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**Working Paper**

## Economic integration and network trade: A comparison of East Asia and the European Union

ADB Working Paper Series, No. 1062

**Provided in Cooperation with:**

Asian Development Bank Institute (ADBI), Tokyo

*Suggested Citation:* Son Thanh Nguyen; Wu, Yanrui (2019) : Economic integration and network trade: A comparison of East Asia and the European Union, ADB Working Paper Series, No. 1062, Asian Development Bank Institute (ADBI), Tokyo

This Version is available at:

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**ADB Working Paper Series**

**ECONOMIC INTEGRATION AND  
NETWORK TRADE: A COMPARISON OF  
EAST ASIA AND THE EUROPEAN UNION**

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Son Thanh Nguyen and Yanrui Wu

No. 1062  
December 2019

**Asian Development Bank Institute**

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Suggested citation:

Nguyen, S. T. and Y. Wu. 2019. Economic Integration and Network Trade: A Comparison of East Asia and the European Union. ADBI Working Paper 1062. Tokyo: Asian Development Bank Institute. Available: <https://www.adb.org/publications/economic-integration-network-trade-east-asia-european-union>

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**Abstract**

The emergence of production networks has changed the structure of international trade, which a large share of intra-regional trade flows and the rising value of intermediate goods trade or network trade between countries within the same region reflect. While a production network exists in both East Asia and the European Union, the patterns could be different due to the differences in sociocultural, political, historical, and institutional factors between the two regions. This paper investigates and compares the pattern of network trade in East Asia and the European Union. It also explores how economic integration is related to the network trade pattern. The paper confirms that network trade in East Asia is more like a “network pattern,” while that in the European Union follows a “hub-and-spoke pattern.” At the global level, intermediate goods exports are more sensitive to trade barriers than total goods exports. A comparison between East Asia and the European Union shows that countries in East Asia have successfully reduced the service link costs. Despite the efforts that East Asia has directed towards export market diversification, the region is still more dependent on other regions’ economic conditions than the European Union is.

**Keywords:** production network, gravity model, European Union, East Asia, interdependence, remoteness, intermediate goods trade

**JEL Classification:** F13, F14, F15

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# 1. INTRODUCTION

In recent years, the development of a global production network has created the opportunity for many countries to achieve rapid growth and convergence with developed economies. The production network has transformed the nature of international trade, characterized by a high volume of trade and a large share of intra-regional trade between countries within the same region. Although production networks and supply chains have formed on a global scale, they are still marked by regional blocks, which we could call Factory Asia, Factory North America, and Factory Europe (Baldwin and Lopez-Gonzalez 2014). Table 1 shows that the European Union (EU), North America, and Asia all have large shares of intra-regional trade, with an increasing trend in Asia and its sub-regions. The share is even larger for intermediate goods trade. Baldwin and Kawai (2013) observed that two-thirds (64%) of East Asian (EA) export trades occur within the region.<sup>1</sup>

**Table 1: Intra-Regional Trade Share by Region in Selected Years (%)**

Region	1990	1995	2000	2005	2012
Asia	45.7	52.9	53.3	56.0	55.5
ASEAN	16.9	21.1	22.7	24.8	24.3
EA (ASEAN+3)	37.5	45.0	45.0	47.3	46.0
EU	65.8	65.4	65.1	65.0	63.2
North America	37.2	42.0	46.8	43.0	40.2

Note: ASEAN+3 consists of the 10 ASEAN member economies, the People's Republic of China, Japan, and the Republic of Korea.

Source: Asian Development Bank.

EA and the EU stand out as the most integrated regions in the world, with a large intermediate trade value and a substantial share of intra-regional trade. Nevertheless, the production networks in these regions may have distinct features due to differences in their sociocultural, political, historical, and institutional factors. The most striking difference between the EU and EA is the asymmetry in terms of economic development. While the EU mostly consists of high-income countries, the EA countries range from low- to high-income countries. This difference has interesting implications for production fragmentation and provides motivation for the comparison of production networks between the two regions.

Based on these observations, this paper investigates and compares the recent changes in the structure of international trade in EA and the EU. It aims to answer two main questions: (i) How does the structure of intra-regional trade differ between EA and the EU? (ii) How does the impact of trade determinants differ between EA and the EU? The empirical analysis studies the impact of trade determinants on total goods exports and intermediate goods exports at both the global and the intra-regional level. The rest of the paper begins with section 2, which provides a literature review of production networks and their impact on the effect of trade determinants. Section 3 analyzes the different structures of intra-regional trade in the EA and EU regions. Section 4 discusses the econometric methods. Section 5 presents the analysis of the results and some robustness checks. Section 6 concludes the paper.

<sup>1</sup> East Asia consists of both Northeast Asia and Southeast Asia.

## 2. IMPACT OF PRODUCTION NETWORKS ON TRADE DETERMINANTS

The literature has referred to the source for the transformation of international trade using different names, such as production sharing (Athukorala 2011), supply chain (Koopman et al. 2010), and production network (Dent 2008). These concepts are just different ways of expressing the same idea, which consists of three key points. First, it is possible to separate the production process into different stages. Second, these stages can occur in many different countries. Third, because of this separation, countries trade more in intermediate goods with each other. The use of these terms has depended on the emphasis of the author. Studies have usually used supply chain when investigating a narrow production process or specific industry. Production sharing stresses the country or countries involved in the process. Production fragmentation and production network highlight the changing characteristics of production. Some authors have also used production network to emphasize regional cooperation and the importance of trade in intermediate goods or network trade.

With the rising importance of trade and production fragmentation around the world, economists have paid substantial attention to analyzing the factors determining trade flows between nations, which they have considered to be increasing in proportion to the “economic masses” of trading partners and decreasing in proportion to the distance between them. The progress in transportation and communication technology has helped us to overcome the barriers of physical distance in trade. Due to globalization, people have become familiar with the concept of a smaller world, where distance no longer plays a significant role. Journalists and consultants have frequently used terms such as “the death of distance,” “flat world,” and “borderless world (Cairncross 2001). However, the literature on international trade is still concerned with the large and continuing importance of distance in determining trade flows. Despite the reduction in trade costs, the internet revolution, and the efforts to remove tariffs and trade barriers, there are no signs of weakening effects of distance (Deardorff 2003). On the contrary, the literature has pointed out that this effect has even increased over time.

The formation of production networks and the increasing importance of intermediate goods trade form one of the explanations for the recent changes in the impacts of trade determinants. The first change is the more important role of distance in intermediate goods trade. Gamberoni, Lanz, and Piermartini (2010) analyzed the effect of distance on different type of goods and found that it matters more for intermediate goods trade than for total goods trade. This finding is consistent with Harrigan and Venables’s (2006) study, which introduced the “just in time” production model. Due to the synchronization of activities, producers cannot complete their production until all the parts and components have arrived. When production is fragmented, the late arrival of any fragments will induce a cost that is disproportionate to the cost of any single fragment. As discussed earlier, the share of intermediate goods trade has increased with production networks. This may help to explain partially why the effect of distance has not decreased over time.

