	2007, 2012,	(+)
6		Quality of Infrastructures	Logistic Performance Index	2014, 2016, and 2018	(+)
7		Time to export: documentary compliance	World Bank's Trading Across Borders	2016 and 2018	(-)
8		Time to export: border compliance	Borders		(-)
9		Cost to export: documentary compliance	Time in hours, cost in USD		(-)
10		Cost to export: border compliance			(-)

Following Marti et al. (2014), this study uses six different equations for LPI estimation since analyzing all measurements of LPI in one equation will lead to multicollinearity due to the correlation nature of the components. This goes the same for time and cost of trade, in which this study uses two different equations for each border and documentary compliance. The estimated equations are as follows:

$$\ln X_{ijt} = \beta_0 + \beta_1 \ln(GDP_{it}) + \beta_2 \ln(GDP_{jt}) - \beta_3 \ln(DIST_{ijt}) + \beta_4 (LP^*) + \beta_A(W) + U_{ijt} \dots\dots\dots 2$$

Where X_{ijt} is export value, export volume from country i to j at time t ; GDP_{it} is GDP of country i at time t ; GDP_{jt} is GDP of country j at time t ; $DIST_{ijt}$ is the distance from country i to j at time t ; LP is logistics performance of the exporting countries; W is dummy variables (common languages, common borders); U_{ijt} is the standard error. In estimating equation (2), logistics performance is described further into 10 different measurements, as stated in Tables 2 and 3. Therefore, ten separate models capture each logistics performance as the variable of interest. For LPI components, variables will be measured in levels, while time and cost for both documentary and border compliance variables will be measured in logarithmic form.

The first step of the panel data analysis employs Breusch and Pagan Lagrangian Multiplier to decide between Ordinary Least Squares (OLS) or Random Effect (RE). Since the result shows a panel effect and significant differences across units, RE is then preferred. The second step is Hausman Test to decide between RE and Fixed Effect (FE). Since the result shows that unique errors correlate with the regressors, FE is preferred. Unfortunately, FE Model drops all time-invariant explanatory variables that are important in gravity models, such as distance and dummy variables.

Another estimation method is then considered, Poisson Pseudo Maximum Likelihood (PPML), as used by similar studies such as the study of UAE trade potential by Dadakas et al. (2020). Developed by Silva and Tenreyro (2006), PPML is a promising method to estimate models like gravity equation since a large proportion of zero dependent variables, which is common in trade data and appears in our dataset², does not affect the estimation result (Gómez-Herrera, 2013). In addition, PPML also gives proper and unbiased estimation given the presence of heteroscedasticity³ (Silva and Tenreyro, 2011; Gómez-Herrera, 2013), which is also common in trade data and appears in our dataset. Further, PPML weighs all observations equally, and its mean is always positive. However, Gómez-Herrera (2013) also argued that PPML has a disadvantage as it may present limited-dependent variable bias when a significant part of the observations are censored.

² Zero trade country pairs: Lao PDR and Myanmar didn't export to the rest of ASEAN member states in 2007

³ Breusch-Pagan test for heteroscedasticity result: The probability value of the chi-square statistic is less than 0.05, implying that the null hypothesis of constant variance can be rejected at a 5% level of significance. In conclusion, there exists heteroscedasticity in the residuals.

Result and Discussion

Descriptive Analysis

In terms of GDP, ASEAN's economy grew more than threefold from 2007 to 2021, making it one of the top 10 largest economies in the world as a country group. The population also grew from 572 to 662 million (ASEANStat, 2022). Indonesia is the largest in both GDP and population size, while Brunei Darussalam is the smallest. In terms of income group, Singapore and Brunei are the only member states in the high-income group, while the rest are split up into upper and lower-middle-income groups. Despite its growing economy and population, intra-ASEAN trade fluctuated with setbacks in 2009 (due to the global financial crisis), 2014-2016, 2019, and 2020 (due to the COVID-19 pandemic) (ASEANStat, 2022).

Regarding physical borders, most of ASEAN member states are connected by land, except the Philippines. Indonesia and the Philippines are maritime countries surrounded by sea, but Indonesia has a common border with Malaysia. In terms of the psychological border, there are only 3 country pairs in ASEAN that have a common language, namely Brunei-Malaysia and Malaysia-Singapore (Malay), and Singapore-Philippines (English).

