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E-commerce and International Trade: The Case for Indonesia and Malaysia

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Abstract*: This study evaluates how e-commerce is reshaping international trade in goods for two Association of Southeast Asian Nations (ASEAN) Member States. E-commerce features in the analysis in two forms: (i) as a global trend in the e-commerce transition, measured as the total e-commerce sales as a percentage of total retail sales, and (ii) as the e-commerce ranking of the exporting and importing nations. We examine the relationship between the e-commerce and exports of Indonesia and Malaysia to their 200 or more trading partners, respectively, over 2014–2020. Our results suggest that the global transition towards e-commerce benefits the exports of both nations, although its mediating role for the bilateral supply chain–exports relationship is conspicuous for Indonesia only. Moreover, an increase in the e-commerce ranking of the two nations impacts their exports positively, but a higher e-commerce ranking of the trading partner countries adversely affects exports in Indonesia and Malaysia. We also find that interactions between e-commerce and supply chains can boost exports. However, in many cases, this occurs if e-commerce growth is falling. Our results imply that e-commerce enablers remain underdeveloped, and that cross-border e-commerce activities depend on existing trade enablers such as supply chain drivers. Therefore, the growth of e-commerce may have been partially responsible for the supply chain disruptions in Indonesia and Malaysia. We show that the results vary between Indonesia and Malaysia and by trading partner. We scrutinise our results using an array of robustness tests and provide policy implications for the two ASEAN Member States.*

Keywords: Gravity export model, e-commerce, digital trade, supply chain, COVID-19, Indonesia, Malaysia

JEL Classification: F14, L81

1. Introduction

Electronic commerce (e-commerce) is reshaping international trade. Cross-border e-commerce caters for trade in both digital and physical goods, which are transported in small packages (parcel trade) (OECD, 2020) or in large freight containers. Digitalisation is de-materialising products that had commercial value as physical products (e.g. books, games, recorded music, and software) and expanding the scope of e-products. E-commerce growth promotes mass entrepreneurship and innovation (Ni, 2022). It is also creating opportunities for small and medium-sized enterprises (SMEs) to find and develop new external markets (Gessner and Snodgrass, 2015). The coronavirus disease (COVID-19) pandemic has expedited the expansion of e-commerce, which has seen growth in new firms, the customer base, and product type (Ni, 2022; Ismail, 2020). Governments in many countries have supported the adoption of e-commerce during the pandemic (Ismail, 2020).

Nonetheless, the transition to e-commerce has varied (Ismail, 2020; OECD, 2020). Critical to the growth of e-commerce is the development of e-commerce enablers such as access to the internet and connectivity, digital skills, and a developed postal or delivery infrastructure between and within countries, whose growth across countries has been disparate (Ismail, 2020; also see Table 1). The importance of international logistics, measured as freight transport, to cross-border e-commerce growth has received some empirical attention (and resonates with the present study). International logistics, also referred to as a supply chain driver,[1] are found to play an important role in cross-border e-commerce trade (Bensassi et al., 2015; Zimon, Tyan, and Sroufe, 2019; Hausman, Lee, and Subramanian, 2013; Hsiao, Chen, and Liao, 2017; Gani, 2017; Hesse, 2002; and He, Wu, and Choi, 2021).

The growth of e-commerce during the COVID-19 pandemic largely depended on the development of certain enablers. OECD (2020) identified a number of challenges for parcel trade that emerged during this period, including: (i) supply-side challenges related to reduced worker availability, which caused service capacity restrictions and closures of specific routes; (ii) at the border, customs and other border agencies faced growing workloads and lower availability of personnel, which caused delays in the parcel trade ecosystem; and (iii) on the demand side, internet access and related costs, which still vary considerably within and between countries, affected the ability of many households to purchase goods online. OECD (2020) noted that enabling elements such as e-payments, digital certificates and signatures, and digital

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[1] See Mashalah et al. (2022).

postal service capacities aided in addressing challenges for parcel trade during the COVID-19 lockdowns.

Other factors that are seen as substantial barriers to doing business across borders – including differences in customs and duty regimes and tax laws – are being alleviated through several bilateral and multilateral programmes using solutions such as creating duty-free zones for the export and import of products. The Malaysian government has partnered with China's Alibaba to create a digital free trade zone (Austrade, 2020; T*i*, 2021). In the case of the United States (US) and Canada, the benefits of the digital free trade zones to SMEs are not always visible (Gessner and Snodgrass, 2015). Several other studies showed that while the digital economy is substantially reducing market frictions, it is also creating new challenges for the efficient functioning of cross-border operations. As explained succinctly in Ni (2022), the drastic reductions in costs, entry, transportation, and reproduction have profound implications for the role of platforms, the value of innovation, and the balance between firms' data and consumer privacy (Ni, 2022; Sturgeon, 2021; Chen, 2020).

Moreover, during the COVID-19 lockdowns, an OECD report indicated that the growth in the number and diversity of digitally ordered parcels crossing borders caused border agencies to manage risks over more numerous sets of consignments, while aiming to facilitate trade in all safety- and quality-approved products (OECD, 2020). The OECD report also pointed out that digitalisation was crucial in supporting efforts to facilitate trade during the COVID-19 crisis (OECD, 2020).

In this study, we develop several gravity export models for Indonesia and Malaysia to map how e-commerce has affected international trade in goods between these two Association of Southeast Asian Nations (ASEAN) Member States (AMS) and their trading partners. Previous studies investigating the link between the digitalisation and bilateral trade of a nation captured digitalisation through the number of internet subscriptions. These studies found a positive relationship between the number of internet subscriptions and international trade (Freund and Weinhold, 2002; 2004; Clarke, 2008; Vemuri and Siddiqi, 2009; Liu and Nath, 2013; Lin, 2015; Abeliansky and Hilbert, 2017; Gnangnon and Iyer, 2018; Xing, 2018). Clarke (2008) explained that the impact of information and communication technology (ICT) is greatest for exports from low-income countries to high-income countries. Liu and Nath (2013) allowed for infrastructure measures, such as exports/imports of ICT-related products, and still found positive effects of the internet on trade. Xing (2018) stated that high-speed internet and secured servers are critical to achieving the e-trade potential of developing and least developed

countries. Other researchers, like Obashi and Kimura (2021), explored the importance of digital technologies on network trade using disaggregated data. The present study's focus on the aggregate exports of goods flowing from two AMS to the rest of the world (ROW) seeks to inform national, multilateral, and global trade policymaking on the general efficiency and effectiveness of e-trade in goods and its possible implications for the supply chain–exports nexus.

We contribute to the literature in two important ways. First, unlike studies that use various measures of digitalisation or e-commerce enablers such as the quality or quantity of internet subscriptions, or infrastructure measures, including ICT imports, we use e-commerce data – specifically, e-commerce rankings by country and global e-commerce sales as a percentage of retail sales. E-commerce rankings by country pinpoint the relative standing of the domestic nation (and its trading partners) against the ROW in the e-commerce business, while global e-commerce sales as a percentage of retail sales explain the global transition to e-commerce.

Second, we examine the mediating role of e-commerce in the relationship between supply chains and bilateral exports of the two AMS. In doing so, we align ourselves with various strands of the literature. The first strand comprises studies that suggest the importance of supply chains to global trade. About 70% of international trade involves global value chains, as services, raw materials, parts, and components cross borders, often several times, with trade in final products only representing around 30% (OECD, 2021). Global supply chain trade accounts for more than 50% of the world's trade in manufactured products (Dixon and Rimmer, 2022). Empirical studies also show the importance of supply chains to trade. Baldwin and Taglioni (2011) showed that supply chains, defined as intermediate goods, have a positive effect on trade. Assuming that supply chain disruptions lengthen delivery time, Attinasi et al. (2021) examined the effects of the global Purchasing Managers' Index supplier's delivery time on global trade and global industrial production. The authors found that world trade fell by 2.7% from November 2020 to September 2021 due to supply chain shocks, while global industrial production fell by around 1.4%. The authors argued that the effect was greater on trade than on industrial production because weaknesses in the logistics sector disproportionately affected trade. Moreover, the shift towards domestic suppliers and domestic goods helped mitigate the repercussions on industrial production.

The second literature strand suggests that supply chains embody e-commerce. Several quantitative and qualitative studies have acknowledged that the impact of digitalisation on supply chains is manifest through e-commerce (Mashalah et al., 2022; Chen, Zhao, and Lan,

2022; Härting et al., 2017). Others have emphasised the importance of cross-border e-commerce in improving the effectiveness of supply chains and increasing international trade, but have not tested this (Terzi, 2011; He, Wu, and Choi, 2021). As mentioned above, various studies have empirically established the link between e-commerce trade and one of the drivers of supply chains, i.e. international logistics. Most of these studies showed a positive relationship between international logistics and supply chains. They argued that if international logistics, measured as freight transport, are well developed and efficient, and if there are sustainable flows of investment in international logistics infrastructure, cross-border e-commerce can increase (Bensassi et al., 2015; Zimon, Tyan, and Sroufe, 2020; Hausman, Lee, and Subramanian, 2013; Hsiao, Chen, and Liao, 2017; Gani, 2017). Some authors also found that an increase in e-commerce is beneficial for the development of logistics (Delfmann, Albers, and Gehring, 2020; Nguyen and Tongzon, 2010). However, a few studies showed that underdeveloped international logistics (freight transport), which cause delays and shortages in international freight services, can negatively affect cross-border e-commerce (Hesse, 2002; He, Wu, and Choi, 2021). Wei and Dong (2019) found that port-related logistics can also provide good conditions for cross-border e-commerce trade.

The third strand is a growing literature on various supply chain drivers, including those relating to transportation (freight transport urban logistics, international distribution, grocery deliveries, and transportation technology); information (e-business, online portals, logistics information systems, auctions, information sharing, and mobile systems); facilities (delivery facilities, network design, location allocation, reverse logistics, and storage policies); sourcing (supplier relationship, e-procurement, and outsourcing); and inventory (inventory policies and dual channel) (see Mashalah et al. (2022) for a survey of the literature).

Across the literature on e-commerce enablers and supply chain drivers, we notice significant cases of convergence and complementarity. International logistics and transport, which are supply chain drivers and e-commerce enablers, can be seen as a source of partial convergence of supply chains and e-commerce. Similarly, digital skills and internet access are e-commerce enablers that can also enhance the digital capacity of supply chains; hence, e-commerce can have a complementarity effect on supply chains. In the same way, if supply chains are fairly digitalised, the digital supply chain drivers can be leveraged to increase cross-border e-commerce.

Unlike this literature, which focuses on the link between one driver of supply chains and e-commerce, we test the importance of the connection between supply chains, defined as

intermediate goods as a percentage of imports, and e-commerce in explaining international trade. To the best of the author's knowledge, the presence, or not, of a mediating role played by e-commerce and the nature of this mediating role in the relationship between supply chains and trade remains to be tested empirically. We aim to test whether complementarity between supply chains and e-commerce, as noticed in the literature, is driving trade between the two AMS and the ROW.

To study the impact of e-commerce on trade and the mediating role of e-commerce in the relationship between supply chains and trade, this study applies the gravity framework. As acknowledged in the literature, the gravity framework is an effective tool for accounting for the cost of trade. Meanwhile, digitalisation (manifest as e-commerce) within the policy arena, e.g. under ASEAN digital trade facilitation, is seen as an avenue to reduce trade costs during the pandemic (ESCAP and ASEAN, 2021). Moreover, in the literature, digitalisation is readily acknowledged as reducing the information cost (Liu and Nath, 2013) and improving access and the general conduct of business. Therefore, the examination of digitalisation under this framework is most suitable as opposed to demand-based export models.

To foreshadow our key findings, we show that unlike previous studies which mainly show a positive link between digitalisation and trade, we find that there is significant disparity in how e-commerce is reshaping exports flowing from Indonesia and Malaysia to the ROW. Nonetheless, the results display a clear pattern that the effect of e-commerce on exports is negative, insignificant, or weakly positive. We also find that the growth of e-commerce mainly fails to complement supply chains and boost exports.

2. Empirical Model

We develop gravity export models for Indonesia and Malaysia to map the relationship between bilateral exports and e-commerce. Beginning with Tinbergen (1962), the gravity trade framework is one of the most successful to model the effects of international trade costs, including those associated with distance between the home and trading partner countries, and trade arrangements that can facilitate trade on bilateral trade. Other theoretically important factors of bilateral trade – such as bilateral exchange rates, the size of the economy, the level of economic development, differences in endowments in the bilateral relationship, and preferential trade agreements – have been incorporated in the gravity model over time and found to be important determinants of trade.