The second change is the role of the relative economic size between trading partners. The economic size affects international trade through two channels, namely the demand side, by showing the market size, and the supply side, by representing the production possibility. With the development of the production network, there could also be a third channel, which is the relative economic size between trading partners. Studies have shown that the EA production network’s great success may be attributable to the region’s distinctness from other regions, that it consists of countries with different incomes

(Kimura and Ando 2005; Athukorala and Menon 2010). This feature allows the production network to take advantage of the difference in effective wages adjusted by the quality of labor. According to Shiozawa (2007), wage rate differentiation or the disparity in national wage rates is one of the most important determinants of trade relations. He stated that current trade flows still follow the Ricardian comparative advantage that wage differentials induce but that the advantage is at the firm level instead of the national level.

The third possible impact of the production network on trade determinants is the rising interdependence of bilateral trade flows. Originally, authors considered the determinants of trade flows to be the bilateral factors between two specific trading partners, such as the economic size, distance, and trade agreement between countries. Later, they included the overall or the third-country effect to capture the interdependence of international trade flows. The argument for this effect is the triangular trade model, with the famous example of the People's Republic of China (PRC), Japan, and the United States (Baldwin and Lopez-Gonzalez 2014). In this example, Japan exports intermediate goods and sophisticated components to the PRC for assembly into final products. The PRC then exports these products for consumption in the United States. In this situation, the trade relation between Japan and the PRC depends not only on the determinants of these two partners but also on the economic condition in the United States. More generally, most of the EA trade flow consists of intermediate goods involving many countries, creating a deeply integrated and highly interdependent region. Takeuchi (2011) showed that, because of the growing fragmentation of production, the business cycles in EA countries have become increasingly synchronized. The production network is also responsible for the greater trade contraction in the region than the overall trade contraction at the global level during the recent financial crisis (Athukorala 2011). With fragmented production, any given degree of contraction in the demand for final goods will affect the trade flows from all the countries involved in the supply chain for the production of those goods.

### **3. STRUCTURE OF INTERMEDIATE GOODS TRADE IN EA AND THE EU**

This research drew data for bilateral trade flows from the UN Comtrade Database, covering the time period 1998 to 2013. The classification of intermediate goods is based on the three-digit Broad Economic Categories (BEC) classification, as Appendix A1 shows. The GDP, GDP deflator, value added in manufacturing, and air transport freight data come from the World Bank's World Development Indicators (WDI). Variables such as distance, common language, common border, and colonial links come from Mayer and Zignago's (2011) CEPII Geodist database. The data regarding membership of regional trade agreements (RTAs) are based on Mayer and Zignago (2011) and the WTO list of all RTAs for the period after 2006. The study constructed the data for GATT/WTO membership from Rose (2013) and the WTO website.

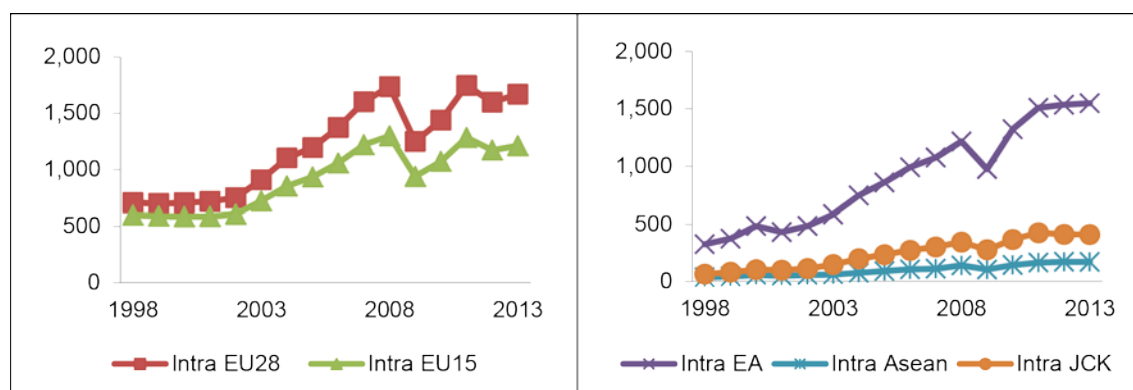
As intra-regional trade characterizes a production network, this section illustrates the intra-regional trade in EA and the EU using some intuitive graphs. During the period of analysis, the average share of intermediate goods in intra-regional exports was 51% in the EU and 64% in EA. Even though, in absolute terms, the intermediate exports in EA were smaller than those in the EU, they accounted for a much larger proportion of intra-regional exports in EA than in the EU. The production networks in EA and the EU may share the important role of intermediate goods in intra-regional export; they are



also distinct based on many differences in sociocultural, political, historical, and institutional factors in the two regions.

Figure 1 illustrates the intra-regional intermediate goods export value in sub-regions for both EA and the EU. The intra-regional intermediate goods exports in the two regions show a similar pattern, namely that exports flourished after the 2000s. The trade reversal effect was evident in 2008, as the export value dropped for both regions. Since 2009, the intermediate export value has recovered and continued its growing trend, while EA has shown faster growth and caught up with the EU in terms of absolute value. If the number of countries in the EU changes from 28 to 15, the intra-regional export value falls only slightly.<sup>2</sup> On the contrary, when considering sub-regions in EA, there is a dramatic fall in the value of intra-regional intermediate exports. This suggests that there are extensive trade links between Northeast Asian (JCK) and Southeast Asian (ASEAN) economies. This is an indication that, in the network of trade in the EU, there is a center, a trading hub that connects other economies in the region, while, in EA, the trading flows are intertwined and all countries trade with each other without a clear center of trade.

**Figure 1: Intra-regional Intermediate Goods Export Value in EA and the EU**  
(\$ billion)



Note: JCK consists of Japan, the People's Republic of China, and the Republic of Korea.

Source: Calculated based on Rieti (2013).

Figures 2 and 3 illustrate the network connection in intermediate goods trade between countries in EA and the EU, using the Stata code that Corten (2011) and Grund (2015) developed for intra-regional trade flows (at constant 2005 US dollar values) from 1998 to 2013.<sup>3</sup> The graphs represent the network of trade flows during this period between countries. A connection between two nodes represents the existence of a positive value of bilateral trade in intermediate goods. Without a cut-off value, each country will have a connection with all the other countries in the region. As the purpose of the graphs is to identify the key players in the production network, they should highlight the connections with a large volume of intermediate goods flows. For this purpose, the graphs only demonstrate the connections with a value of intermediate goods trade above \$5 billion (grey lines) and \$10 billion (red lines) in constant 2005 prices. The study derived these values from real average trade values in EA and the EU during the period. The countries that are most connected with other countries are located at the center of the network, whereas countries with fewer or no connections are on the verge of the graph.