Table 4 shows the changes in LPI of ASEAN member states from the year 2007 to 2018 in terms of the average score of each component, the gaps, and the best performers. Overall, the ASEAN member states improved all logistics performance components during the period. The most improvement was recorded in the ability to track and trace consignment in shipping, which score increased by 0.24. This might be due to the private sector's development and wide use of information and communication technology. Quality of trade and transport related to infrastructure stayed on the lowest score but, despite its improvement, indicated by an additional score of 0.10. This is probably due to the long-term and costly nature of infrastructure development.

In terms of member states' performance, Myanmar had the lowest score of LPI in 2007, while Singapore was the best performer. In 2018, Singapore was still the best performer, while Myanmar levelled with Lao PDR at the bottom. During the 2007-2018 period, the minimum score in each component showed improvements, and correspondingly the gaps between the best and the lowest performers also decreased in each component.

Table 4 ASEAN Member States Logistics Performance Index 2007 and 2018

Year	Statistics	Track Trace	Competence	Ease	Efficiency	Frequency	Quality
2007	Mean	2.82	2.89	2.88	2.77	3.34	2.69
	Min	1.57	2.00	1.73	2.07	2.08	1.69
	Max	4.25	4.21	4.04	3.90	4.53	4.27
	Gaps	2.68	2.21	2.30	1.83	2.45	2.58
2018	Mean	3.06	3.00	3.01	2.80	3.37	2.79
	Min	2.20	2.28	2.20	2.17	2.84	1.99
	Max	4.08	4.10	3.58	3.89	4.32	4.06
	Gaps	1.88	1.82	1.38	1.72	1.48	2.07

Source: World Bank (2021)

Note: Range "very low" (1) to "very high" (5).

Table 5 shows ASEAN member states' Trading Across Borders score in 2016 and 2018. Overall, Singapore was still the best performer. Further, despite the slight improvement tendency shown by each member state, there were no significant reforms in some aspects.

Table 5 ASEAN Member States' Trading Across Borders 2016 and 2018

Country	Time Documentary (hours)		Time Border (hours)		Cost Documentary (USD)		Cost Border (USD)	
	2016	2018	2016	2018	2016	2018	2016	2018
Brunei	168	155	120	117	90	90	340	340
Indonesia	72	61.32	62.6	62.6	170	138.8	253.7	253.7
Cambodia	132	132	48	48	100	100	375	375
Lao PDR	60	60	13	13	235	235	140	140
Myanmar	144	144	144	141.6	140	140	431.7	431.7
Malaysia	10	10	48	45	35	35	274	274
Philippines	36	36	42.5	42.5	52.5	52.5	456	456
Singapore	2	2	12	10	37	37	335	335
Thailand	11.3	11.3	51	51	96.9	96.9	222.6	222.6
Vietnam	83.1	50	60.4	55	139.2	139.2	309.1	290

Estimation Results

Appendix 1 shows the PPML estimation results. Model (1) includes basic control variables in the gravity model: GDP origin, GDP destination, the distance between capitals, common language, and common border. Models (2) to (5) include variables of interest from private sector areas of improvement: tracking and tracing; competence of logistics services; ease and competitive shipping price; and frequency of scheduled time. Models (6) to (11) include variables of interest from government areas of improvement, which are the efficiency of customs and clearance, quality of infrastructure, time and cost at the border, and time and cost for documentary compliance.

Model 1 shows the PPML estimation results with export value as the dependent variable and control variables as the independent. The estimated signs of the coefficients are as expected. GDP in origin and destination countries significantly impacts export value, supporting previous findings reported by Ho et al. (2021) and Sunaryati (2015). An increase of GDP in the origin country of 1% will increase export value by USD 8,210, *ceteris paribus*. On the other hand, an increase of GDP in the destination country of 1% will increase export value by USD 7,310, *ceteris paribus*. The magnitude might seem similar, but it is noteworthy that the role of GDP in the origin country on export value is significantly larger than the GDP in the destination country. According to Wardani (2016), GDP in the origin country reflects the production capacity, whereas GDP in the destination country indicates the market size. Therefore, the higher the GDP in the origin country, the higher the production capacity and, thus, the export capacity due to economies of scale (Wardani, 2016; Ridwannulloh & Sunaryati, 2018).