Following Cheng and Wall (2005), we use a two-step procedure that separates the estimations of time-variant and time-invariant gravity variables. As a first step, we estimate:

$$lnX_{ij,t} = \delta_1 + \delta_2 COVID_t + \delta_3 E - commerce_{n,t} + \delta_4 SC_{ij,t} + \delta_5 SC_{ij,t} * E - commerce_{n,t} + \delta_6 Z_t + SE_1 + \varepsilon_{1ij,t}$$ (1)

where $X_{ij,t}$ is the flow of exports from each AMS, i, to trading partners, j, at time, t; and $COVID_t$ is a binary variable that takes the value of 1 for the COVID-19 period and zero otherwise. The inclusion of the COVID-19 variable is important to explain the disruptions in exports during the pandemic.

$E - commerce_{n,t}$, where n is i, j, or g, tracks e-commerce, measured in two ways: (i) as global (g) e-commerce sales as a percentage of total retail sales; and (ii) as a ranking of the AMS, i, and its trading partner countries, j, in e-commerce. The former measure allows testing of the impact of the global transition to e-commerce on trade, while the latter allows for the testing of the relative standing of the AMS in terms of e-commerce on international trade (New Zealand Government, n.d.). The e-commerce index, which we use to rank nations, is calculated by the United Nations Conference on Trade and Development (UNCTAD) as the average of four e-commerce enablers: (i) account ownership at a financial institution or with a mobile money service provider (% of the population aged 15+); (ii) individuals using the internet (% of the population); (iii) postal reliability index; and (iv) secure internet servers (per 1 million people).

SC captures the supply chain within the bilateral relation, i and j. Following Baldwin and Taglioni (2011), we measure the supply chain as imports of intermediate goods by country i from country j as a percentage of the total imports of country i. $SCHAIN_{i,j,t} * E - commerce_{n,t}$ captures the mediating role of digitalisation. Considering the aforementioned literature, which demonstrates that cross-border e-commerce can increase or decrease with more e-commerce enablers (supply chain drivers) such as international logistics, we expect to see these variables having positive and negative effects.

Z_t captures the key determinants of exports under the gravity model: income (Y), exchange rate (NER), and trade openness for the AMS (TOi) and the AMS' trading partners (TOj). Following previous studies, the income (Y) of country i and j is represented as the product of gross domestic product (GDP) (YP); the product of GDP per capita (YCP); and the difference between the AMS' and a trading partner's GDP per capita (YCD).

These three income variables are highly correlated. Hence, each of these income variables enters the equations one at a time, which means that we estimate three versions of the equations.

In terms of the expected impact of the income factors, the product of GDP (*YP*) captures a nation's economic size, which should positively influence trade. This means that an increase in the size of an economy should see an increase in trade. Similarly, the product of the AMS' per capita GDP and trading partner *j*'s per capita GDP (*YCP*) captures the level of economic development, which should encourage the flow of exports from AMS. The impact of the difference in the per capita incomes (*YCD*) depicts the difference in the endowment, and its impact on trade can be explained by two trade theories. The Heckscher-Ohlin theory calls for a positive impact of difference in endowment on trade, emphasising that trade volume increases as factor endowments between the countries diverge. In contrast, the hypothesis of Linder (1961) implies a negative effect of the gap in endowment, suggesting that two nations will trade more if their factor endowments are similar.

$NER_{ij,t}$ is the exchange rate between the AMS (*i*) and trading partner (*j*) at time *t*. Depreciation of the exchange rate (here, the currency of the AMS is in terms of the trading partner currency) makes domestic exports more competitive; hence, the exchange rate effect on trade is expected to be positive. TO_{it} and TO_{jt}, respectively, capture the trade openness of AMS and trading partners (*js*), measured as a ratio of total trade to GDP at time *t*. The export volume is likely to grow as the AMS or its trading partners become more open to the world market; as a result, *TOi* and *TOj* are expected to exert positive effects on bilateral exports.

All variables in Equations (1) and (2) appear in their stationary form and are estimated using the fixed effects method, allowing us to extract the specific country effects (*SE$_1$*), which are used to estimate the effect of the time-invariant variables as part of the second step:

$$SE_1 = \delta_1 + \delta_2 lnDist_{ij} + \delta_3 D_{,ASEAN} + \delta_3 D_{APEC} + \epsilon_{1ij} \qquad (2)$$

where the specific country effects (*SE*) are from model (1); and *DIST$_{ij}$* (in natural log form) indicates the geographic distance between the AMS (country *i*) and country *j*. *D$_{ASEAN}$* and *D$_{APEC}$* are two binary variables that take the value of 1 if the AMS (*i*) and a trading partner (*j*) are in the same trading or regional bloc (ASEAN or Asia-Pacific Economic Cooperation (APEC)), and 0 otherwise. Preferential trade agreements create favourable trading conditions for member countries; as a result, binary variables for ASEAN and APEC membership are expected to induce positive impacts on export flows. The distance between the AMS and a trading partner inflates the cost of the transport of traded commodities; therefore, this link should bear a negative sign.

3. Data

This study employs annual data for 2014–2020 covering the two AMS, Indonesia and Malaysia, and their trading partners globally. Data sources include the World Bank database, the Direction of Trade Statistics of the International Monetary Fund (IMF), Statista, UNCTAD, and the IMF's International Financial Statistics. Details are presented in Table A1 in the Appendix.

Table 1 presents the descriptive statistics on the key variables, depending on the importance of the trading partners, with trading partners (TP)1–TP3 indicating the most important to the least important. Importance is measured by the exports to trading partners from Indonesia or Malaysia in the most recent 5 years. The mean and coefficient of variation (CV) of the variables in level form are developed, considering the importance of the trading partners to the two AMS in the most recent 5-year period (2016–2020). Trading partners importing merchandise goods worth $200 million or more, $199 million–$50 million, and $49 million or less are represented by TP1, TP2, and TP3, respectively. For Indonesia, bilateral exports (X_{ij}) in TP1 take the highest mean, followed by X_{ij} in TP2 and TP3. For Malaysia, X_{ij} in TP1 are in first position, while X_{ij} in TP3 are higher than X_{ij} in TP2 due to a dramatic fall in Malaysian exports in recent years to some trading partners. Furthermore, while the coefficient of variation (CV of X_{ij}, which is measured as its standard deviation divided by the mean, is always higher for Malaysia than Indonesia, and for TP3, it is the strongest. This suggests that Malaysia's bilateral exports are more volatile on average than those of Indonesia.

For the two income variables from the left, measuring scope of the market (*YP*) and the level of economic development (*YCP*), TP1 captures the largest scope and highest level of development, while the TP2 and TP3 groups cater for the scope and level of development, i.e. medium and low, respectively. This is true for Malaysia and Indonesia. The third income variable (*lnYCD*) captures the gap in income per capita between the AMS and its trading partners. The negative figure in TP1, TP2, and TP3 for Indonesia signifies that Indonesian income per capita is on average lower than that of its trading partners. For Malaysia, the opposite is true, given that this figure is positive for TP1–TP3.

The mean statistics on the trade openness of the *i* and *j* nations, depicted by *Toi* and *Toj*, indicate that Indonesia's economy is less open against its trading partners on average in all three groups, while Malaysia is more open to international trade than its trading partners.

Globally, e-commerce sales as a percentage of retail sales have averaged 13%. For 2019 and 2020, this figure was higher than the average, at 17.8% and 19.6%, respectively. The e-

commerce ranking of a country, as depicted by the *ECR* index, is interpreted to be higher as the *ECR* index declines and lower as the *ECR* index increases. We find that Malaysia's e-commerce ranking (*ECRi*) is much higher than that of Indonesia. Moreover, on average, the e-commerce ranking of Indonesia is lower than the ranking of its trading partners (*ECRj*), while the opposite is true for Malaysia.

Malaysia's ICT imports as a share of total imports (*ICTIMi*) and internet usage (*INTERi*) are stronger than in Indonesia. Moreover, Indonesia's ICT imports as a proportion of imports (*ICTIMi*) and internet usage (*INTERi*) are on average lower than its trading partners' *ICTIMj* and *INTERj*. Meanwhile, the opposite is true for Malaysia. Retail e-commerce sales data from Statista indicate that in terms of retail e-commerce sales growth rate in 2022, Indonesia (23%) and Malaysia (18.3%) ranked third and seventh in the world, respectively.

Table 1: Descriptive Statistics by Trading Partner Size

Item	X_{ij} ($ million)	YCP ($)	YP ($)	LNYCD (Log)	TOi (% GDP)	TOi (% GDP)	EC_TRW (%)	ECRi (rank)	ECRj (rank)	ICTIMi (% imports)	ICTIMj (% imports)	INTERi (% pop)	INTERj (% pop)
INDONESIA: TP1													
Mean	3310.177	80,379,364	2.E+24	-1.071	40.067	86.716	12.829	89.833	53.178	6.844	10.703	12.259	32.787
CV	1.590	0.996	2.181	-1.226	0.112	0.870	0.356	0.067	0.687	0.288	0.856	1.224	0.989
Obs.	1,472	1,472	1,472	1,472	1,472	1,472	322	276	269	828	896	1,242	1,260
INDONESIA: TP2													
Mean	95.499	53,955,027	1.E+23	-0.423	40.087	82.651	12.829	89.833	72.815	7.737	7.062	13.858	29.929
CV	0.564	1.381	1.176	-3.421	0.112	0.487	0.356	0.067	0.604	0.255	0.589	1.083	1.015
Obs.	1,664	1,664	1,664	1,664	1,664	1,664	364	312	254	828	797	1,242	1,154
INDONESIA: TP3													
Mean	9.407	49,881,665	2.E+22	-0.385	40.106	81.379	12.829	89.833	87.453	6.844	5.009	12.259	23.524
CV	1.304	1.559	2.157	-3.604	0.112	0.773	0.356	0.067	0.404	0.288	0.743	1.224	1.143
Obs.	3,264	3,264	3,264	3,264	3,264	3,264	714	612	322	1,836	1,464	2,754	2,208
MALAYSIA: TP1													
Mean	1896.459	123,000,000	2.E+23	0.094	168.390	74.614	12.829	37.500	59.229	30.265	8.420	42.640	31.097
CV	2.746	1.496	4.081	16.874	0.186	0.760	0.356	0.146	0.674	0.228	0.829	0.689	1.042
Obs.	1,668	1,668	1,668	1,668	1,668	1,668	324	324	279	1,134	947	1,566	1,395
MALAYSIA: TP2													
Mean	102.623	71,089,818	3.E+22	0.697	167.693	68.247	12.829	37.500	79.782	30.265	5.805	42.640	23.655
CV	2.406	2.040	3.278	2.074	0.186	0.665	0.356	0.146	0.521	0.228	0.631	0.689	1.171
Obs.	1,201	1,201	1,201	1,201	1,201	1,201	240	240	188	1,134	947	1,566	1,395
MALAYSIA: TP3													
Mean	395.502	86,509,173	3.E+22	0.647	168.163	78.127	12.829	37.500	79.273	30.265	6.222	42.640	25.587
CV	5.082	2.162	4.937	2.259	0.186	0.755	0.356	0.146	0.525	0.228	0.538	0.689	0.834

| Item	X_{ij} ($ million)	YCP ($)	YP ($)	LNYCD (Log)	TOi (% GDP)	TOi (% GDP)	EC_TRW (%)	ECRi (rank)	ECRj (rank)	ICTIMi (% imports)	ICTIMj (% imports)	INTERi (% pop)	INTERj (% pop)
Obs.	3,134	3,134	3,134	3,134	3,134	3,134	382	624	384	2,184	1,633	3,016	2,357

GDP = gross domestic product, ICT = information and communication technology, ROW = rest of the world.

Notes: This table presents the common statistics on the variables covering 200 trading partners for Indonesia and 202 trading partners for Malaysia. These are expressed in their raw form and divided by trading partner importance. TP1–TP3 are trading partner groups developed based on their imports over the most recent 5 years from Indonesia or Malaysia. TP1 comprises trading partners importing $200 million or more worth of goods; TP2 includes imports of $199 million–$50 million; and TP3 consists of trading partners importing $49 million or less. The common statistics are developed using common sample. The variables are bilateral exports (X_{ij}) from country i to the ROW, j; the income variables, including the difference between countries i's and j's GDP per capita (*YCD*), the product of countries i's and j's GDP (*YP*), and the product of countries i's and j's GDP per capita (*YCP*); and *Toi* and *Toj* measure trade openness in the home country (i) and trading partner countries (j). *EC_TRW* is the global transition to e-commerce; and *ECRi* and *ECRj* are the e-commerce rankings of i and j nations. *ICTIMi* and *ICTIMj* are ICT imports to home country i and trading partner countries j, while *INTERi* and *INTERj* capture the internet subscriptions of the home country i and trading partner countries j. Additional information on the variables is available in Table A1.