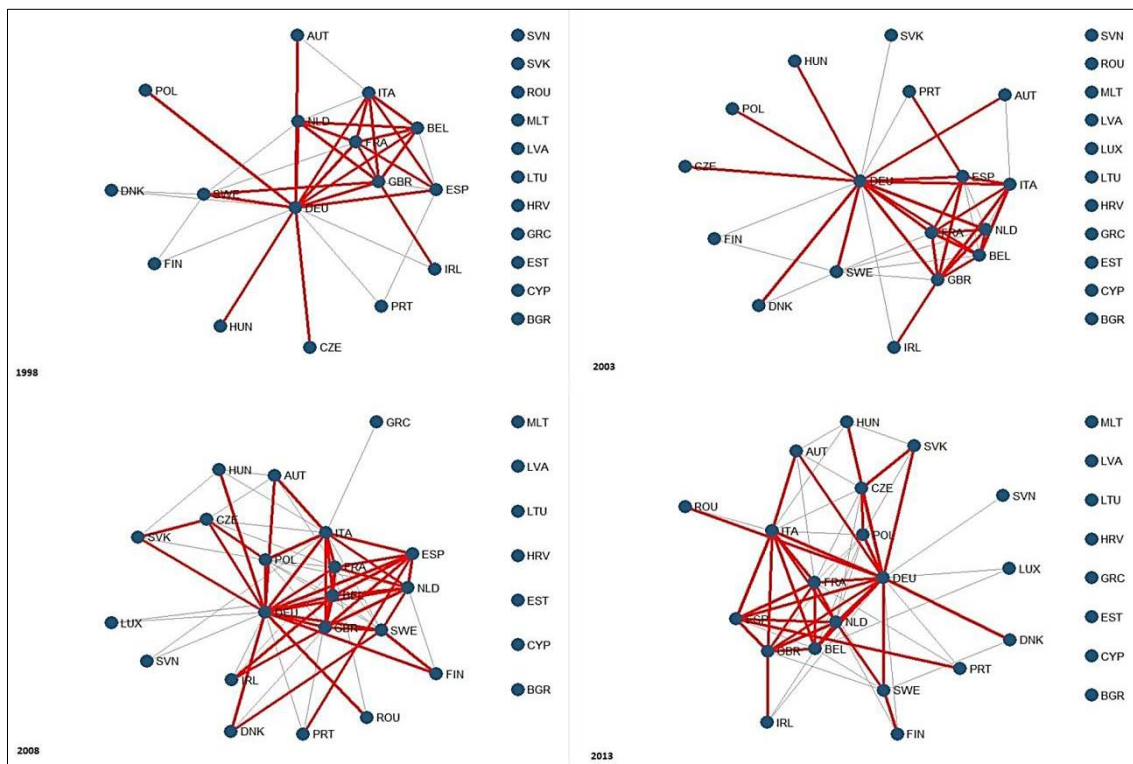
<sup>2</sup> The EU15 includes the United Kingdom, France, Germany, Italy, Austria, Belgium, Luxembourg, Denmark, Finland, Greece, Ireland, the Netherlands, Portugal, Spain, and Sweden.

<sup>3</sup> Network analysis using Stata: <https://nwcommands.wordpress.com/>.

For countries with no connection with another country, it does not mean that they do not trade with others but rather that their intermediate trade value is smaller than the critical values that the graph illustrates.

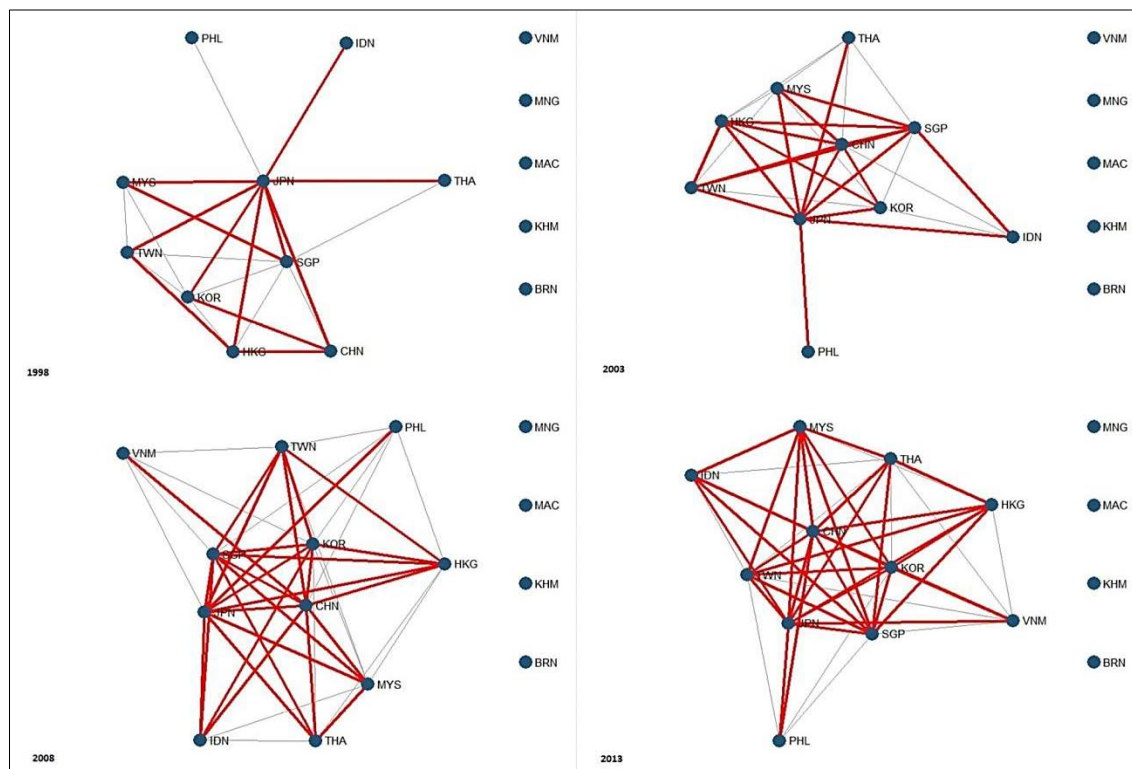
The role of Germany is clearly noticeable in Figure 2, as it is always the center of the network and has the most connections with other countries. Within the countries in the network, we can separate them visually into two groups. The first group consists of seven countries (Germany, France, the Netherlands, the United Kingdom, Italy, Belgium, and Spain) at the center of the network, with many red line connections with other countries. This is no surprise, as we expect these countries to have a large volume of trade with each other based on their economic size, proximity, and historical and cultural links. The second group is the countries that have mostly grey intermediate trade connections with others. The dynamics of the network through time show that there has been little change in these two groups. The core network trade is still happening between countries in the first group. Countries in the second group are linked to the network through their connection to one country, mostly Germany. The only countries that have shown significant changes in terms of moving closer to the center of the network in this period are Poland and Sweden. This confirms that trade flows in Europe follow the hub-and-spoke pattern (Johnson and Noguera 2012).