The distance variable is also significant and has a negative sign which shows that an increase in distance will lower the export value. An increase in distance between two

countries of 1% will decrease the export value by USD11,810, *ceteris paribus*. This result agrees with Wardani (2016), which suggests that greater distance between countries can lead to lower exports. Exports are reduced as distance increases because of the higher transportation costs.

Model (2), (3), (4), and (5) shows the PPML estimation results with export value as the dependent variable and logistics performance of the private sector as the independent variable. PPML estimation results are significant, and the signs are as expected for most independent variables, except for the cost of border compliance. This shows that any improvement in logistics performance by the private sector can increase export value. Since all variables in the private sector area are in the same unit of measurement, the order of importance can be shown directly, with all control variables being equal. The order of importance from the most to the least are; competitive price of the shipment, frequency on scheduled time, tracking and tracing, and competence of logistics services. An increase of 1 unit in competitive shipment price will increase export value by USD 1,226,000, *ceteris paribus*. If the problem arises from increasing shipment costs, exporters might focus on exporting goods that may not be great in volume, but high in value, as supported by Hornok and Koren (2015).

Increasing 1 unit in frequency on scheduled time will increase export value by USD 1,207,000, *ceteris paribus*. Previous literature shows that longer transit delays can lower trade. This explains the importance of arriving on scheduled time. Time is important since many exports are time-sensitive. They might be needed to be transported faster due to the continuity of the supply chain. Small disturbances due to delays can affect another part of the chain. As the final receiver of goods, consumers will also demand timely shipment.

An increase of 1 unit in tracking and tracing will increase export value by USD 1,060,000, *ceteris paribus*. The improvement made by countries to improve their private sector's ability to track and trace goods depends on the role of ICT. Not only ICT helps to inform parties about the schedule, but it also helps to see the exact location of goods that are being transported. The traditional method of tracking and tracing may consist solely of calling the drivers or those who are currently moving the products, but the implementation of ICT-based tracking and tracing can result in a large rise in export value. An increase of 1 unit in the competence of logistics services will increase export value by USD 925,000 USD, *ceteris paribus*. Based on its definition, logistics services evaluate the competence of transport operators such as shipping companies, trucking companies, freight forwarders, and customs brokers to help exporters deal with tariffs, laws, documentaries, and payment needed to the customs agency. Freight forwarders and customs brokers are two different entities, while the former focus on managing the shipment of goods to the destination country, and focus on the destination country's customs clearance.

Models (6) to (11) show the government's area of improvement. Most of the variables are significant at a 1% level, except for the cost of border compliance. The signs of the

significant variables are as expected. Variables in government areas differ in the unit of measurement; thus, the order of importance cannot be shown directly.

An increase of 1 unit in the quality of infrastructure will increase export value by USD 793,000, *ceteris paribus*. Infrastructure might stay behind customs, but the impact is similar. Infrastructure is a long-term policy, prone to change, depending on how each ruling government spends the state budget on infrastructure.

An increase of 1 unit in the efficiency of customs will increase export value by USD 827,000, *ceteris paribus*. Increasing 1 unit in customs performance is preferred over infrastructure. The main reason lies in the ease of integrating ASEAN member states' custom procedures rather than integrating infrastructures. The increased customs efficiency will depend on the ICT level and coordination among customs agencies.

An increase of 1% of the time for documentary compliance will decrease the export value by USD 3,420, *ceteris paribus*. An increase of 1% of the time for border compliance will decrease the export value by USD 840, *ceteris paribus*. In this case, time is more important for documentary compliance, including waiting time to sign documents, certificate of origin, and customs declaration. The longer the time to process documents to export, the more export will decrease.

An increase of 1% in cost for documentary compliance will decrease the export value by USD 5,010, *ceteris paribus*. Again, documentary compliance is also significant. The more cost needed for documentary compliance, the less export value. In the case of all ASEAN, the border compliance cost is insignificant in explaining the export value.