Source: Author's calculations.

Meanwhile, the importance of bilateral exports and the supply chain is represented in Figures 1 and 2, respectively. Bilateral exports as a percentage of GDP averaged 25% for Indonesia and 81% for Malaysia over 1990–2021. The supply chain, captured in terms of the share of intermediate goods imports to total imports (%), captured in Figure 2, averaged 31% and 24% for Indonesia and Malaysia, respectively, over 2010–2019.

Figure 1: Bilateral Exports as a Percentage of GDP
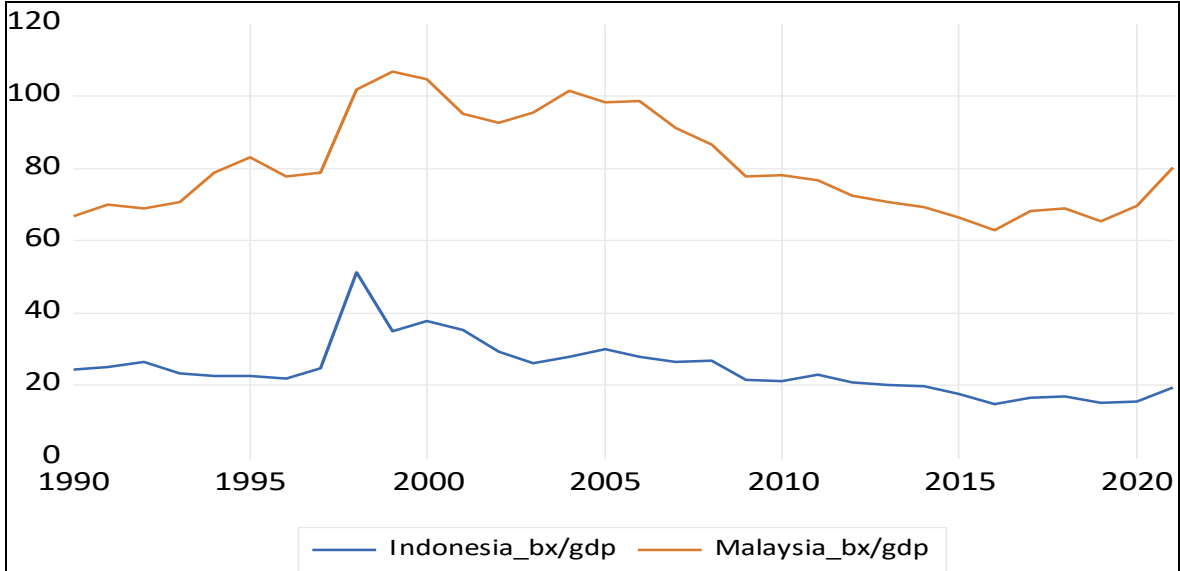
GDP = gross domestic product.
Source: World Bank.

Figure 2: Importance of Supply Chain – Intermediate Goods as a Percentage of Imports
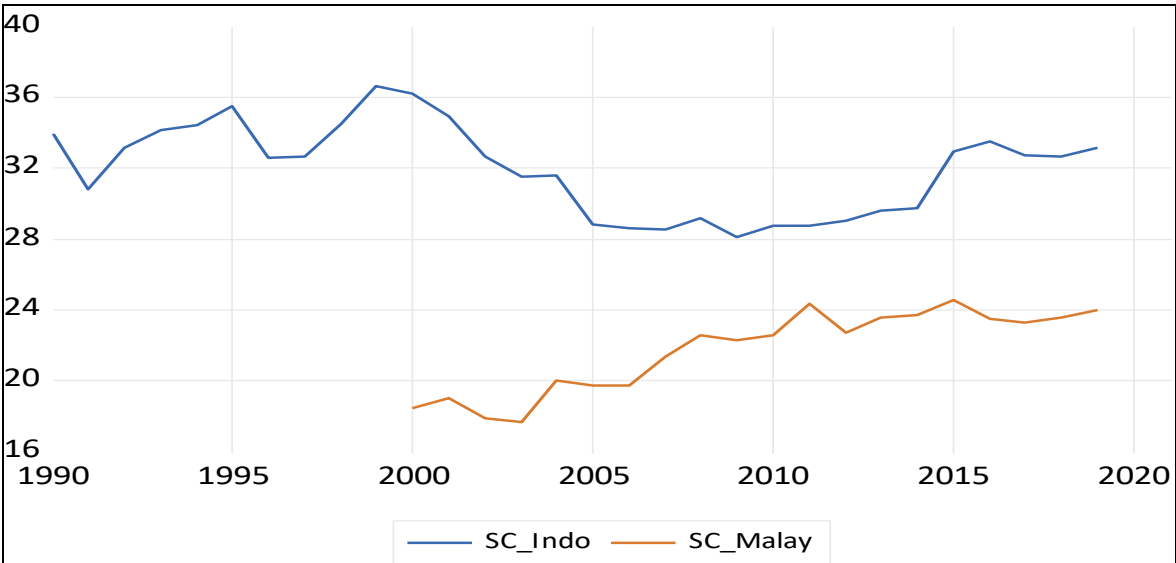
Source: World Bank; author's calculations.

4.   Empirical Results

We begin by estimating several versions of models 1 and 2, using our main variables, e-commerce measured as e-commerce sales as a share of total retail sales (*EC_TRW*), and the e-commerce index rank (*ECR*) of Indonesia (*i*) and the ROW (*j*).

The number of models 1 and 2 estimated for each nation depends on the correlation between the three income variables. For Indonesia, the product of income per capita (level of development), product of income (scale), and the difference between income per capita are correlated, although this is less than 50%. Hence, all three income variables are estimated within one model. Malaysia's product of income per capita (level of development) and product of income (scale), in contrast, show a high correlation of more than 50%; hence, two models (A and B), each with one of the income variables, are estimated.

Table 2 displays the (full sample) results for Indonesia and Malaysia, which capture their exports to the trading partners. The form that the variables take in the models is dictated by the unit root tests. All variables found to be *I(0)* appear in the model in their level forms while those found to be *I(1)* need to be differenced (D) once to take a stationary form. Our stationary models are estimated using the fixed effects method, allowing for period fixed effects. Our data are unbalanced and covered the period 2014–2020. To correct for some heteroskedasticity, White consistent standard errors are allowed.

4.1.   E-commerce Variables

The key finding relating to e-commerce effects on the exports of a full sample of trading partners is as follows. E-commerce sales as a share of total retail sales (*EC_TRW*), one of the three measures of e-commerce we use, is a measure of the global transition to e-commerce. We find that it is positively and highly significantly (at the 1% level) associated with the bilateral exports of the two AMS. The exports of Indonesia and Malaysia to their trading partners increase by 0.2% and 1.0%, respectively, for a 1% increase in the share of global e-commerce in total retail sales in the world, and vice versa.

E-commerce rankings by country *i* or *j* are our two other measures, which depict the relative standing of the nation's e-commerce industry against that of the ROW. The e-commerce ranking results, presented in Table 2, provide some additional perspective. We find that e-commerce in Indonesia or Malaysia (*ECRi*) has a negative effect on exports, implying that an increase in *ECRi*, which symbolises a decrease in e-commerce activity in Indonesia relative to the ROW, decreases exports, and vice versa. This is significant in the case of Indonesia, but not in the case of Malaysia. Table 2 shows that a 1% increase in the e-commerce ranking of

Indonesia boosts its exports by 1.53%. This result is consistent with the result derived from our global transition variable seen above – implying that e-commerce promotes exports, both in terms of total and relative standing.

Table 2: Gravity Trade and E-commerce, 2014–2020

Indonesia			Malaysia				
Variable	EC_TW	ECIR		EC_TW (A)	EC_TW (B)	ECR (A)	ECR (B)
COVID19	-0.1010	-0.0737	COVID19	-0.7593	-0.7669	-0.0720	-0.0722
	0.2254	0.2435		0.0172	0.0158	0.5999	0.5975
SCHAIN	-0.0009	-0.0780	SCHAIN	0.0089	0.0090	-0.0101	-0.0100
	0.5693	0.0073		0.0101	0.0099	0.3382	0.3412
EC/TRW	0.0264		EC_TRW	0.1028	0.1026		
	0.0167			0.0000	0.0000		
SCHAIN*EC_TRW	0.0001		SCHAIN*EC_TRW	-0.0008	-0.0008		
	0.5535			0.0022	0.0022		
LNECRI		-1.5303	LNECIRI			-0.4988	-0.5003
		0.0576				0.1705	0.1194
LNECRJ		0.4838	LNECIRJ			0.0137	0.0136
		0.0004				0.8077	0.2798
SCHAIN*ECRI		0.0144	SCHAIN*ECRI			0.0044	0.0044
		0.0027				0.1190	0.1688
SCHAIN*ECRJ		0.0034	SCHAIN*ECRJ			-0.0015	-0.0015
		0.2457				0.2799	0.8086
LNYCD	-0.4631	-0.3252	LNYCD	-0.6419	-0.6428	-0.4669	-0.4655
	0.0021	0.0671		0.0002	0.0002	0.0280	0.0289
DLNYP	1.7181	0.1624	DLNYCP	0.2590		0.3111	
	0.4762	0.9233		0.4808		0.1088	
DLNYCP	-1.8329	-0.1018	DLNYP		0.2138		0.3090
	0.4390	0.9544			0.5548		0.1089
LNNER	-0.0462	-0.0257	LNNER	-0.1097	-0.1100	-0.0736	-0.0726
	0.6275	0.7751		0.0007	0.0007	0.1471	0.1547
DTOi	0.0098	0.0109	DTOI	-0.0300	-0.0301	-0.0118	-0.0117
	0.0984	0.3559		0.0105	0.0102	0.0471	0.0468
TOj	0.0022	0.0010	TOJ	0.0060	0.0060	0.0051	0.0051
	0.1476	0.4655		0.0000	0.0000	0.1183	0.1185
LDIST	-1.2832	-1.1716	LDIST	-1.0965	-1.0957	-0.7102	-0.7098
	0.1749	0.2083		0.0058	0.0058	0.0491	0.0492
APEC	3.1940	3.3474	APEC	3.5050	3.5044	3.0551	3.0583
	0.0136	0.0091		0.0000	0.0000	0.0000	0.0000
ASEAN	-1.4377	-1.2470	ASEAN	0.4430	0.4449	1.3392	1.3428
	0.5648	0.6125		0.7018	0.7005	0.2024	0.2012
C	3.2035	8.5964	C	2.2022	2.1981	5.9432	5.9422
	0.0015	0.0331		0.0000	0.0000	0.0049	0.0049
Adjusted R-squared	0.9631	0.9617		0.8768	0.8768	0.9702	0.9702
Periods	7	7		7	7	6	6

	Indonesia			Malaysia			
Variable	EC_TW	ECIR		EC_TW (A)	EC_TW (B)	ECR (A)	ECR (B)
Cross-sections included	184	184		184	184	148	148
OBS.	1,230	1,230		1,230	1,230	809	809

GDP = gross domestic product, ROW = rest of the world.

Notes: The table estimates the bilateral exports gravity model with the log of bilateral exports (X_{ij}) from country i to the ROW, j. The key regressors are *COVID-19*; *SCHAINi,j*, denoting imports of intermediates from j to i; e-commerce variables *EC/TRW, ECRi, and ECRj,* denoting the global transition to e-commerce; and the e-commerce ranking of i and j nations. The controls are three income variables, including the difference between countries i's and j's GDP per capita (*YCD*), the product of countries i's and j's GDP (*YP*), and the product of countries i's and j's GDP per capita (*YCP*); the trade openness of countries i and j (*Toi* and *Toj*); the nominal exchange rate between countries i and j (*NER*); the distance between i and j (DIST); and trading blocs (*APEC* and *ASEAN*). These appear in the models expressed in natural logarithmic form (LN) and first difference form (D).

Source: Author's calculations.

However, our results show that e-commerce in Indonesia's trading partners (*ECRj)* is a substitute for the Indonesian exports (X_{ij}). We find that there is a significantly positive relationship between *ECRj* and X_{ij}. A 10% increase in the ranking of the trading partners of Indonesia (which equates to a 10% decrease in *ECRj*) can see a 4% decrease in Indonesian exports.