**Figure 2: Network of Intermediate Goods Trade in the EU  
(Trade Flows above 5 Billion and 10 Billion in Constant 2005 USD)**



Source: Authors' own illustration based on the data.

**Figure 3: Network of Intermediate Goods Trade in EA  
(Trade Flows above 5 Billion and 10 Billion in Constant 2005 USD)**



Source: Authors' own illustration based on the data.

Figure 3 shows that there were many changes in the network of intra-regional intermediate goods trade in EA during the 1998–2013 period. The role of Japan in the EA network in 1998 resembled that of Germany in the EU, as Germany was a hub linking all the other countries in the region. However, in later years, this was no longer the case, as countries like the PRC, Singapore, and the Republic of Korea moved closer to the center of the network. By 2013, the PRC, the Republic of Korea, and Japan were all acting as the center of the network, as the red line connections with most of the other economies in the region capture.

Another striking difference between EA and the EU is that the countries involved in the EA network trade with every country in the network, dominating with red line connections (above \$10 billion). Nine economies, namely Japan; the PRC; Hong Kong, China; the Republic of Korea; Indonesia; Thailand; Malaysia; Singapore; and Taipei, China are connected with a large flow of intermediate goods trade, especially since 2008. Viet Nam and the Philippines are the newcomers to the network and have shown a rapid increase in the intermediate trade value in recent years. Although the number of countries in the network did not change much during the period, the number of connections changed dramatically for some countries. Most notable are Indonesia and Thailand. Both countries started with only one significant trade flow with Japan in 1998 and had six flows in 2013. A similar change is observable for the Republic of Korea; Taipei, China; and Malaysia. This is very different from the EU, where the number of connections for countries was relatively stable. This shows that, during the period, the intermediate goods trade flow in the EU was between traditional partners, while, in EA, there was diversification of partners. All of this supports Baldwin and Lopez-Gonzalez's (2014) and

Kimura, Takahashi, and Hayakawa's (2007) argument that trade flows in the EA are more like a network than a hub-and-spoke pattern.

The final observation is the comparison of core groups in the network of EA and the EU. In the EU, the core group is the first group of seven countries, and, in EA, it is the nine countries mentioned above. The first difference, as noted earlier, is the vast changes in the number of connections for East Asian countries while European countries remained stable in the period. The second difference is that, while we expect a large trade volume between the seven economies in the EU, it is more of a surprise for the nine economies in EA, given the level of diversity between these countries. Despite their geographic proximity and cultural links, EA countries are different in terms of their economic size, level of income, geographic area, population, and so on. There are also tensions between some countries, both historically and presently. Unlike the EU, there is no regional institution to regulate trade flows, and only preferential trade agreements and regional policy coordination exist. Despite these, EA network trade is still growing and will continue to expand.

## 4. THE GRAVITY MODEL AND ECONOMETRIC METHOD

This paper based its econometric approach on Anderson and van Wincoop's (2003) gravity trade model, which has been the most successful in the empirical analysis of the determinants of bilateral trade. In this paper, the log-linear form of the pooled cross-section gravity equation of bilateral trade between exporter  $i$  and importer  $j$  is:

$$\ln(E_{ijt}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(Y_{jt}) + \alpha_3 \ln(d_{ij}) + \alpha_4 X_{ij} + \alpha_5 \ln(Rem_{ijt}) + F_t + \varepsilon_{ijt} \quad (1)$$

where  $E_{ij}$  is the value of exports from country  $i$  to country  $j$ ;  $Y_i$  and  $Y_j$  are the economic mass of countries  $i$  and  $j$ ; and  $d_{ij}$  is the distance between country  $i$  and country  $j$ , representing larger shipping expenses, cost of insurance, or freight charges when countries are physically further away from each other.  $Rem_{ij}$  is the remoteness of country pair  $i$  and  $j$  to account for the multilateral resistance terms.  $X_{ij}$  is a set of seven dummy variables, namely common border, colonial relationship, common colonizer, WTO membership, common language, same origin, and common regional trade agreements (RTAs) to account for the subjective bilateral resistance. The study performs the global export flow analysis using both total goods and intermediate goods as the dependent variable and includes all the above bilateral resistance variables. The regional analysis for EA and the EU concentrates only on the intermediate goods export flow and excludes WTO membership and common RTAs from the bilateral resistance variables. These estimations include a set of year-specific fixed effects ( $F_t$ ) to control for unexpected global variation during the period, such as the value of the US dollar, the global business cycle, and oil shocks.

Most gravity models so far have used a country's GDP as the standard proxy for the economic mass variable ( $Y_i$  and  $Y_j$ ). Baldwin and Taglioni (2011) argued that the GDP is a value-added measure and only takes into account the final goods and services, while the trade value is measured on a gross basis. The GDP is a good proxy for the demand of the destination country as well as the supply of the origin country if the consumer goods trade dominates. As trade in parts and components is becoming more important, the GDP of trading partners is losing its explanatory power, and the demand in third

countries should explain bilateral trade increasingly better. With this idea, the authors proposed a new way of accounting for the economic mass of trading partners. If the destination country of a bilateral trade flow is in the production network or supply chain, its imports are more often a function of its exports rather than its GDP. Thus, to proxy for the demand of the importing country, Baldwin and Taglioni (2011) proposed:

$$Y_j = GDP_j + \sum_{k \neq i, j} E_{kj}^{interm} \quad (1)$$

The gross expenditure of the importing country is the demand shifter of the bilateral trade flow, which consists of expenditure on both final goods and intermediate goods. To account for the demand of imported goods when trade in intermediate goods is becoming increasingly important, it is necessary to add the sum of imported intermediates to destination country  $j$  across all its partners  $k$  ( $E_{kj}^{interm}$ ) to the traditional GDP of destination country  $j$ . This implies that a destination country that imports more intermediate goods from different sources should have a larger economic mass. To avoid putting the bilateral trade flow from  $i$  to  $j$  on both sides of the estimation, the sum of imported intermediates to  $j$  excludes the flow from  $i$ .

Similarly, the total cost in the source country of the bilateral trade flow captures the gross output that it will produce. It is possible to separate this cost into the source country's value added in manufacturing and its purchases of intermediate inputs from all sources except itself:

$$Y_i = AV_i^{manuf} + \sum_{k \neq i} E_{ki}^{interm} \quad (2)$$

where  $AV_i^{manuf}$  is the source country's value added in manufacturing and  $E_{ki}^{interm}$  is its imports of intermediate inputs from all partners  $k$  except itself. The sum of foreign intermediate inputs and domestic value added in manufacturing represents the gross production possibility of the source country. Baldwin and Taglioni (2011) suggested that the use of the new proxy gives better results in capturing the demand and supply for intermediates than the traditional use of the GDP.

Anderson and van Wincoop (2003) suggested that trade between two countries depends on the bilateral barriers between them relative to the average trade barriers that they face with all other trading partners. These average trade barriers are called multilateral resistances. The authors proposed that the most efficient way to account for these terms is to use a custom non-linear least-squares (NLS) estimation technique. However, this technique proved to be too complicated for application in the gravity model. A more applicable method to account for multilateral resistance that studies have adopted widely (Rose and van Wincoop 2001; Baldwin and Taglioni 2006) is to use importer and exporter dummies or country fixed effects. By using this technique, the fixed-effect estimation will account for any country-specific factors that affect trade, including multilateral resistance and the country's economic mass.