Discussion

The coefficients for PPML estimates might be smaller than OLS estimates for the same dataset, as argued by Silva and Tenreyro (2006). Therefore, this study cannot directly compare the magnitude of logistics performance with previous studies that used other estimation strategies. However, the pattern for which component might affect trade more than others is similar to previous studies mentioned in the literature review. Continuing the work of Gani (2017), which includes only three ASEAN member states out of the 60 countries studied, this study expands the analysis across all ASEAN member states. The estimation results show that the impact of the short-term policy of customs in ASEAN has more magnitude than a long-term policy of infrastructure, *ceteris paribus* to control variables. From the private sector area of change, the results align with Gani (2017), where timeliness and competitive shipping prices in ASEAN have the largest impact on trade.

Private Sector Area of Improvement

The private sector actors are shipping companies, freight forwarders, and customs brokers. Based on the estimation results, all components significantly affect export value. The average of ASEAN member states' LPI score for the private sector is of change is

considered good with a score above 3.00. Certain member states, especially Singapore, dominate the considerably high score.

As previously discussed, the highest magnitude is improving competitive shipping prices. However, the problem of ASEAN is the existence of gaps within its member states. For example, ASEAN member states' shipping capacity is different. Singapore, Malaysia, and Indonesia have more competitive international shipping that is not dominated by foreign shipping, unlike the rest of the ASEAN member states (Tongzon & Lee, 2015). With the assistance of government regulation, the private sector should prioritize the competitive price of shipping since a reduction in freight rate can reduce the cost of trade, thereby increasing the involvement of smaller firms on the worldwide market (Melitz, 2003; Lawless, 2010).

Table 6 shows the gap in the private sector's logistics performance among ASEAN member states that can be used to show improvements needed by each member state. Indonesia, Malaysia, Singapore, Thailand, and Vietnam's private sector logistics performance were above average in 2018. In contrast, Brunei, Cambodia, Lao PDR, Myanmar, and the Philippines were still below average. This data supports recent literature where lower middle-income countries tend to have a lower logistics performance (Bugarčić et al., 2020; Gani, 2017). Although, Brunei is an exception, as we argued in the first place. Brunei, as predicted, was lacking in logistics performance despite being a high-income country. Each ASEAN member state has its field where they lack. For example, the largest gap is shown by Myanmar in terms of tracking and tracing, with a score gap of 0.886 below average.

The effort to create a more competitive private sector is developing at both regional and national levels. ASEAN Freight Forwarder Association is an example of regional integration by the private sector. Each member states have its own National Association, although under different but similar names (e.g., Indonesian Logistics and Forwarders Association, Federation of Malaysian Freight Forwarders). Their works represent the growing realization in the importance of ASEAN's convergence. They started with the initiation of

Table 6 Gaps Among ASEAN Member States Private Sector's Logistics Performance (2018)

Country	Tracking and Tracing	Gaps	Competence of Logistics Services	Gaps	Ease/Competitive Price Shipment	Gaps	Frequency on Scheduled Time	Gaps
	2018		2018		2018		2018	
Brunei	2.747	-0.341	2.710	-0.303	2.513	-0.515	3.174	-0.227
Indonesia	3.300	0.212	3.100	0.087	3.228	0.200	3.670	0.269
Cambodia	2.515	-0.573	2.408	-0.605	2.794	-0.234	3.155	-0.245
Lao PDR	2.914	-0.174	2.649	-0.364	2.716	-0.313	2.843	-0.558
Myanmar	2.202	-0.886	2.279	-0.734	2.199	-0.829	2.908	-0.492
Malaysia	3.148	0.060	3.298	0.285	3.348	0.319	3.464	0.064
Philippines	3.059	-0.029	2.776	-0.237	3.293	0.264	2.984	-0.417
Singapore	4.080	0.992	4.100	1.087	3.580	0.552	4.320	0.920
Thailand	3.467	0.379	3.411	0.398	3.457	0.429	3.814	0.414
Vietnam	3.450	0.362	3.399	0.386	3.155	0.127	3.672	0.272
Average	3.088		3.013		3.028		3.400	

Ministers of Transport and Communication of ASEAN member states in 1985 and have been developing until recent times. At both regional and national levels, they focus on coordinating with government agencies to negotiate and make agreements and dialogue to give input and insight for policy making. They also guide private sectors to meet international standards, increasing competitiveness and increasing service quality. Some national level associations also give training. For example, Singapore Logistics Association offers exclusive training and learning for the logistics workforce under The Logistics Academy, which is a private education institute.