With Malaysia, similar to its e-commerce ranking, we notice that an increase in the ranking of trading partners has an insignificant effect on Malaysia's exports. The finding for Malaysia may signify that e-commerce development in the nation has been heavily focused on satisfying domestic consumers, and although international trade is affected by the diversion of resources, the expansion of cross-border e-commerce has been limited. For example, Malaysia's largest e-commerce platforms, which are either a combination of direct sales and marketplace (Lelong) or pure marketplace models (PrestoMall and Lazada), are based domestically in Malaysia (Austrade, 2020). Lazada is the largest e-commerce platform in Southeast Asia – owned by China's Alibaba, but based in Malaysia (Austrade, 2020). Therefore, Malaysia's largest e-commerce platforms are geared to serve Malaysian consumers more than foreigners.

4.2. E-commerce Interacted with the Supply Chain

To begin, we test whether the supply chain (*SCHAIN*) is important for ASEAN exports. Here, we find that it is significantly associated with exports. In the case of Indonesia, the supply chain has a deteriorating effect on the country's exports, with a 10% increase in the dependence on the supply chain reducing exports by 0.7%. The literature on the supply chain identifies

several important supply chain drivers, which in broad terms include transportation, facilities, pricing, sourcing, and inventory (see Mashalah et al., 2022). Disruptions and delays in the production and transportation of intermediate goods pose problems for international trade.

For Malaysia, the supply chain is an export enhancer, with a 10% increase in the supply chain increasing exports slightly by 0.09%.

Having established the importance of the supply chain, our hypothesis that e-commerce can improve the association between the supply chain and exports may not always be relevant for Malaysia and Indonesia. To test this hypothesis, we interacted the supply chain variable with our different measures of e-commerce.

We find that in the case of Indonesia, our hypothesis responds to one out of three measures of e-commerce. If Indonesia's own e-commerce activity relative to the ROW (measured using $ECRi$) is interacted with Indonesia's supply chain, we find evidence that the supply chain can have an export-enhancing effect. However, as noted earlier, a higher $ECRi$ depicts a fall in e-commerce activities in Indonesia relative to the ROW. This means that the ranking of Indonesia's e-commerce, when associated with higher supply chain activities, can lead to higher exports if the ranking is falling. This finding suggests that e-commerce growth in Indonesia relative to the ROW is currently not helping to solve the supply chain–exports relationship because the growth of cross-border e-commerce enablers is not well developed, hence cross-border e-commerce dependence on established supply chain drivers is a burden.

Our results also show that in the case of Indonesia, when the supply chain is interacted with the other two measures of e-commerce, EC_TRW (which portrays the global e-commerce trends) and $ECRj$ (which captures the ranking of trading partners), the positive mediating role of e-commerce is noticed but is statistically insignificant.

Overall, e-commerce in Indonesia, which generally remains nascent, may also depend significantly on supply chain drivers to conduct cross-border e-commerce – making it a competitor, not an enhancer, of supply chain activities. This is consistent with the global transition towards e-commerce, which is still insignificantly affecting exports, and in relative terms against the ROW, Indonesia's e-commerce enhances the supply chain–exports relations only if the supply chain is combined with falling e-commerce activity in Indonesia.

In the case of Malaysia, we find the mediating role of e-commerce in the form of $ECRi$. As in the case of Indonesia, Malaysia's e-commerce activity relative to the ROW needs to be falling to increase exports. In contrast, $ECRj$, when combined with the supply chain, weakens exports. Nonetheless, both these e-commerce variables are found to be insignificant in their

interaction with the supply chain variable. *EC_TRW,* which captures the global e-commerce trend, interacted with the supply chain, like *ECRj,* is found to have a negative and highly significant effect on Malaysia's exports. This suggests that e-commerce weakens the relationship between the supply chain and exports. This finding echoes our previous point that the focus on the growth of e-commerce in Malaysia has been largely domestic, and not the international market. It is also consistent with our results for interacting the supply chain with the *ECRi* for the two exporting nations. Our results also suggest that despite the growth seen in Malaysia in e-commerce, the growth of cross-border e-commerce is underdeveloped and relies on existing infrastructure, such as the supply chain, to conduct its business.

4.3. COVID-19

The effect of COVID-19 is negative on the bilateral exports of Indonesia to all trading partners, but this is insignificant. For Malaysia, it is significant in the *EC_TRW* model only.

4.4. Control Variables

The difference in income between exporters (Indonesia or Malaysia) and importers (trading partners) has a negative and significant effect on exports, suggesting that the trade patterns in both nations are consistent with the Heckscher-Ohlin theory. The other two income variables are found to be insignificant for the full sample. Depreciation of the exchange rate has an unexpected negative effect, although this is insignificant. Trade openness in Indonesia or its trading partner nations is not significant at the 5% level. In contrast, trade openness in Malaysia has a negative impact, while trade openness in its trading partner nations has a positive effect. Distance has the expected negative effect for both AMS, although this is only significant for Malaysia. ASEAN is associated with a negative effect for Indonesia and a positive effect for Malaysia, although it is insignificant in both cases. APEC, on the other hand, has a positive and highly significant effect for both countries.

5.   Robustness Tests

To test the robustness of the findings, the following tests are performed.

(1)   Different measures of e-commerce – through its enablers

The nexus between e-commerce and exports in this paper is seen as explaining digital trade. In the literature, e-commerce enablers such as the number of internet subscriptions or ICT imports as a percentage of total imports are commonly modelled separately (Xing, 2018; Abeliansky et al., 2021). Hence, we substitute our broad measures of e-commerce with factors

like the number of internet subscriptions and ICT products, which are critical to facilitating e-commerce sales. In this study, we allow for ICT imports or internet usage in the exporting (Indonesia and Malaysia) and importing (trading partners) nations to capture bilateral engagement in digital trade. Moreover, the mediating role of these factors in the relationship between the supply chain and exports is investigated.

While the results in Table 3 are consistent with the e-commerce results, some additional insights may be gained. First, the results suggest that in Indonesia and its trading partner countries, internet usage, not ICT imports, promoted exports for Indonesia. This signals the use of the internet as being critical to increasing exports or cross-border sales. This is not surprising, given that the internet is the key e-commerce driver. Since individual consumers and smaller businesses, particularly SMEs, access the internet via mobile phones to purchase merchandise (see Rachman, Gregory, and Narayan, 2015), e-commerce in Indonesia has the potential to increase exports with increased usage of the internet.

In stark contrast, Malaysia's exports respond positively and significantly to ICT imports by Malaysians and by some trading partners, and internet usage has an insignificant effect on exports. This finding suggests that digital trade is driven by consumers and businesses investing in ICT products, but these digital cross-border transactions are largely unrelated to the most important e-commerce enabler, i.e. the internet. This finding is consistent with our previous result that e-commerce can have zero to negative effects on Malaysia's exports. This implies that Malaysia needs to invest in more internet services to facilitate growth of e-commerce.

In terms of the mediating role of ICT imports and internet usage, we find that an increase in internet usage in Indonesia (*INTERi*) (which is the key e-commerce enabler) can negatively affect the supply chain–exports nexus. This is seen in the pre-COVID-19 period and in the sample inclusive of the COVID-19 pandemic. More internet usage in trading partner countries (*INTERj*) enhances the relationship between the supply chain and exports in both the pre-COVID-19 period and the period inclusive of the COVID-19 pandemic.

For Malaysia, both ICT imports by Malaysians (significantly) and trading partners (insignificantly) are debilitating for the supply chain–exports nexus. Moreover, while internet usage has a positive effect on the supply chain–exports link, this effect is insignificant. These results are consistent with our main result, stated previously, that the supply chain–exports nexus is only enhanced by reducing e-commerce activities in Malaysia.

Table 3: Gravity Trade with E-commerce Enablers (Internet Users and ICT Imports), 1991–2020

Variable	Indonesia (1991–2020) 3	(1991–2019) 4		Malaysia (1991–2020) 3.A	(1991–2020) 3.B	(1991–2019) 4.A	(1991–2019) 4.B
COVID19	-0.6762**		COVID19	0.7682***	0.7827***		
	0.0546			0.0088	0.0076		
SCHAIN	-0.0002	0.0000	SCHAIN	0.0594***	0.0596***	0.0596***	0.0598***
	0.8380	0.9997		0.0000	0.0000	0.0000	0.0000
INTERi	0.0393***	0.0382***	DINTERI	-0.0266	-0.0260	-0.0264	-0.0259
	0.0000	0.0000		0.4994	0.5119	0.4979	0.5108
INTERj	0.0053***	0.0065***	DINTERJ	0.0011	0.0012	0.0021	0.0021
	0.0095	0.0021		0.8286	0.8277	0.8263	0.8255
DICTMi	0.0111	0.0110	ICTIMI	0.0315***	0.0313***	0.0312***	0.0310***
	0.8491	0.8482		0.0048	0.0053	0.0053	0.0058
DICTMj	-0.0040	-0.0055	ICTIMJ	0.0142	0.0144	0.0174*	0.0177*
	0.6391	0.5846		0.1517	0.1467	0.0836	0.0802
SCHAIN*INTERi	-0.0001**	-0.0001**	SCHAIN*DINTERI	0.0002	0.0002	0.0002	0.0002
	0.0191	0.0329		0.7591	0.7648	0.7653	0.7710
SCHAIN*INTERj	0.0001***	0.0001***	SCHAIN*DINTERJ	0.0000	0.0000	0.0000	0.0000
	0.0001	0.0001		0.6461	0.6433	0.7197	0.7177
SCHAIN*DICTMi	0.0002	0.0002	SCHAIN*ICTIMI	-0.0018***	-0.0018***	-0.0018***	-0.0018***
	0.7303	0.7232		0.0000	0.0000	0.0000	0.0000
SCHAIN*DICTMj	0.0001	0.0001	SCHAIN*ICTIMJ	-0.0003	-0.0003	-0.0004*	-0.0004*
	0.6479	0.5673		0.2756	0.2735	0.0599	0.0593
LNYCD	-0.3467***	-0.3464***	LNYCD	-0.4840***	-0.4807***	-0.4661***	-0.4630***
	0.0074	0.0076		0.0009	0.0010	0.0017	0.0018
DLNYP	-5.6761**	-5.6313*	DLNYP	-0.2872		-0.2960	
	0.0665	0.0716		0.3630		0.3544	
DLNYCP	5.9738**	5.9236*	DLNYCP		-0.2423		-0.2503
	0.0540	0.0585			0.4471		0.4377
LNNER	0.0698***	0.0690***	LNNER	-0.1065	-0.1066***	-0.1060***	-0.1060***

Variable	Indonesia (1991–2020)	Indonesia (1991–2019)		Malaysia (1991–2020) 3.A	Malaysia (1991–2020) 3.B	Malaysia (1991–2019) 4.A	Malaysia (1991–2019) 4.B
	3	4		3.A	3.B	4.A	4.B
	0.0015	0.0020		0.0003	0.0003	0.0004	0.0004
DTOI	0.0014	0.0014	DTOI	-0.0134	-0.0134	-0.0132	-0.0133
	0.7863	0.7871		0.2275	0.2279***	0.2315***	0.2319***
TOJ	0.0035***	0.0036***	TOJ	0.0047	0.0047	0.0048	0.0048
	0.0001	0.0001		0.0000	0.0000	0.0000	0.0000
LDIST	-0.6435	-0.6571	LDIST	-1.0289***	-1.0259***	-1.0118***	-1.0089**
	0.1348	0.1287		0.0089	0.0091	0.0103	0.0105
APEC	3.1016***	3.0968***	APEC	3.7265***	3.7322***	3.7684***	3.7738***
	0.0000	0.0000		0.0000	0.0000	0.0000	0.0000
ASEAN	1.2977	1.2656	ASEAN	0.4164	0.4150	0.4164	0.4148
	0.2235	0.2375		0.7167	0.7176	0.7174	0.7183
Adjusted R-squared	0.89	0.89	Adjusted R-squared	0.8775	0.8774	0.8760	0.8759
Cross-section fixed effects	Yes	Yes	Cross-section fixed effects	Yes	Yes	Yes	Yes
Cross-sections	187	189	Cross-sections	195	195	195	195
Obs.	4,695	4,530	Total panel (unbalanced) obs.	5,243	5,243	5,071	5,071
White standard errors & covariance	Yes	Yes	White standard errors & covariance	Yes	Yes	Yes	Yes

ICT = information and communication technology, ROW = rest of the world.
Notes: The table estimates the bilateral exports gravity model with the log of bilateral exports (X_{ij}) from country i (i.e. Malaysia or Indonesia) to the ROW, j. Here, in place of the e-commerce variables, some of the key e-commerce enablers are used in country i and j. The other key regressors are *COVID-19*; and *SCHAINi,j*, denoting imports of intermediates from j to i. The controls are three income variables, including the difference between countries i's and j's GDP per capita (*YCD*), the product of countries i's and j's GDP (*YP*), and the product of countries i's and j's GDP per capita (*YCP*); the trade openness of countries i and j (*Toi* and *Toj*); the nominal exchange rate between countries i and j (*NER*); the distance between i and j (DIST); and trading blocs (*APEC* and *ASEAN*). These appear in the models expressed in natural logarithmic form (LN) and first difference form (D). ***, **, and * denote the level of significance at 1%, 5%, and 10%.
Source: Author's calculations.