The major drawback of fixed-effect estimation is the demolition of structure, as most variables of interest to economists or policy makers are country specific and the estimation will omit them. To overcome this problem, economists have suggested the use of different proxies or approximations for the multilateral resistance terms. The most popular way of accounting for the third-country effect on bilateral trade flows has been to use remoteness. This paper uses three specifications of remoteness, which it denotes as *Rem1*, *Rem2*, and *Rem3*, respectively. These different specifications of remoteness all capture the average distance from country pair *ij* to another trading partner *k* but use different output weights. The intuition behind this is the use of the weighted economic distance, with the inclusion of the economic mass or output as the weights. The idea is that a larger trading partner will have a bigger impact on the value of remoteness of a country.

The first measure of remoteness (*Rem1*) follows Melitz (2007):

$$Rem1_{ij} = \left( \sum_{k=1, k \neq j} \frac{Y_k}{Y_w} * d_{ik}} \right) \left( \sum_{m=1, m \neq i} \frac{Y_m}{Y_w} * d_{mj} \right) \quad (3)$$

where *Rem1<sub>ij</sub>* is the remoteness of country pair *ij*, *Y<sub>k</sub>* (*Y<sub>m</sub>*) is the economic mass of partner *k* (*m*), *Y<sub>w</sub>* is the total economic mass of all the other trading partners, and *d<sub>ik</sub>* (*d<sub>mj</sub>*) is the distance from country *i* (*j*) to partner *k* (*m*). The study derives *Y<sub>k</sub>*, *Y<sub>m</sub>*, and *Y<sub>w</sub>* based on equations (2) and (3).

The second measure of remoteness (*Rem2*), as equation (5) expresses, is called the output-weighted measure of remoteness by Baier and Bergstrand (2002). Using Anderson and van Wincoop's (2003) formula for multilateral resistance, Baier and Bergstrand (2002) proposed to proxy for the multilateral resistance terms by normalizing prices and gross tariffs to unity and using the GDP as a proxy for the number of varieties of goods and bilateral distance as a proxy for the transport cost.

$$Rem2_{ij} = \left\{ \sum_{k=1, k \neq j} Y_k d_{ik}^{1-\delta} \right\}^{\frac{1}{1-\delta}} \left\{ \sum_{m=1, m \neq i} Y_m d_{mj}^{1-\delta} \right\}^{\frac{1}{1-\delta}} \quad (4)$$

where *Y<sub>k</sub>* and *Y<sub>m</sub>* are the economic mass based on equations (2) and (3) and the elasticity of substitution ( $\delta$ ) is arguably 4. *Rem2* still resembles the remoteness variable, as the study calculates it based on the gross output and distance of all the trading partners. The advantage of *Rem2* over *Rem1* is that it derives from a theoretical model using some simplification techniques rather than purely an intuitive measure, like *Rem1*.

The final measure of remoteness (*Rem3*) follows Baier and Bergstrand (2009) by using Taylor series approximation. To avoid a non-linear procedure, the study calculates multilateral resistance through linear approximation using information on all bilateral resistance:

$$\begin{aligned}
MRW_{ij} = & \left[ \sum_{k=1, k \neq j} \theta_k \ln(d_{ik}) + \sum_{m=1, m \neq i} \theta_m \ln(d_{mj}) \right. \\
& \left. - \sum_{k=1} \sum_{m=1} \theta_k \theta_m \ln(d_{mk}) \right] \\
& + \left[ \sum_{k=1, k \neq j} \theta_k X_{ik} + \sum_{m=1, m \neq i} \theta_m X_{mj} - \sum_{k=1} \sum_{m=1} \theta_k \theta_m X_{mk} \right] \\
= & MRd_{ij} + MRX_{ij}
\end{aligned} \tag{5}$$

where the subscripts denote countries,  $MRW$  is the world multilateral resistance of bilateral trading partners  $i$  and  $j$ ,  $d$  is distance,  $X$  is the set of bilateral trade resistance, and  $\theta$  is the share of the country's GDP in the world GDP. The study applies the approximation procedure to all of the observable factors of bilateral trade resistance, and the approximation for each factor is similar to the expression in square brackets in equation (6). The approximation closely resembles the use of remoteness with the inclusion of the distance to other trading partners and the share of output as the weight. The first set of square brackets in equation (6) is similar to  $Rem1$  and  $Rem2$  and is called the multilateral distance ( $MRd_{ij}$ ). The difference of this approach from the previous use of remoteness is that previous research only accounted for multilateral distance and ignored other multilateral effects, which equation (6) denotes as  $MRX_{ij}$ . This analysis defines  $Rem3$  as the multilateral distance  $MRd_{ij}$ .

$$\begin{aligned}
Rem3_{ij} = MRd_{ij} = & \sum_{k=1, k \neq j} \theta_k \ln(d_{ik}) + \sum_{m=1, m \neq i} \theta_m \ln(d_{mj}) \\
& - \sum_{k=1} \sum_{m=1} \theta_k \theta_m \ln(d_{mk})
\end{aligned} \tag{6}$$

Appendix 3 describes the detailed estimation forms and techniques. Model (a) is the traditional panel data model, without accounting for the effect of multilateral resistance. The other specifications control for multilateral resistance using different approaches. Model (b) uses the fixed exporter time and fixed importer time effects; models (c) and (d) use  $Rem2$ ; models (e) and (f) use  $Rem1$ ; and model (g) uses  $Rem3$ . The study uses the random effect instead of the pair fixed effect, because the purpose of the analysis is to compare the impact of bilateral trade determinants, which a fixed-effect model would omit. The GLS random-effect model requires the treatment of the  $\varepsilon_{ijt}$  term as a random variable and the assumption that there is no correlation between  $\varepsilon_{ijt}$  and other explanatory variables. For these models, some weaknesses must be mentioned. First, using random-effect estimation poses a risk that some explanatory variables may be correlated with the bilateral random effect. Second, as Anderson and van Wincoop (2003) stated, remoteness indexes have only a low correlation with multilateral resistance and are not in conformity with the theory. Thus, they can introduce a bias. Even so, remoteness still captures some of the multilateral resistance effects and provides an intuitive explanation.

## 5. DISCUSSION OF THE RESULTS

The data used in this research cover the time period 1998 to 2013 for 143 countries around the world. Appendix 2 provides a description of the variables that the analysis uses. The EU consists of 28 countries and the EA contains 15 economies (Table 2Table 2).