Government Area of Improvement

Government area of improvement is complex. It requires coordination among ministries as policymakers, customs agencies, and even infrastructure heavily rely on state budgets. Based on the estimation results, time for documentary compliance is considered the most important. Customs and infrastructure are almost equally important depending on whether states focus on short-term or long-term policy, with customs having a slightly larger impact on export than infrastructure quality. Time for border compliance, including inspections, is not as important as time for documentary compliance.

On the other hand, the cost of documentary and border compliance differ in importance. This can be interpreted as the preference of the exporter in terms of cost. Exporters in lower to middle-income ASEAN member states might not be concerned about the cost of arranging documents and certificates, as long as it is not a bribery payment.

Table 7 Gaps Among ASEAN Member States Customs Efficiency and Infrastructure (2018)

Country	Efficiency of Customs/Clearance	Gaps	Quality of Infrastructure	Gaps
	2018		2018	
Brunei	2.622	-0.163	2.461	-0.341
Indonesia	2.673	-0.112	2.895	0.093
Cambodia	2.370	-0.415	2.145	-0.657
Lao PDR	2.613	-0.172	2.441	-0.360
Myanmar	2.167	-0.618	1.995	-0.807
Malaysia	2.898	0.113	3.147	0.345
Philippines	2.529	-0.256	2.726	-0.076
Singapore	3.887	1.102	4.064	1.262
Thailand	3.142	0.357	3.138	0.336
Vietnam	2.950	0.165	3.005	0.204
Average	2.785		2.802	

Table 7 shows the gap among ASEAN member states' customs efficiency and quality of trade and transport-related infrastructure to show improvements that are needed by each member state. In the previous section, we discussed the magnitude impact of the improvement made by the government on export value. The magnitude impacts of one unit increase on export value are quite similar between the efficiency of customs (827,000 USD) and quality of trade and transport related (793,000 USD). However, similar to gaps

in the private sector area, the gaps in government areas still existed and were dominated by lower-middle-income countries, except for Brunei.

Infrastructure (e.g., Ports, roads, airports, ICT) is still a problem for lower-middle-income countries. As shown in Table 7, Brunei, Indonesia, Cambodia, Lao PDR, Myanmar, and the Philippines have significant gaps from the rest of the ASEAN member states. Myanmar is the least developed country in terms of the quality of trade-related infrastructure. Given the importance that can be seen from the magnitude of impact, prioritizing building international quality infrastructure is needed, especially for Myanmar. Plummer et al. (2016) show how Myanmar actually has a potential trade-related infrastructure. Surrounded by India, Thailand, China, and Lao PDR by borders should give Myanmar opportunities to increase its trade performance. Developing their deep-sea ports for big containers and improving road infrastructures for traded goods moved by land should be Myanmar's priority. For other countries that are still lagging in infrastructure, involving the private sector to build infrastructure is needed to reduce the high financing cost of infrastructure (Plummer et al., 2016). In addition, ICT-related infrastructure is on the list of improvements. This improvement is quite related to the next component, which is customs efficiency.

In the case of Indonesia, the quality of infrastructure is slightly above average, while the efficiency of the customs needs improvement. Since 2017, the Indonesian government has shown its interest in infrastructure development by allocating an enormous budget. As a result, Indonesia's trade-related infrastructure quality is already improving. This does not imply that infrastructure is unnecessary since allocating the infrastructure's budget in Indonesia might be targeted to achieve connectivity within the nation. Improving the efficiency of their custom is also the top priority, given the importance and magnitude of customs on the export value that is slightly higher than infrastructure.

The cost of removing customs barriers might be lower than improving the quality of hard infrastructure. However, the political cost of reforming customs procedures might be larger than it seems, especially in lower-middle-income countries. Nevertheless, modernizing customs procedures should be more beneficial than the cost. An efficient customs procedure helps to boost firm productivity, solve tax problems, and remove corruption at the border (Cadot et al., 2017; Moisé & Le Bris, 2013).