(2)   Do the results differ during the COVID-19 pandemic and the pre-COVID-19 period?

COVID-19 is an unprecedented event that had disruptive effects on trade, as well as the macroeconomy. We, therefore, check the robustness of the models during the COVID-19 period and the pre-COVID-19 period. Table 3 organises the results in this manner. E-commerce data are insufficient in the pre-COVID-19 period, which motivated the adoption of commonly used digital variables (the number of internet subscriptions and ICT imports), or e-commerce enablers, from the previous subsection. Our results are mainly consistent across the two samples. In essence, adding one additional year did not change the results.

Only one key difference in the results across the samples is notable. The supply chain effect on the exports of Indonesia is negative in the period inclusive of the COVID-19 pandemic but positive in the pre-COVID-19 period. This result is probably not surprising, given the degree of supply chain disruptions during the pandemic. Moreover, our results show that an increase in e-commerce activities may have contributed to the supply chain disruptions. For Malaysia, we find that the supply chain had similar effects on exports in the two samples.

(3)   Trading partner size

We have accounted for as many trading partners as possible to allow for an increased observation size, particularly for our e-commerce variables. This can mean that the results may be distorted by mixing small and large trading partners. To solve the issue of trading partner size (or importance), we divided the trading partners for both ASEAN exporters based on their imports over the most recent 5 years. We created three groups: TP1 comprises trading partners importing $200 million or more worth of goods; T2 imports are worth $199 million–$50 million; and T3 consists of trading partners importing $49 million or less of goods.

For each trading partner group, three sets of models were developed – the first two models with the e-commerce variables, *ECRi* and *ECRj*, and *EC_TRW*, while the third one uses digital infrastructure (or e-commerce enablers), i.e. internet usage and ICT imports. For Indonesia, each set is estimated twice, given the strong correlation between the income variables, *YP* and *YCP*.

The main results are as follows. First, the results are strongly robust, with the same e-commerce and digitalisation variables featuring significance as in our main models. Second, some differences exist according to trading partner size (or importance). With Malaysia, the magnitude of the effects is the reason for the heterogenous outcomes witnessed. For Indonesia, the results are strongly heterogenous, both in terms of the significance of the coefficient and magnitude.

For Indonesia (Table 4), the e-commerce enablers featured here are important across the board for all trading partners, but e-commerce itself has a solid impact in trading partner nations

of moderate to low importance. We find that internet usage and ICT imports, not e-commerce, promote Indonesia's export relations with its most important trading partners (TP1). A 10% increase in internet usage increased trade by 0.48% in Indonesia and 0.14% in its trading partner countries. A 10% increase in Indonesia's ICT imports as a percentage of total imports sees a 0.38% increase in trade between Indonesia and its most important trading partners. However, e-commerce, the internet, and/or ICT imports are found to be important for Indonesia's exports to TP2 and TP3 countries.

Table 4: Digitalisation and Supply Chain Effects on Trade by Trading Partner Size – Indonesia

	TP1						T2						T3					
	E-commerce				Internet/ICTIM		E-commerce				Internet/ICTIM		E-commerce				Internet/ICTIM	
Model	1A-B	1A-C	2A-B	2A-C	3A-B	3A-C	1A-B	1A-C	2A-B	2A-C	3A-B	3A-C	1A-B	1A-C	2A-B	2A-C	3A-B	3A-C
SCHAIN	0.009	0.009	-0.004	-0.004	-0.001	-0.001	0.112	0.112	-0.009**	-0.009**	-0.001	-0.001	-0.062	-0.063	-0.003	-0.003	0.000	0.000
	0.928	0.933	0.242	0.242	0.759	0.563	0.485	0.573	0.021	0.021	0.486	0.453	0.041	0.431	0.349	0.347	0.756	0.778
COVID19	-0.040	-0.043	-0.068	-0.069	-1.199**	-1.202***	0.017	0.017	0.046	0.046	-1.062**	-1.064***	-0.118	-0.116	-0.081	-0.079	-0.790**	-0.792***
	0.741	0.772	0.625	0.621	0.012	0.000	0.774	0.904	0.432	0.435	0.036	0.000	0.232	0.463	0.488	0.497	0.020	0.000
LNECRI	-0.255	-0.237					-0.992	-0.991					-2.841***	-2.848**				
	0.635	0.645					0.129	0.120					0.001	0.037				
LNECRJ	-0.087	-0.087					-0.089	-0.088					0.125	0.125				
	0.399	0.453					0.212	0.542					0.311	0.239				
*SCHAIN*LNECRi*	-0.001	-0.001					-0.024	-0.024					0.015***	0.015				
	0.948	0.951					0.492	0.576					0.008	0.403				
*SCHAIN*LNECRj*	-0.001	-0.001					-0.001	-0.001					-0.001	-0.001				
	0.483	0.283					0.431	0.681					0.772	0.705				
EC_TRW			0.007	0.007					0.004	0.004					0.031	0.031		
			0.188	0.181					0.578	0.578					0.019	0.020		
*SCHAIN*EC_TRW*			0.000	0.000					0.001	0.001					0.000	0.000		
			0.422	0.422					0.036	0.035					0.335	0.334		
INTERi					0.048***	0.048***					0.049***	0.049***					0.042***	0.042***
					0.000	0.000					0.000	0.000					0.000	0.000
INTERj					0.014***	0.014***					0.001	0.001					0.008***	0.008***
					0.006	0.001					0.902	0.841					0.008	0.001
ICTIMi					0.037	0.038***					0.008	0.008					0.023	0.023
					0.651	0.001					0.917	0.722					0.681	0.420
ICTIMj					-0.003	-0.003					-0.016	-0.015					-0.003	-0.003
					0.748	0.305					0.256	0.502					0.848	0.801
*SCHAIN*INTERi*					0.000	0.000					0.000	0.000					0.000	0.000
					0.681	0.439					0.990	0.996					0.581	0.769
*SCHAIN*INTERj*					0.000***	0.000***					0.000***	0.000***					0.000	0.000
					0.004	0.001					0.015	0.008					0.720	0.761
*SCHAIN*ICTIMi*					0.000	0.000					0.000	0.000					0.000	0.000
					0.628	0.645					0.682	0.559					0.984	0.987

| Model | TP1 E-commerce | | | | TP1 Internet/ICTIM | | T2 E-commerce | | | | T2 Internet/ICTIM | | T3 E-commerce | | | | T3 Internet/ICTIM | |
	1A-B	1A-C	2A-B	2A-C	3A-B	3A-C	1A-B	1A-C	2A-B	2A-C	3A-B	3A-C	1A-B	1A-C	2A-B	2A-C	3A-B	3A-C
*SCHAIN*ICTIMj*					0.000	0.000					0.000	0.000					0.000	0.000
					0.784	0.805					0.561	0.835					0.353	0.277
Adj'd R-squared	0.97	0.97	0.97	0.97	0.83	0.83	0.62	0.62	0.45		0.57	0.57	0.84	0.84	0.87	0.87	0.65	0.65
Obs.	266	266	319	319	1,346	1,346	251	251	355	355	1,383	1,383	289	289	610	610	2,218	2,218

GDP = gross domestic product.

Notes: The table estimates the bilateral exports gravity model with the log of bilateral exports (X_{ij}) from Indonesia, i, to trading partners, j. The trading partners are divided in three groups, T1–T3, depending on their importance. The key regressors are *COVID-19*; *SCHAINi,j*, denoting imports of intermediates from j to i; e-commerce variables *EC/TRW, ECRi,* and *ECRj*, denoting the global transition to e-commerce; and the e-commerce ranking of i and j nations. The controls are three income variables, including the difference between countries i's and j's GDP per capita (*YCD*), the product of countries i's and j's GDP (*YP*), and the product of countries i's and j's GDP per capita (*YCP*); the trade openness of countries i and j (*Toi* and *Toj*); the nominal exchange rate between countries i and j (*NER*); the distance between i and j (DIST); and trading blocs (*APEC* and *ASEAN*). These appear in the models expressed in natural logarithmic form (LN) and first difference form (D). ***, **, and * denote the level of significance at 1%, 5%, and 10%.

Source: Author's calculations.

For Malaysia (Table 5), e-commerce, measured as *EC_TRW*, has a positive and significant effect on its bilateral export relations with TP1–TP3 nations. However, these vary by magnitude, with the e-commerce effect strongest in the TP1 group or the most important trading partners, followed by the TP3 group and the TP2 group. A 10% increase in *EC_TRW* shows a 1.1% increase in exports going to TP1, 1.04% for TP3, and 0.98% for TP2. The interaction of e-commerce and the supply chain across all trading partner sizes gives the same result as above.

Moreover, consistent with previous results, internet usage in TP1 and TP2 nations helps ease supply chain tensions for Indonesian exporters. E-commerce is also found to ease supply chain issues for Indonesian exporters to TP2 nations. However, the opposite is true for the TP3 group, which comprises the least important trading partners.

Table 5: Digitalisation and Supply Chain Effects on Trade by Trading Partner Size – Malaysia

	TP1						TP2						TP3					
	E-commerce				Internet/ICTIM		E-commerce				Internet/ICTIM		E-commerce				Internet/ICTIM	
Model	**1A-B**	**1A-C**	**2A-B**	**2A-C**	**3A-B**	**3A-C**	**A-B**	**A-C**	**2A-B**	**2A-C**	**3A-B**	**3A-C**	**1A-B**	**1A-C**	**2A-B**	**2A-C**	**3A-B**	**3A-C**
SCHAIN	0.015	0.015	0.010**	0.010**	-0.002	-0.002	.010	.011	.012***	0.012***	0.000	0.000	-0.015	-0.014	0.008**	0.008**	0.007**	0.007**
	0.655	0.669	0.040	0.039	0.641	0.522	.783	.831	0.002	0.002	0.973	0.961	0.401	0.725	0.012	0.012	0.041	0.041
COVID19	0.012	0.011	-0.975***	-0.979***	0.806***	-0.802***	.045	.046	0.660**	-0.669	-0.382***	-0.383**	-0.069	-0.066	-0.762**	-0.772**	-0.679***	-0.678***
	0.944	0.948	0.004	0.004	0.000	0.000	.821	.773	0.038	0.036	0.011	0.052	0.742	0.803	0.022	0.020	0.000	0.000
LNECRi	-0.241	-0.243					.003	.003					-0.629	-0.629				
	0.551	0.660					.995	.996					0.091	0.151				
LNECRj	-0.022	-0.022					.249	.249					0.003	0.003				
	0.421	0.720					.037	.210					0.978	0.980				
*SCHAIN*LNECRi*	-0.002	-0.003					.001	.001					0.004	0.004				
	0.777	0.807					.846	.937					0.414	0.754				
*SCHAIN*LNECRj*	-0.001	-0.001					.002	.002					0.000	0.000				
	0.646	0.622					.730	.446					0.863	0.904				
EC_TRW			0.111***	0.111***					.098***	0.098***					0.104***	0.104***		
			0.000	0.000					0.000	0.000					0.000	0.000		
*SCHAIN*EC_TRW*			-0.001***	-0.001***					.001**	-0.001**					-0.001***	-0.001***		
			0.003	0.003					0.053	0.052					0.004	0.004		
INTERi					.034***	0.034***					0.031***	0.031***					0.036**	0.036**
					0.000	0.000					0.000	0.000					0.000	0.000
INTERj					-0.005	-0.005					0.005	0.005					-0.004	-0.004
					0.064	0.223					0.172	0.180					0.135	0.136
ICTIMi					.005***	-0.005***					-0.012***	-0.012***					-0.003	-0.003
					0.092	0.027					0.000	0.001					0.437	0.438
ICTIMj					0.007	0.007					0.035	0.035					-0.008	-0.008

	TP1						TP2						TP3					
	E-commerce				Internet/ICTIM		E-commerce				Internet/ICTIM		E-commerce				Internet/ICTIM	
Model	1A-B	1A-C	2A-B	2A-C	3A-B	3A-C	A-B	A-C	2A-B	2A-C	3A-B	3A-C	1A-B	1A-C	2A-B	2A-C	3A-B	3A-C
					0.421	0.198					0.058	0.023					0.445	0.446
SCHAIN*INTERi					0.000	0.000					0.000	0.000					0.000	0.000
					0.573	0.646					0.757	0.731					0.066	0.066
SCHAIN*INTERj					0.000	0.000					0.000	0.000					0.000	0.000
					0.819	0.866					0.637	0.767					0.108	0.108
SCHAIN*ICTIMi					0.000	0.000					0.000	0.000					0.000**	0.000**
					0.695	0.776					0.189	0.266					0.036	0.036
SCHAIN*ICTIMj					0.000	0.000					-0.001	-0.001					-0.001*	-0.001*
					0.280	0.344					0.447	0.519					0.069	0.069
Adt'd R-squared	0.983	0.983	0.885	0.885	0.924	0.924	.932	.932	0.740	0.740	0.820	0.820	0.948	0.948	0.831	0.831	0.879	0.879
Obs.	268	268	1,513	1,513	1,513	1,513	181	181	181	1,058	1,058	1,058	360	360	2,672	2,672	2,672	2672

GDP = gross domestic product.