**Table 2: Regional Country Groupings**

Region	Countries
EU	Austria; Belgium; Bulgaria; Croatia; Cyprus; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hungary; Ireland; Italy; Latvia; Lithuania; Luxembourg; Malta; the Netherlands; Poland; Portugal; Romania; Slovakia; Slovenia; Spain; Sweden; the United Kingdom
EA	Brunei Darussalam; Cambodia; Hong Kong, China; Macau, China; Indonesia; Japan; Malaysia; Mongolia; the People's Republic of China; the Philippines; the Republic of Korea; Singapore; Taipei,China; Thailand; Viet Nam

### 5.1 Determinants of Total Goods and Intermediate Goods Exports: Global Analysis

Table 3 reports the estimation results for both total and intermediate goods export flows, using the whole sample, *Rem1*, and *Rem3*. However, correlated estimation errors may accompany the separate estimation of total goods and intermediate goods. That is, unobservable factors, such as non-tariff barriers, may simultaneously affect both final goods and intermediate goods exports. Therefore, random effect estimation is preferable to pooled OLS and is generally more efficient. For complete results of all the specifications, refer to Appendix 4. Each model specification shows the result of a system of equations for bilateral exports in total goods and in intermediate goods. To test whether total goods and intermediate products have different export patterns, the study performs the Wald test of the null hypothesis that all the coefficients are identical in both equations. The results of the test show that the estimated coefficients for intermediate goods exports are different from those for total goods exports. While the absolute value of the difference may be small, it is statistically significant.

Although the estimated coefficients differ in size between specifications, the significance and expected signs are consistent. Overall, the distance between trading partners reduces the export value, representing the impact of trade costs. Other trade determinants all have a positive impact on export flows, as the theory suggests. Neighboring countries are likely to trade more with each other. Historical and social links, such as a colonial relationship, similar spoken languages, and being part of the same country at some point in time, lead to a higher export value for both total goods and intermediate goods. Different specifications of remoteness also have significant and positive effects on trade flows. This shows that, as a country pair becomes further away from the rest of its trading partners, the export value between the pair increases.

**Table 3: Impact of Trade Determinants on Total Goods and Intermediate Goods Export Flows**



	(1)			(2)		
	Total	Intermediate	Difference	Total	Intermediate	Difference
$Y_i$	1.193*** (0.009)	1.226*** (0.009)	0.033*** (0.001)	1.325*** (0.008)	1.369*** (0.009)	0.045*** (0.004)
$Y_j$	0.945*** (0.008)	0.965*** (0.009)	0.020*** (0.001)	0.991*** (0.008)	1.045*** (0.009)	0.054*** (0.004)
$d_{ij}$	-1.347*** (0.025)	-1.400*** (0.028)	-0.053*** (0.001)	-1.152*** (0.023)	-1.239*** (0.026)	-0.087*** (0.010)
$contig_{ij}$	1.010*** (0.127)	1.186*** (0.138)	0.176*** (0.005)	0.820*** (0.128)	0.963*** (0.141)	0.143*** (0.033)
$colony_{ij}$	1.256*** (0.120)	1.301*** (0.127)	0.045*** (0.005)	0.825*** (0.111)	0.887*** (0.123)	0.062 (0.038)
$comcol_{ij}$	0.473*** (0.073)	0.448*** (0.080)	-0.025*** (0.003)	0.774*** (0.075)	0.836*** (0.083)	0.062* (0.032)
$WTO\_both_{ij}$	0.151*** (0.024)	0.227*** (0.027)	0.076*** (0.002)	1.034*** (0.106)	1.243*** (0.120)	0.208*** (0.047)
$comlang_{ij}$	0.622*** (0.051)	0.575*** (0.057)	-0.047*** (0.002)	0.750*** (0.052)	0.705*** (0.059)	-0.045* (0.023)
$smctry_{ij}$	0.659*** (0.181)	0.716*** (0.187)	0.057*** (0.006)	0.651*** (0.178)	0.753*** (0.192)	0.102*** (0.039)
$RTA_{ij}$	0.280*** (0.024)	0.337*** (0.029)	0.057** (0.002)	0.653*** (0.051)	0.613*** (0.057)	-0.039* (0.022)
$Rem_{ij}$	0.711*** (0.056)	0.821*** (0.063)	0.110*** (0.003)	0.223*** (0.013)	0.263*** (0.015)	0.039*** (0.006)
Cons	-37.371*** (1.035)	-41.081*** (1.166)		-32.328*** (0.381)	-35.235*** (0.428)	
N	192,869	192,869		192,869	192,869	
R2	0.6747	0.6303		0.707	0.662	

Notes: Standard errors in brackets. \*, \*\*, and \*\*\* indicate significance at the levels of 10%, 5%, and 1%. Models (1) and (2) correspond to models (f) and (g) in Appendix 4.

Source: Authors' own estimates.

The comparison between the estimates for intermediate and total exports is somewhat consistent with the findings of Bergstrand and Egger (2010): the coefficients do not vary much between the goods. However, this variation is statistically significant, with an increase in most of the estimates moving from total goods exports to intermediate goods exports. This suggests that the market size, distance between two countries, both being WTO members, and sharing the same border or country origin are more important for conducting trade in intermediate goods than trade in total goods. Another variable of interest, remoteness, also has greater importance for intermediate exports than for total exports, which the larger effect of remoteness for intermediate goods exports captures. As distance and remoteness jointly show the impact of overall distance, this is an expected result. The results here support the arguments that intermediate goods exports are more sensitive to trade barriers than total goods exports, as the previous literature has mentioned (Gamberoni et al. 2010; Harrigan and Venables 2006), partly justifying why regional blocks form production networks. This has implications for developing countries to implement liberalization trade policies in order to join and benefit from international production networks.

## 5.2 Determinants of Intermediate Goods Exports in EA and the EU: Intra-regional Analysis

The next step in the analysis is the comparison of export determinants between EA and the EU. Given the discussion on the determinants of intermediate exports and total exports, as well as the fact that trade in intermediate goods has a bigger role in EA, the hypothesis is that export determinants have a larger effect in EA than in the EU. To examine the trade determinants in each region, the study estimates gravity models for intra-regional intermediate exports in EA and the EU. Since remoteness is one of the variables of interest, it uses the model specification with different types of remoteness. There are three points to mention here concerning this regional analysis. First, the pooled OLS method is now preferable to the random-effect model because, in intra-regional analysis, specific regional factors, which are not random, affect bilateral flows more. Second, the estimation for intra-regional export flows excludes WTO membership and a trade agreement link between two countries. This is because the bias of signing a trade agreement between countries is a much bigger concern at the regional level than it is at the global level. Third, although the estimation is only for intra-regional flows, the study puts the remoteness of each bilateral pair in the context of global trade. The analysis considers the intra-regional export flows only, but the remoteness still reflects the overall distance of exporting and importing countries from all of their trading partners, not just other partners in the same region.