In reality, ASEAN member states do have their own National Single Window to promote the efficiency of customs, but their successful implementation rates differ. Burdensome requirements, discrimination, lack of client orientation, minimum use of technology, and bureaucratic delays are still ASEAN's problems, especially in Myanmar (Cadot et al., 2017; Tongzong & Lee, 2016). Indonesia, for example, has more than 15 private and government agencies working on its Indonesia National Single Window (INSW), so it takes all agencies to work together in one single platform.

Table 8 Gaps Among ASEAN Member States' Trading Across Borders Score (2018)

Country	Time Documentary (hours)	Gaps	Time Border (hours)	Gaps	Cost Documentary (USD)	Gaps	Cost Border (USD)	Gaps
	2018		2018		2018		2018	
Brunei	155	-88.838	117	-58.43	90	16.44	340	-28.2
Indonesia	61.32	4.842	62.6	-4.03	138.8	-32.36	253.7	58.1
Cambodia	132	-65.838	48	10.57	100	6.44	375	-63.2
Lao PDR	60	6.162	13	45.57	235	-128.56	140	171.8
Myanmar	144	-77.838	141.6	-83.03	140	-33.56	431.7	-119.9
Malaysia	10	56.162	45	13.57	35	71.44	274	37.8
Philippines	36	30.162	42.5	16.07	52.5	53.94	456	-144.2
Singapore	2	64.162	10	48.57	37	69.44	335	-23.2
Thailand	11.3	54.862	51	7.57	96.9	9.54	222.6	89.2
Vietnam	50	16.162	55	3.57	139.2	-32.76	290	21.8
Average	66.162		58.57		106.44		311.8	

The pattern for time and cost is more diverse than customs efficiency and infrastructure. Table 8 shows how Lao PDR is improving regarding time and cost, with only a gap (128.56 USD) left in the cost for documentary compliance. Indonesia (32.36 USD) and Myanmar (33.56 USD) were also still below the average in terms of cost for documentary compliance.

For example, in 2018, Indonesia's largest gap was in the cost of documentary compliance, with a total cost exceeding the average cost of ASEAN member states. This aligns with the regulation proposed by the Indonesian government in April 2018, where the cost for a Certificate of Origin's establishment increases from 0.36 USD/IDR 5,000.00 in previous years to 1.8 USD/IDR 25,000.00 (*Peraturan Pemerintah Nomor 31 Tahun 2017*). These gaps support recent literature where the limitations in the government's area of improvement in lower-middle-income countries include unnecessary customs procedures, physical inspection, corruption in border compliance, and lack of infrastructure (Gani, 2017). In 2020, as a response to the global pandemic, Indonesia decided to cut the cost of establishing a Certificate of Origin to zero. In return, they expect an increase in export performance. This study cannot provide further information regarding the impact magnitude on export. However, if possible, the reduction in cost needs to be examined for other document requirements such as customs declaration, export permit, contract, etc.

Time for documentary compliance was still a problem for Brunei, Cambodia, and Myanmar, where their time still exceeded the ASEAN's average time. In 2018, in terms of time for border compliance, Brunei and Myanmar were still behind other member states' performance, while Indonesia slightly underperformed. Lastly, the cost of border compliance differs in each ASEAN member state. There was no certain pattern of why some states have higher costs (e.g., Singapore's cost for border compliance is 2.3 times higher than Lao PDR). The key to improving ASEAN's problem in time and cost for both documentary and border compliance lies in the importance of modernization of customs procedures as suggested by Gani (2017), for example, National Single Window on a national level. Thus, each member state has first to improve its governance quality for

such regulation to be fully implemented. However, NTMs are not meant to be fully eliminated. Cadot et al. (2017) show that shifting towards a more improved regulatory agency is needed.