Notes: The table estimates the bilateral exports gravity model with the log of bilateral exports (X_{ij}) from Malaysia, *i*, to trading partners, *j*. The trading partners are divided in three groups, T1–T3, depending on their importance. The key regressors are *COVID-19*; *SCHAINi,j*, denoting imports of intermediates from *j* to *i*; e-commerce variables *EC/TRW*, *ECRi*, and *ECRj*, denoting the global transition to e-commerce; and the e-commerce ranking of *i* and *j* nations. The controls are three income variables, including the difference between countries *i*'s and *j*'s GDP per capita (*YCD*), the product of countries *i*'s and *j*'s GDP per capita (*YCP*); the trade openness of countries *i* and *j* (*Toi* and *Toj*); the nominal exchange rate between countries *i* and *j* (*NER*); the distance between *i* and *j* (DIST); and trading blocs (*APEC* and *ASEAN*). These appear in the models expressed in natural logarithmic form (LN) and first difference form (D). ***, **, and * denote the level of significance at 1%, 5%, and 10%.
Source: Author's calculations.

(4) Trading Blocs

The ever-growing importance of digital commerce has led to regional initiatives through regional trade agreements (*Digital Watch*, n.d.). In the Asia-Pacific region, APEC is seen as the focal point for regional cooperation in e-commerce. APEC members adopted one of their first e-commerce-related programmes in 1998 in the form of the APEC Blueprint for Action on Electronic Commerce, and in 2017 the APEC Internet and Digital Economy Roadmap was adopted for the development of the internet and the digital economy (*Digital Watch*, n.d.). The Digital and Sustainable Trade Facilitation report on the ASEAN region, prepared by the United Nations Economic and Social Commission for Asia and the Pacific and the ASEAN Secretariat (ESCAP and ASEAN, 2021), showed that AMS have accelerated their digital trade facilitation over recent years through paperless trade and cross-border paperless trade. ESCAP and ASEAN (2021) indicated that several positive efforts have been made in both these areas by ASEAN in recent years.

Given that Malaysia and Indonesia are members of both regional blocs, we test the robustness of the digitalisation results for trading partners in the ASEAN and APEC trading blocs, where a higher level of commitment to cross-border e-commerce would provide more favourable conditions for international trade and e-commerce links. For this reason, the international trade literature gives special consideration to export determination within trade blocs.

Table 6 reports the results for the two blocs. The key results are as follows. First, we find that e-commerce results for our full sample and the trade blocs are consistent for both Indonesia and Malaysia in terms of sign effects. More importantly, as expected, in terms of magnitude and significance, we notice much more favourable effects of e-commerce on exports flowing to the two blocs than on the exports of all trading partners (previous results). Starting with Indonesia's exports to AMS and APEC members, we find that these improve with a higher e-commerce ranking in Indonesia. For every 1% increase in e-commerce ranking, a 5%−6% increase in exports to ASEAN is noticed, compared with a 2% increase in exports to APEC members. Moreover, e-commerce interacted with the supply chain has a significantly positive effect on exports to ASEAN, but the effect is the opposite in the case of exports to APEC.

Table 6: E-commerce and Supply Chain Effects on Trade – by Preferential Trade Membership

Indonesia

	ASEAN							APEC					
	1.A	1.B	1.C	2.A	2.B	2.C		1.A	1.B	1.C	2.A	2.B	2.C
COVID19	-0.0738	-0.2960	-0.2919	0.1321	0.3238	0.3385	COVID19	-0.3236	-0.8538**	-0.8525**	-0.4260	-0.7853**	-0.7910**
	0.6637	0.2086	0.2233	0.6086	0.3779	0.3663		0.3574	0.0445	0.0450	0.1189	0.0233	0.0234
SCHAIN	-0.0103	-0.0051	-0.0050	-0.2431	-0.3458**	-0.3436**	DSCHAIN	0.0118	0.0131	0.0131	-0.0967	-0.1084	-0.1073
	0.2390	0.6146	0.6199	0.1466	0.0339	0.0354		0.3462	0.3713	0.3726	0.5980	0.6196	0.6239
EC_TRW	0.0097	0.0316	0.0309				EC_TRW	0.0129	0.0426***	0.0419***			
	0.7026	0.3537	0.3684					0.3976	0.0049	0.0053			
SCHAIN*EC_TRW	0.0005	0.0003	0.0003				DSCHAIN*EC_TRW	-0.0010	-0.0010	-0.0010			
	0.3679	0.5860	0.5906					0.2948	0.3248	0.3257			
LNECRi				-4.6047	-6.2538**	-6.2738**	LNECIRi				-2.1680**	-0.4848	-0.4625
				0.1111	0.0467	0.0471					0.0416	0.6383	0.6532
LNECRj				0.2517**	0.3014*	0.2998*	LNECIRj				-0.0567	-0.0244	-0.0242
				0.0233	0.0661	0.0642					0.1140	0.2521	0.2614
SCHAIN*LNECRi				0.0614	0.0831**	0.0824**	DSCHAIN*LNECIRi				0.0185	0.0212	0.0209
				0.1115	0.0292	0.0303					0.6574	0.6679	0.6721
SCHAIN*LNECRj				-0.0069**	-0.0056*	-0.0055*	DSCHAIN*LNECIRj				0.0019	0.0015	0.0015
				0.0287	0.0538	0.0589					0.2588	0.3535	0.3513

Malaysia

	ASEAN					APEC				
	1.A-B	1.A-C	2.A-B	2.A-C		1.A-B	1.A-C	2.A-B	2.A-C
COVID19	-0.0568	0.5660**	-0.4001*	-0.4137*	COVID19	0.1053**	0.1067**	-0.0614	-0.0576
	0.8026	0.0326	0.0743	0.0480		0.0229	0.0237	0.5667	0.5938
SCHAIN	0.0251***	0.0204***	-0.2046	-0.2138*	DSCHAIN	-0.0014	-0.0014	0.0862	0.0857
	0.0003	0.0015	0.1038	0.0880		0.1195	0.1193	0.5226	0.5258
EC_TRW	0.0663	0.0734			EC_TRW	-0.0027	-0.0023		
	0.0000	0.0001				0.1240	0.1922		
SCHAIN*EC_TRW	0.0002	-0.0015			DSCHAIN*EC_TRW	0.0001	0.0001		
	0.5590	0.0051				0.1835	0.1662		
LNECRi			-1.9388**	-2.0959**	LNECIRi			0.3054*	0.3020*
			0.0152	0.0080				0.0797	0.0801

LNECRj		0.1452	0.1621	LNECIRj	0.0303	0.0305
		0.1405	0.1952		0.6560	0.6539
SCHAIN*LNECRi		0.0587*	0.0622*	DSCHAIN*LNECIRi	-0.0195	-0.0194
		0.0749	0.0615		0.5219	0.5252
SCHAIN*LNECRj		-0.0005	-0.0011	DSCHAIN*LNECIRj	-0.0008	-0.0008
		0.8690	0.7313		0.4877	0.4904

APEC = Asia-Pacific Economic Cooperation, ASEAN = Association of Southeast Asian Nations, GDP = gross domestic product.

Notes: The table estimates the bilateral exports gravity model with the log of bilateral exports (X_{ij}) from country, i, to trading partners, j. Here, the trading partners belong to the ASEAN or APEC trading bloc. The key regressors are *COVID-19*; *SCHAINi,j*, denoting imports of intermediates from j to i; e-commerce variables *EC/TRW, ECRi,* and *ECRj*, denoting the global transition to e-commerce; and the e-commerce ranking of i and j nations. The controls are three income variables, including the difference between countries i's and j's GDP per capita (*YCD*), the product of countries i's and j's GDP (*YP*), and the product of countries i's and j's GDP per capita (*YCP*); the trade openness of countries i and j (*Toi* and *Toj*); the nominal exchange rate between countries i and j (*NER*); the distance between i and j (DIST); and trading blocs (*APEC* and *ASEAN*). These appear in the models expressed in natural logarithmic form (LN) and first difference form (D). ***, **, and * denote the level of significance at 1%, 5%, and 10%.

Source: Author's calculations.

Similarly, with Malaysia, e-commerce is seen to have a significantly positive effect on exports for the first time, with a 1% increase in e-commerce ranking leading to a 2% increase in exports to ASEAN, and a 1% increase in global e-commerce is associated with a 0.07% increase in exports. The expansion of global e-commerce also helps solve some of the supply chain jitters facing Malaysian exporters servicing ASEAN markets. Our results show that e-commerce interacted with the supply chain has a positive and significant effect, with a 1% increase in the interactive variable (that suggests the falling e-commerce standing of Indonesia) improving exports by 0.06%. In stark contrast, against expectations, the expansion of Malaysia's own e-commerce ventures make its exports less attractive to the APEC group. The interaction between the supply chain and relative e-commerce standing of Malaysia negatively affects APEC exports. Here, a 1% increase in the interactive variable (that suggests the falling relative e-commerce standing of Indonesia) reduces exports by 0.02%, but this association is insignificant.

(5) Income and Regional Groups

The robustness of the findings is tested against regional and income differences following Narayan and Nguyen (2016; 2019) and Narayan and Bui (2021). These studies showed that both the regional and income regions of the trading partners matter for the determination of trade. In the same way, differences in the e-commerce and trade relations are also expected by the region and income of the trading partners, given the differences in adaptation to e-commerce by different countries. Regional and income groups are developed according to the World Bank classification.

a. Income

For Indonesia, we were able to estimate the results for lower middle-income (LMID), upper middle-income (UMID), and high-income (HIGH) country categories. For LMID countries, an increase in the relative standing of e-commerce in Indonesia can reduce exports. For LMID nations, exports increase by 7% with every 10% decrease in the relative e-commerce ranking of Indonesia (or higher *ECRi*). Moreover, a higher supply chain combined with a lower e-commerce ranking of Indonesia increases exports. On its own, every 1% increase in *SCHAIN* is associated with a 0.04% fall in exports to LMID nations; however, its interaction with *ECRi* sees a recovery in exports by half (Table 7, panel 1). We see that for the UMID nations, *EC_TRW* plays a similar role. With the high-income group, *EC_TRW* has a positive relationship with exports to this group, but when combined with *SCHAIN*, it can reduce exports.

In the case of Malaysia (Table 7, panel 2), the results are mainly consistent across the income groups. We notice that *EC_TRW* has a positive relationship with its exports to the LOW, LMID, UMID, and high-income groups, but when combined with *SCHAIN*, it can reduce exports. This result is consistent with some of our earlier findings on *ECRi*. A higher e-commerce ranking, or lower *ECRi,* increases exports to LOW and UMID countries. For LOW countries, when a lower e-commerce ranking, or higher *ECRi,* is combined with *SCHAIN*, these interactive variables reverse some of the negative effect of *SCHAIN*. On the other hand, a higher e-commerce ranking of trading partners, or lower *ECRj,* is found to reduce exports to the LMID group.

b.   Regional

We can estimate models for the regional groups – including Europe and Central Asia (ECA); North America, Latin America, and the Caribbean (NALAC); and Sub-Saharan Africa (SSA) – for Indonesia.[2] *EC_TRW* shows a positive and significant relationship with exports for ECA and NALAC, but negative for SSA. For NALAC, *ECRj* has a deteriorating effect on Indonesia's exports but *ECRi* is export-promoting for Indonesia. *SCHAIN* is significant and can increase Indonesia's exports going to NALAC and SSA but reduce exports to *ECA*. However, as an interactive variable, *SCHAIN* with *EC_TRW* improves exports to *ECA* but reduces exports to NALAC and SSA.