To compare the impact of intermediate trade determinants in EA and the EU, the study draws a subset of global export flows to include only intra-regional exports in these two regions. It pools data for intra-regional intermediate exports in EA and the EU in one single regression, with the inclusion of an interaction term to make a direct comparison:

$$\ln(E_{ijt}) = \text{const} + \alpha X_{ijt} + \beta(EA * X_{ijt}) + \varepsilon_{ijt} \quad (7)$$

where  $\alpha$  shows the impact of trade determinants  $X$  on the base region (EU),  $\beta$  indicates whether the impact of these determinants  $X$  is different in the other region (EA), and  $\alpha + \beta$  is the impact of trade determinants  $X$  in EA.<sup>4</sup> The interaction term applies to each trade determinant  $X_{ij}$ .

Table 4 reports the impact of trade determinants on intra-EU and intra-EA bilateral intermediate exports.<sup>5</sup> The significance level of  $\alpha + \beta$  is based on the joint significance test. With the exclusion of trade policy variables, the analysis of the impact in the two regions focuses on the distance, adjacency, and remoteness of trading partners. As expected, the gravity model does not perform as well at the regional level as it does at the global level. Colonial links, a common language, and the same country of origin show less significant impacts across different specifications compared with the study at the global level.

<sup>4</sup> The estimation assumes that the same intercept affects the export flows in both regions. The estimates of the interaction terms for each trade determinant variable will capture any difference between EA and the EU.

<sup>5</sup> For the full set of results for all the model specifications, refer to Appendix 5.

**Table 4: Impact of Trade Determinants on Intermediate Goods Exports in EA and the EU**

	(3)			(4)			(5)		
	EU	Difference	EA	EU	Difference	EA	EU	Difference	EA
$Y_i$				1.298*** (0.031)	0.191*** (0.073)	1.489*** (0.069)	1.437*** (0.036)	0.024 (0.052)	1.461*** (0.061)
$Y_j$				0.938*** (0.023)	0.177*** (0.057)	1.115*** (0.054)	1.057*** (0.030)	0.052 (0.043)	1.109*** (0.045)
$d_{ij}$	-1.202*** (0.091)	0.440** (0.222)	-0.762*** (0.202)	-1.237*** (0.096)	0.241 (0.223)	-0.997*** (0.202)	-1.077*** (0.094)	0.072 (0.188)	-1.005*** (0.165)
$contig_{ij}$	0.161 (0.183)	1.051** (0.462)	1.212*** (0.424)	0.175 (0.203)	0.751* (0.423)	0.926** (0.369)	0.337** (0.172)	0.535 (0.402)	0.873** (0.363)
$colony_{ij}$	0.781*** (0.293)	-0.403 (0.853)	0.378 (0.801)	0.586** (0.242)	-0.858 (0.678)	-0.271 (0.635)	0.702** (0.272)	-0.549 (0.835)	0.154 (0.791)
$comcol_{ij}$	2.638*** (0.330)	-2.519*** (0.532)	0.119 (0.417)	2.703*** (0.747)	-1.724** (0.869)	0.979** (0.439)	3.217*** (0.510)	-2.903*** (0.688)	0.314 (.463)
$comlang_{ij}$	0.325 (0.333)	-0.212 (0.425)	0.114 (0.263)	0.088 (0.268)	0.465 (0.418)	0.553* (0.320)	0.231 (0.280)	-0.382 (0.411)	-0.151 (0.299)
$smctry_{ij}$	0.37 (0.244)	0.229 (0.637)	0.599 (0.589)	0.277 (0.260)	-0.476 (0.604)	-0.199 (0.543)	0.184 (0.245)	0.335 (0.640)	0.519 (0.589)
$Rem_{ij}$				1.854*** (0.497)	-0.675*** (0.167)	1.178*** (0.422)	0.738*** (0.108)	-0.395*** (0.118)	0.343*** (0.094)
Cons				-60.376*** (8.292)			-41.500*** (2.004)		
N	13,747			13,747			13,747		
R2	0.909			0.833			0.853		

Notes: Standard errors in brackets. \*, \*\*, and \*\*\* indicate significance at the levels of 10%, 5%, and 1%. Models (3), (4), and (5) correspond to models (b), (e), and (g) in Appendix 5.

Source: Authors' own estimates.

The first comparison between the two regions is the impact of economic mass on intermediate export flows. Although the estimates for economic mass in EA have larger values than those in the EU, this difference is not always statistically significant. The implication is that economic size contributes to trade promotion at least as much in EA as it does in the EU, if not more. This in part helps to explain why the export values in EA have reached the same level as in the EU, despite the smaller economic size of the trading partners. We observe that, given the same size of trading partners, the intermediate export flows are larger in EA than those in the EU.

The second important comparison between the two regions is the size of the coefficients for distance and the interaction term. As mentioned, we expect EA intra-regional exports to exhibit a significantly larger negative impact of distance as a result of a larger share of the intermediate export value. Interestingly, the results in Table 4 do not show any statistical differences between EA and the EU. The  $\beta$  for the distance interaction term is insignificant across all models except (3). When it is significant in model (3), the estimated coefficient for distance in EA is actually smaller than that in the EU. The recent reductions in the transportation cost in EA can partly explain this unexpected result.

The transportation cost is directly related to the physical distance between trading partners. The main method of transportation of goods remains maritime shipping, as the international shipping industry carries approximately 90% of world trade in terms of volume. Ducruet and Notteboom (2012) showed that, during the period 1996–2006, there was a rapid increase in the number of ports with high connectivity in EA, particularly in

the PRC. These ports provide the cheapest method of transportation, especially for the high weight-to-value type of goods, reducing the transportation cost in EA. In 2008, the economies of the PRC; Singapore; Hong Kong, China; and the Republic of Korea accounted for 38% of the world's container port traffic. By 2012, of the top ten world ports in terms of container traffic, eight were located in EA, specifically five in the PRC and one each in Singapore; Hong Kong, China; and the Republic of Korea.<sup>6</sup> These ports provide the cheapest method of transportation, especially for the high weight-to-value type of goods. For products that have high value and low volume (low weight-to-value) or require timely delivery, air transportation is a better alternative. During the period 1998–2013, the air transport freight volume increased consistently in the EA countries but remained stable in the EU countries. This trend could help to reduce the effect of distance on trade in some intermediate goods associated with fragmentation, which delivery dates or storage costs constrain (Hummels and Schaur 2013). These changes in transportation cost have helped EA to overcome the barrier of physical distance more efficiently, at least for intra-regional trade flows.

The third comparison is the difference in the impact of adjacency between two regions. While the effect on export flows is significantly large for neighboring countries in EA, this border effect is insignificant in the EU. The effect of contiguity may extend beyond geographic distance and provide the implication for the impact of psychic distance (Johanson and Vahlne 1977) or the sum of factors preventing or disturbing the flows of information between markets. As a more homogeneous region, countries in the EU will have a smaller psychic distance or more similarities in culture, tradition, and religion without having to share a common border. On the contrary, countries in EA are more likely to share these commonalities if they are neighbors. According to the estimation results of distance and contiguity, it is arguable that the impact of geographic distance on intermediate exports is similar in EA and the EU, while psychic distance (or economic closeness) plays a more important role in EA.