In response to the gaps mentioned above, ASEAN as a region has made a good start since its early days on reaching convergence and ease in the government area of improvement. First, ASEAN member states must participate in a related framework, the ASEAN Framework Agreement on Facilitation of Goods in Transit (AFAFGIT). AFAFGIT was initially signed in 1998. Under AFAFGIT, ASEAN established ASEAN Customs Transit Systems (ACTS) for goods that are transported by road. This ICT-based system helps exporters to pay and prepare for only one customs procedure. There will not be several customs declarations from the origin to the destination country. All information and electronic data are already stored in the system. Coordination of customs and land transport authorities allows eligible licensed qualifying vehicles to operate across borders so truck changes will not occur in a different country. Singapore, Thailand, and Malaysia are ASEAN member states that joined the pilot phase for ACTS in 2020. The rest of the ASEAN member states have agreed on ACTS and already agreed with each country's designated routes and customs offices. The implementation depends on the level of readiness of AMS.

Not only in transit systems, but ASEAN as a region is also currently working on ASEAN Single Window (ASW). This requires its member states to implement their own National Single Window fully. ASW enables the exchange of electronic trade-related documents between customs and other government agencies, the transport sector, as well as bank and insurance agencies. This will help exporters to reduce the time and cost to export goods. Starting from March 2016, Indonesia and Singapore have already exchanged their electronic ASEAN Certificate of Origin, Form D. Other trade-related documents, such as custom declarations, is also in progress as an expansion of ASW under the name ASEAN Customs Declaration Document (ACCD). In December 2020, Singapore, Cambodia, and Myanmar joined and implemented ACCD. Other ASEAN member countries are expected to join by late 2021. In addition to that, ASEAN member states' public policies are different from each other. Tongzon and Lee (2013) show how Singapore and Malaysia provided more maritime sector subsidies than Indonesia and the Philippines.

Reaching infrastructure convergence in ASEAN is also tough. Each member state might have different priorities, budgets, strategies, or other infrastructure regulations. Given the fact that ASEAN's infrastructure quality is growing, the gap still exists. Recently, ASEAN has been working on The Framework for Improving ASEAN Infrastructure Productivity. The goals are to make ASEAN member states have the same understanding of the importance of infrastructure and to improve their infrastructure further. This framework focuses on building a sustainable infrastructure plan, making infrastructure still relatable even in the future. ASEAN is encouraging its member states to have a coordinated, data-driven, and well-planned infrastructure as priorities. A well-built coordination of regulations and standards has proven beneficial since it increases welfare. In conclusion, convergence logistics performance can help reduce trade costs to help domestic and least productive firms participate in international trade (Moisé & Le Bris, 2013).

Conclusion

This paper examines the impact of logistics performance on intra-ASEAN trade. The findings revealed statistically significant impacts of most logistics performance components on export value. Improvements made by the private sector and government areas of responsibility have similar and significant impacts on export value. Short-term customs policy reform has more impact on mean export value than long-term infrastructure development policy. The private sector is the main actor in transporting goods across borders, with the competitive price of the shipment being the most important component.

Time and cost are areas of improvement that are important in increasing ASEAN's export value by the private sector. While giving input to the government through discussion is important, adjusting more focus on internal quality is equally important. On the other hand, government-related policies, especially customs, administrative time, and cost, play a similarly significant role in export. As supported by Hornok & Koren (2015), trade facilitation in terms of government-related logistics performance will benefit trade more if all countries are at the customs union level rather than just a free trade area. This condition is supported by the movement toward an ASEAN Economic Community that may act as a substitute for the customs union. Another issue regarding public policy is the priorities set and planned by the governments of each member state. The main goal should be the progress of ASEAN's connected and developed customs and infrastructure. Convergence with the rest of the ASEAN member states in trade policy and requirements is needed. Given its importance, infrastructure should be the main priority of ASEAN member states.

There are limitations to this study. First, since this study uses PPML other than fixed effect, all impacts on export are initially calculated by levels, not percentage changes. Second, the data for cost and time for documentary and border compliance changed its method in 2016, so this study only uses data from 2016 and 2018. There are a few suggestions for future studies. First, future studies may consider examining the extra-ASEAN trade level since ASEAN member states trade more with other countries outside ASEAN. Second, following previous literature, this study only uses logistics performance data from the World Bank's Logistics Performance Index and Trading Across Border. This paper suggests future research to include other logistics performance measurements that are more specific (e.g., infrastructure spending as a percentage of GDP) to show more than just the quality but also the progress.

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