For Malaysia, models for all regions can be estimated. *EC_TRW* is consistently positive for exports going to most regions, except for South Asia (SA). However, when interacted with *SCHAIN*, exports to MENA and SSA fall, but exports to EAP increase. As with the other main results, regional effects of *ECRi* or *ECRj* are not visible, although as interaction variables, *ECRi* and *SCHAIN* are positively associated with exports to NALAC.

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[22] For Indonesia, regional estimates for East Asia and Pacific (EAP), Middle East and North Africa (MENA), and South Asia (SA) are not provided due to data limitations.

Table 7: E-commerce and Supply Chain Effects on Trade – by Income of Trading Partner

Panel 1: Indonesia

	LMID						UMID				HIGH			
	1.A	1.B	1.C	2.A	2.B	2.C	1.A-B	1.A-C	2.A-B	2.A-C	1.A-B	1.A-C	2.A-B	2.A-C
COVID19	0.0654	0.0948	0.0928	-0.0618	-0.0747	-0.0738	-0.0372	-0.0348	-0.1237	-0.1142	-0.1804	-0.1811	0.1372	0.1322
	0.6153	0.4292	0.4371	0.3709	0.3455	0.3529	0.7605	0.7751	0.3977	0.4331	0.1712	0.1670	0.2312	0.2496
SCHAIN	-0.0092	-0.0093*	-0.0093*	-0.0467*	-0.0453	-0.0453	-0.0033*	-0.0033**	-0.0724	-0.0715	0.0059*	0.0059*	0.0136	0.0137
	0.1071	0.0971	0.0968	0.0974	0.1211	0.1214	0.0524	0.0522	0.4810	0.4836	0.0686	0.0685	0.7422	0.7356
EC_TRW	-0.0020	-0.0062	-0.0061				0.0258*	0.0257*			0.0401***	0.0402**		
	0.8866	0.6434	0.6500				0.0861	0.0881			0.0069	0.0068		
SCHAIN*EC_TRW	0.0006	0.0006	0.0006				0.0004**	0.0004**			-0.0005**	-0.0005**		
	0.1813	0.1757	0.1754				0.0136	0.0135			0.0307	0.0313		
LNECRi				0.7238**	0.7179***	0.7178**			-0.3116**	-3.3394**			-0.7014	-0.6873
				0.0017	0.0028	0.0028			0.0042	0.0040			0.2408	0.2412
LNECRj				0.0608	0.0841	0.0840			-0.3466	-0.3476			0.0292	0.0284
				0.7194	0.6095	0.6096			0.1292	0.1278			0.7631	0.7693
SCHAIN*LNECRi				0.0152**	0.0155**	0.0155**			0.0129	0.0127			-0.0027	-0.0027
				0.0345	0.0412	0.0411			0.5691	0.5735			0.7598	0.7516
SCHAIN*LNECRj				-0.0052	-0.0058	-0.0058			0.0033	0.0033			-0.0004	-0.0003
				0.1470	0.1469	0.1472			0.3453	0.3409			0.7140	0.7258
Adjusted R-squared	0.927	0.927	0.927	0.943	0.943	0.943	0.967	0.967	0.970	0.970	0.981	0.981	0.979	0.979
Obs.	335	335	335	189	189	189	364	364	218	218	447	447	288	288

Panel 2: Malaysia

	LOW				LMID				UMID				HIGH			
	1.A-B	1.A-C	2.A-B	2.A-C	1.A-B	1.A-C	2.A-B	2.A-C	1.A-B	1.A-C	2.A-B	2.A-C	1.A-B	1.A-C	2.A-B	2.A-C
COVID19	-0.1837**	-1.1970	-0.6808**	-0.8235**	-0.7076*	-0.7168*	0.1738	0.1702	-0.7622**	-0.7712**	0.1904	0.1960	-0.3790*	-0.3825*	-0.0104	-0.0084
	0.0462	0.0049	0.0478	0.0145	0.0837	0.0793	0.3119	0.3218	0.0049	0.0043	0.2087	0.2008	0.0833	0.0793	0.9443	0.9546
SCHAIN	0.0006	0.0048	-0.2773*	-0.1861	0.0081**	0.0081**	0.0215	0.0218	0.0092**	0.0092**	-0.0149	-0.0133	0.0079**	0.0079**	-0.0272	-0.0271
	0.8492	0.3781	0.0946	0.1187	0.0363	0.0350	0.5555	0.5519	0.0025	0.0024	0.5890	0.6331	0.0214	0.0213	0.3372	0.3387
EC_TRW	-0.0123*	0.1324***			0.1084***	0.1082***			0.1047***	0.1044***			0.0626***	0.0625***		
	0.0903	0.0001			0.0002	0.0002			0.0000	0.0000			0.0001	0.0001		
SCHAIN*EC_TRW	0.0000	-0.0010**			-0.0007**	-0.0007**			-0.0008***	-0.0008***			-0.0003	-0.0003		

	0.8624	0.0499			0.0243	0.0237			0.0004	0.0004			0.2115	0.2116		
LNECRi			-1.0231**	-1.6825**			0.4745	0.4702			-0.7245*	-0.7231*			-0.5052	-0.5035
			0.0445	0.0079			0.3811	0.3866			0.0939	0.0927			0.2450	0.2439
LNECRj			-0.4956	0.2090			-0.1784*	-0.1787*			-0.0396	-0.0393			0.0224	0.0222
			0.2132	0.6299			0.0634	0.0623			0.7579	0.7579			0.7380	0.7399
*SCHAIN*LNECRi*			0.0644	0.0561*			-0.0108	-0.0108			0.0052	0.0047			0.0092	0.0092
			0.1428	0.0672			0.1714	0.1696			0.4381	0.4884			0.2003	0.2015
*SCHAIN*LNECRj*			0.0087	-0.0055			0.0038	0.0038			-0.0011	-0.0011			-0.0013	-0.0013
			0.4127	0.4449			0.6274	0.6299			0.7672	0.7768			0.5185	0.5185
Adjusted R-squared	-0.0212	0.7515	-0.1268	0.8904	0.8405	0.8403	0.9685	0.9685	0.8612	0.8611	0.9739	0.9740	0.9326	0.9326	0.9817	0.9817
Obs.	94	94	94	94	1419	1419	1419	1419	1473	1473	1473	1473	1744	1744	1744	1744

Notes: The table estimates the bilateral exports gravity model with the log of bilateral exports (X_{ij}) from country, i, to trading partners, j. Here, the trading partners belong to different income groups: high-income (HIGH); low-income (LOW); upper middle-income (UMID); and lower middle-income (LMID). The key regressors are *COVID-19; SCHAINi,j*, denoting imports of intermediates from j to i; e-commerce variables *EC/TRW*, *ECRi*, and *ECRj*, denoting the global transition to e-commerce; and the e-commerce ranking of i and j nations. The controls are three income variables, including the difference between countries i's and j's GDP per capita (*YCD*), the product of countries i's and j's GDP (*YP*), and the product of countries i's and j's GDP per capita (*YCP*); the trade openness of countries i and j (*Toi* and *Toj*); the nominal exchange rate between countries i and j (*NER*); the distance between i and j (DIST); and trading blocs (*APEC* and *ASEAN*). These appear in the models expressed in natural logarithmic form (LN) and first difference form (D). ***, **, and * denote the level of significance at 1%, 5%, and 10%.
Source: Author's calculation.

Table 8: E-commerce, Supply Chain, and COVID-19 Effects on Indonesia's Trade – by Regional Group

Region	Model	COVID19	SCHAIN	EC_TRW	SCHAIN*EC_TRW	LNECRi	LNECRj	SCHAIN*LNECRi	SCHAIN*LNECRj	$\overline{R^2}$	Obs.
ECA	1.A-B	**0.2243****	**-0.0064**	-0.0008	**0.0005*****					0.960	321
		0.0194	**0.0018**	0.8006	**0.0087**						
	1.A-C	**0.2206****	**-0.0064**	-0.0004	**0.0005*****					0.960	321
		0.0232	**0.0017**	0.8982	**0.0085**						
	2.A-B	0.0600	-0.0229			-1.6839	-0.0219	0.0053	-0.0004	0.957	262
		0.6966	0.7739			0.0192	0.8595	0.7665	0.8234		
	2.A-C	0.0516	-0.0229			-1.6843	-0.0216	0.0053	-0.0004	0.957	262
		0.7420	0.7770			0.0189	0.8618	0.7698	0.8263		
NALAC	1.A	**-0.4051*****	**0.0038**	**0.0539*****	**-0.0003*****					0.980	276
		0.0000	**0.0559**	**0.0000**	**0.0038**						
	1.B	-0.3411	**0.0032**	**0.0444*****	**-0.0002*****					0.980	276
		0.1004	**0.0997**	**0.0039**	**0.0152**						
	1.C	-0.3406	**0.0032**	**0.0444*****	**-0.0002*****					0.980	276
		0.1002	**0.0999**	**0.0037**	**0.0153**						
	2.A	-0.1599	-0.0049			**-1.8476*****	**0.3714****	0.0043	-0.0037	0.977	141
		0.2458	0.9256			**0.0611**	**0.0523**	0.7164	0.1138		
	2.B	0.1641	0.0063			**-3.1648*****	0.1208	0.0011	**-0.0028***	0.978	141
		0.2233	0.9197			**0.0011**	0.1166	0.9345	**0.0972**		
	2.C	0.1664	0.0067			**-3.1717*****	0.1265	0.0011	**-0.0028***	0.978	141
		0.2199	0.9150			**0.0011**	0.1083	0.9374	**0.0971**		
SSA	1.A	**-0.4051*****	**0.0038**	**0.0539*****	**-0.0003*****					0.980	276
		0.0000	**0.0559**	**0.0000**	**0.0038**						
	1.B	-0.3411	**0.0032***	0.0444	**-0.0002****					0.980	276
		0.1004	**0.0997**	**0.0039**	**0.0152**						
	1.C	-0.3406	**0.0032***	**0.0444*****	**-0.0002****					0.980	276

Region	Model	COVID19	SCHAIN	EC_TRW	SCHAIN*EC_TRW	LNECRi	LNECRj	SCHAIN*LNECRi	SCHAIN*LNECRj	$\overline{R^2}$	Obs.
		0.1002	**0.0999**	**0.0037**	**0.0153**						

COVID-19 = coronavirus disease; ECA = Europe and Central Asia; NALAC = North America, Latin America, and the Caribbean; SSA = Sub-Saharan Africa.

Notes: The table estimates the bilateral exports gravity model with the log of bilateral exports (X_{ij}) from Indonesia, i, to trading partners, j. Here, the trading partners belong to different regional groups: ECA, NALAC, and SSA. The key regressors are *COVID-19*; *SCHAINi,j*, denoting imports of intermediates from j to i; e-commerce variables *EC/TRW, ECRi*, and *ECRj*, denoting the global transition to e-commerce; and the e-commerce ranking of i and j nations. The controls are the income variables (*YCD, CYP, and YCP*); trade openness (*Toi,* and *Toj*); distance between i and j (*DIST*); and trading blocs (*APEC* and *ASEAN*). These appear in the models expressed in natural logarithmic form (LN) and first difference form (D). See Table A1 for the calculation of the variables. ***, **, and * denote the level of significance at 1%, 5%, and 10%.

Source: Author's calculations

Table 9: E-commerce, Supply Chain, and COVID-19 Effects on Malaysia's Trade – by Regional Group

Region	Model	COVID19	SCHAIN	EC_TRW	SCHAIN*EC_TRW	LNECRI	LNECRJ	SCHAIN*LNECRI	SCHAIN*LNECRJ	$\overline{R^2}$	Obs.
EAP	1.A-B	-0.8996***	0.0151	0.1152***	-0.0011***					0.935	86
		0.0023	0.0001	0.0000	0.0001						
	1.A-C	-0.9063***	0.0152	0.1148***	-0.0011***					0.935	86
		0.0020	0.0001	0.0000	0.0001						
	2.A-B	0.2807	-0.0516			-0.3429	0.0469	0.0172	0.0003	0.991	86
		0.3511	0.6185			0.7584	0.2574	0.5446	0.8079		
	2.A-C	0.2843	-0.0515			-0.3427	0.0463	0.0171	0.0003	0.991	86
		0.3492	0.6186			0.7591	0.2583	0.5448	0.7961		
ECA	1.A-B	-0.3727	0.0103	0.0873*	-0.0004					0.908	251
		0.2248	0.0015	0.0000	0.1182						
	1.A-C	-0.3756	0.0103	0.0872*	-0.0004					0.908	251
		0.2202	0.0015	0.0000	0.1168						
	2.A-B	-0.0731	-0.0046			-0.6707	0.0632	0.0019	-0.0009	0.968	251
		0.6380	0.8241			0.0785	0.2910	0.7495	0.5478		
	2.A-C	-0.0813	-0.0046			-0.6815	0.0632	0.0019	-0.0009	0.968	251
		0.6131	0.8227			0.0789	0.2909	0.7478	0.5515		
NALAC	1.A-B	-0.7141**	0.0064	0.0881***	-0.0003					0.871	154
		0.0137	0.0567	0.0000	0.2857						
	1.A-C	-0.7318**	0.0064	0.0878***	-0.0003					0.870	154
		0.0113	0.0549	0.0000	0.2783						
	2.A-B	0.1155	-0.0625			-0.1611	0.1128	0.0147*	0.0020	0.969	154
		0.4710	0.0519			0.4689	0.6284	0.0644	0.1146		
	2.A-C	0.1126	-0.0624			-0.1702	0.1123	0.0147*	0.0019	0.969	154
		0.4813	0.0520			0.4441	0.6300	0.0641	0.1217		
MENA	1.A-B	-0.4407**	0.0072	0.0572***	-0.0006**					0.811	94
		0.0274	0.0342	0.0002	0.0129						
	1.A-C	-0.4378**	0.0072	0.0573***	-0.0006**					0.811	94

Region	Model	COVID19	SCHAIN	EC_TRW	SCHAIN*EC_TRW	LNECRI	LNECRJ	SCHAIN*LNECRI	SCHAIN*LNECRJ	$\overline{R^2}$	Obs.
		0.0286	**0.0349**	**0.0002**	**0.0139**						
	2.A-B	-0.1394	-0.0161			-0.7983	-0.0588	0.0087	-0.0032	0.969	94
		0.4391	0.6464			0.2759	0.4582	0.4263	0.3110		
	2.A-C	-0.1347	-0.0155			-0.7892	-0.0594	0.0085	-0.0032	0.969	94
		0.4567	0.6602			0.2819	0.4502	0.4370	0.3120		
SA	1.A-B	-0.3118	-0.0009	0.0003	-0.0002					-0.045	36
		0.2306	0.6991	0.9830	0.8080						
	1.A-C	-0.3113	-0.0009	0.0003	-0.0002					-0.045	36
		0.2308	0.6990	0.9807	0.8082						
	2.A-B	-0.4231	-0.2826			-0.1713	-0.5263	-0.0233	0.0782	-0.135	36
		0.4577	0.5170			0.9102	0.7416	0.7671	0.2736		
	2.A-C	-0.3583	-0.2767			-0.0276	-0.5466	-0.0240	0.0775	-0.129	36
		0.4887	0.5213			0.9845	0.7318	0.7578	0.2760		
SSA	1.A-B	**-1.0839****	0.0062	**0.1316*****	**-0.0008****					0.701	188
		0.0333	0.2243	**0.0001**	**0.0297**						
	1.A-C	**-1.0949****	0.0062	**0.1313*****	**-0.0008****					0.700	188
		0.0312	0.2227	**0.0001**	**0.0294**						
	2.A-B	-0.0948	0.0167			-0.0649	0.0997	-0.0049	0.0004	0.9118	188
		0.6943	0.7873			0.8618	0.6562	0.6200	0.9536		
	2.A-C	-0.0924	0.0168			-0.0609	0.0984	-0.0049	0.0004	0.9118	188
		0.7012	0.7869			0.8699	0.6629	0.6190	0.9539		

COVID-19 = coronavirus disease; EAP = East Asia and Pacific; ECA = Europe and Central Asia; MENA = Middle East and North Africa; NALAC = North America, Latin America, and the Caribbean; SA = South Asia; SSA = Sub-Saharan Africa.

Notes: The table estimates the bilateral exports gravity model with the log of bilateral exports (X_{ij}) from Malaysia, i, to trading partners, j. Here, the trading partners belong to different regional groups: EAP, ECA, MENA, NALAC, SA, and SSA. The key regressors are *COVID-19; SCHAINi,j*, denoting imports of intermediates from j to i; e-commerce variables *EC/TRW, ECRi, and ECRj*, denoting the global transition to e-commerce; and the e-commerce ranking of i and j nations. The controls are the income variables (*YCD*, *CYP*, and *YCP*); trade openness (To*i*, and To*j*); distance between i and j (DIST); and trading blocs (APEC and ASEAN). These appear in the models expressed in natural logarithmic form (LN) and first difference form (D). See Table A1 for the calculation of the variables. ***, **, and * denote the level of significance at 1%, 5%, and 10%.

Source: Author's calculations.

6. Summary of the E-commerce Findings

6.1. Global Transition to E-commerce

The global transition to e-commerce on its own seems to be beneficial to Indonesia's and Malaysia's exports flowing to most trading partners. For Indonesia, exports to TP3, the APEC bloc, the upper middle-income group and the high-income group, NALAC, and the SSA are driving this result. Powering the significant result for Malaysia are its exports to most trading partners, except for the SA region and the ASEAN and APEC blocs.

However, we see some increase (and decrease) in exports through the interaction of the supply chain and the global e-commerce transition. Specifically, the mediating role of the global e-commerce transition adds minor support to Indonesia's *SCHAIN-BX* nexus in the full sample, although robustness tests indicate that this may be significant for exports with the TP2 group importing $199 million–$150 million from Indonesia, the upper middle-income trading partners, and ECA. However, in the case of high-income countries and the NALAC and SSA regions, the interactive variable is significantly negative, suggesting that the addition of e-commerce with the supply chain is a deterrent for Indonesia's exports.

Moreover, this interactive variable is found to significantly weaken Malaysia's exports for the full sample of trading partners. Analysis that segregates trading partners by their importance, income, and region, echo the main finding, although exports of the APEC bloc do not respond significantly to this variable.

6.2. Indonesia's Relative Standing in E-commerce against the ROW

Our results indicate that cross-border e-commerce enablers and supply chain drivers support Indonesia's exports to most trading partners. Moreover, lower cross-border e-commerce activities, combined with higher supply chain activities, increase Indonesia's exports, and vice versa. This suggests that cross-border enablers are underdeveloped, and the growth of e-commerce is possibly relying on existing supply chain drivers, which puts pressure on the supply chain–exports relationship. This result is highly consistent with the findings portrayed in part A.

Our tests show that cross-border e-commerce enablers are working well on their own in Indonesia and are encouraging trade with TP3, the least important trading partners that import $49 million or less; the ASEAN and APEC trading bloc members; upper middle-income nations; and the NALAC region. However, if we consider the joint effects of the supply chain and e-commerce (in Indonesia), we find that several trading partner groups, like TP3 and the ASEAN bloc, show positive and significant effects of the interactive variable, although the e-

commerce ranking of Indonesia needs to be falling.

6.3. Malaysia's Relative Standing in E-commerce against the ROW

In Malaysia, an increase in its relative e-commerce standing fails to significantly increase exports to most trading partners, and when e-commerce is incorporated in the supply chains, they can drive exports if cross-border e-commerce is falling. This is confirmed by our analysis of separate trading partners by their importance and region. Further analysis reveals some significant results. Specifically, exports to ASEAN and low-income and upper middle-income nations are enhanced, while exports to APEC members are found to weaken with growth in Malaysia's e-commerce ranking.

When combined with the supply chain, the e-commerce ranking of Malaysia can boost exports of the ASEAN bloc, low-income trading partners, and the NALAC region, as long as Malaysia's ranking in e-commerce is falling.

6.4. Trading Partners and Their Relative Standing in E-commerce

E-commerce growth in trading partner nations discourages Indonesia's exports to TP3 or trading partners importing $49 million or less from Indonesia, the AMS, and the NALAC region. For Malaysia, the full sample results show weakening effects of an increase in trading partner e-commerce, but these are insignificant. This result is echoed in most of our robustness tests. Exports to lower middle-income countries saw export-promoting but insignificant effects.

A lower e-commerce ranking of trading partner nations interacted with *SCHAIN* has a positive and significant effect on Indonesia's exports in the full sample analysis. This result is largely driven by the ASEAN bloc group. The NALAC group's e-commerce activities are not working well enough with Indonesia's supply chain drivers to boost their imports from Indonesia.

For Malaysia's exports, the full sample analysis shows a negative, but insignificant, effect of trading partner e-commerce to support the *SCHAIN-BX* relationship. This result is highly robust, with all additional tests confirming the insignificant result for sign effects that can be positive or negative. This result is consistent with the results in part A.

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7. Conclusion

In this study, we have examined how e-commerce is shaping trade for two AMS: Indonesia and Malaysia. We tested the impact of e-commerce on exports to the ROW. The panel-based fixed effects estimation method, which accounts for cross-sectional fixed effects, was used to estimate our main models and accommodate a variety of robustness tests.

For Indonesia, the key findings are as follows. First, Indonesia's e-commerce enablers are underdeveloped to fully support cross-border e-commerce activities. Although we notice some increase in exports due to e-commerce, this is extremely less than proportional. Second, Indonesia's cross-border e-commerce activities can disrupt supply chain activities. Indeed, Indonesia's bilateral supply chain drivers on their own may not be working efficiently to boost Indonesia's exports, but they do seem to somewhat boost exports when e-commerce activities fall. Nonetheless, not all supply chain issues are being solved by reducing e-commerce activities. Third, higher trading partner cross-border e-commerce fails to increase Indonesia's exports, but if interacted with the supply chain, can boost demand for imports from Indonesia, although this is not true for all trading partners.

For Malaysia, we reveal the following. First, Malaysia's exports, and their supply chain–export relationship, have deteriorated with an acceleration in the growth of their e-commerce activity. Second, trading partner cross-border e-commerce growth or the interaction of their e-commerce with the supply chains between them and Malaysia do not matter much for boosting Malaysia's exports (or trading partner demand for imports from Malaysia).

These findings have one clear message. It is that for Indonesia, Malaysia, and their trading partners, the nature of development of e-commerce globally has indeed varied, is likely to be mainly unsynchronous and uncoordinated, and is heavily dependent on traditional cross-border trade structures, such as those developed for trade in intermediate goods (supply chains). As such, the findings of this paper are that (i) the e-commerce effects on trade are negative and insignificant, or weakly positive; and (ii) the growth of e-commerce mainly damages the link between supply chains and exports.

The policy implications are clear. For e-commerce to drive international trade effectively and efficiently, the development of e-commerce cannot be a national effort but one that is global. A cooperative approach at the global scale, such as the World Trade Organization's Joint Initiative on E-commerce, is needed to coordinate the building of cross-border trade structures to facilitate e-trade across nations in a manner that encourages the growth of cross-border e-commerce that harmonises and enhances international trade.

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Appendix

Table A1: Data Definition and Sources

Data	Indicator Name	Indicator Code
EC_TR_W	E-commerce sales as a share of total retail sales	ID379046
ECIR (i, j)	E-commerce index of Indonesia (i) and the ROW (j)	UNCTAD B2C
GDP	GDP (current US$)	NY.GDP.MKTP.CD
GDP per capita	GDP per capita (current US$)	NY.GDP.PCAP.CD
Exchange rate	Official exchange rate (LCU per US$, period average)	PA.NUS.FCRF
Exports of goods and services	Exports of goods and services (current US$)	NE.EXP.GNFS.CD
Imports of goods and services	Imports of goods and services (current US$)	NE.IMP.GNFS.CD
Secure Internet servers	The number of distinct, publicly trusted TLS/SSL certificates found in the Netcraft Secure Server Survey	IT.NET.SECR
Individuals using the internet (% of population)	Internet users are individuals who have used the internet (from any location) in the last 3 months. The internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV, etc.	IT.NET.USER.ZS
ICT goods imports (% of total goods imports)	ICT goods imports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods (miscellaneous).	TM.VAL.ICTG.ZS.UN
Bilateral Exports	Exports from home country (i) to trading partner (j) (all products)	Exports by country in US$ from WITS website, World Bank
Intermediate goods imports	Intermediate goods imports as a percentage of total imports (World Bank data)	
Distance		
From Jakarta to the capital city of the trading partner	https://www.distance-between-countries.com/countries/distance_between_countries.php?from=Indonesia&language=English	
From Kuala Lumpur to the capital city of	https://www.distance-between-countries.com/countries/distance_between_countries.php?from=Malaysia&language=English	

Data	Indicator Name	Indicator Code
the trading partner	48	

GDP = gross domestic product, ICT = information and communication technology, LCU = local currency, ROW = rest of the world, SSL = Secure Sockets Layer, TLS = Transport Layer Security, US = United States.
Source: Compiled by Author.

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