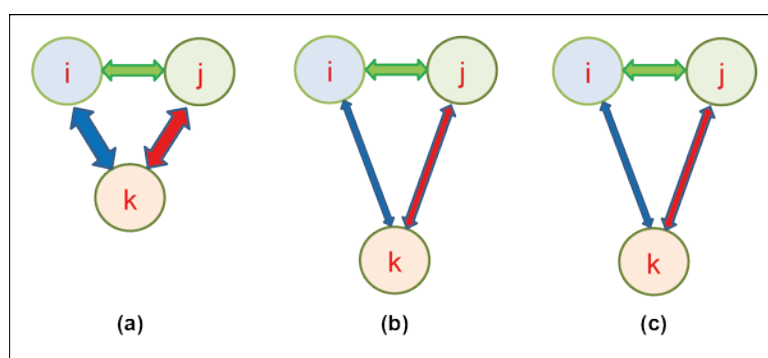
Lastly, the estimation shows different impacts of remoteness in the two regions. Remoteness is a variable that represents the third-country effect or overall distance effect or acts as a proxy for the multilateral resistance effect. In the regional analysis, remoteness may also provide implications for cross-regional interdependence in trade. With the economic rise of Asia, particularly EA, there has been a discussion about the economic “decoupling” of EA from other regions, especially the EU and the US. Some have argued that, although intra-regional trade in EA has increased over the years, the region still depends heavily on extra-regional trade in final goods (Athukorala 2011). Others have pointed out that EA has shown signs of diversified export markets, so its dependence on the US market has declined (Park and Shin 2009; Ando 2010).

The regional interdependence provides several expected impacts of remoteness on intra-regional export flows. If trade in intermediate goods between country  $i$  and country  $j$  is dependent on a third country  $k$  in a triangular trade model (Takeuchi 2011), then the increase in remoteness of a country pair  $ij$  ( $Rem_{ij}$ ) has two opposite effects. The first effect is an increase in trade between  $i$  and  $j$  because of the lack of other options. The second effect is the reduction of trade in intermediate goods because of the fall in demand for final goods from country  $k$ , reducing the demand for all products in the supply chain. Thus, remoteness should have a smaller effect when  $i$  and  $j$  are dependent on  $k$  than when  $i$  and  $j$  are independent from  $k$ . Figure 4 illustrates these effects. Figure 4c shows that  $i$  and  $j$  are more dependent on  $k$  than they are in Figure 4b, leading to a smaller increase in bilateral trade flows when the remoteness of the pair rises relative to the initial state in Figure 4a. In the traditional trade model,

<sup>6</sup> Source: The *Journal of Commerce's* annual top 50 world container ports.

in which final goods dominate, remoteness has a positive and significant expected outcome. In the triangular trade model, in which intermediate goods are important, remoteness may have more than one expected outcome. If the second effect of trade reduction is large enough, the overall effect of remoteness could be insignificant or even negative, although this is very unlikely to happen.

**Figure 4: Two Opposite Effects of Remoteness on Intra-regional Exports in Intermediate Goods**



Source: Author's own illustration.

The estimation in Table 4 shows that the coefficient for remoteness in EA is significantly smaller than that in the EU. Remoteness has a positive and significant effect in both EA and the EU, suggesting that countries in the same region trade more with each other in intermediate goods when they become more remote. The smaller value of the coefficient for remoteness in EA may indicate that EA is more dependent on outside regions than the EU. When trading partners in EA become more remote from other countries, they increase their trade with each other, but this increase is smaller than economies in the EU would experience given the same situation. This shows that countries in EA depend more on third countries' demand for final goods in other regions. When EA countries become more remote, they reduce the trade in final goods with the third country and consequently decrease the demand for intermediate goods trade between each other. As remoteness is not just a measure of geographic distance but also considers the weight of economic activities, the same mechanism would apply when the third country's economic condition deteriorates.

One final point worth noting regarding the use of remoteness for regional analysis is that remoteness still represents the overall distance, regardless of whether third country  $k$  is in the same region as  $i$  and  $j$  or in another region. The conclusion would be much clearer if it was possible to make a distinction between an internal third-country effect ( $k$  is in the same region as  $i$  and  $j$ ) and an external third-country effect ( $k$  is in a different region from  $i$  and  $j$ ). Nevertheless, this paper shows that remoteness in the context of intra-regional trade analysis is more likely to show the external third-country effect. The first reason is the number of trading partners that the analysis uses to construct remoteness. The number of trading partners outside the region is much larger than the number from the same region. For example, in 2010, 28 countries in the EU traded with a minimum of 144 countries (Croatia) to a maximum of 184 countries (France, Germany). These numbers for the 15 countries in EA were 130 (Singapore) and 184 (the PRC, Japan), except for Macau, China, which traded with only 70 partners. The second reason is that remoteness is more sensitive to changes in the countries outside the region. When measuring remoteness as a weighted average using the economic share of a trading partner as the weight, it will increase more when a more

distant country (outside of the region) gains 1% of the weight than when a nearby country (within same region) gains the same amount.

In conclusion, the different impacts of remoteness on intermediate exports in EA compared with the EU implies that export flows in EA are more dependent on other regions' economic conditions than export flows in the EU are. This result is in accord with the view of Athukorala (2011), who argued that, due to the rise of global production sharing, the export dynamism of EA countries has become more dependent on the global economy. This helps to explain the mechanism through which trade contraction spread in EA during the GFC, even though the source of the crisis was North America and Europe. It shows that EA is still vulnerable to global shocks, but this vulnerability does not necessarily affect EA's ability to overcome these shocks. The fact that EA has recovered from the GFC better than other regions shows that the EA region had diversified the export markets to withstand economic shocks better but not enough to be disconnected from these shocks, as the "decoupling" theory suggests.

### 5.3 Robustness Checks

Recently, one of the most discussed issues regarding the estimation of gravity models for international trade flows has been the problem of zero trade flows. As studies have often used the log-linear approach for the estimation of gravity trade models, they have had to drop zero trade flows from the sample. Zero trade flows may represent two situations, namely missing observations that are wrongly reported as zeros and actual zero trade flows. In the second situation, estimates of a log-linear gravity model might lead to inconsistent results, showing the impact of the determinants on existing trade flows rather than the determinants of trade formation. For example, if the excluded zero trade was a result of a prohibitive transport cost (due to distance or a lack of commonalities) or a small economic mass of trading partners, then there will be a loss of useful information in the estimated sample. One of the ways to address this selection bias problem is to use the Poisson pseudo-maximum likelihood (PPML) method, which allows for easy incorporation of zero trade flows.

For the analysis in this study, the problem of zero trade flows is not the biggest concern. The comparison made between the determinants of total goods and intermediate goods trade flows is still possible for the positive trade flows only. It shows how the trade determinants differ between intermediate goods and total goods for those countries that have trade relations. The regional analysis of EA and the EU does not face this problem at all, as all intra-regional export flows are positive. As a robustness check, this research provides the PPML results for the comparison between determinants of intermediate and total goods flows in Appendix 6. It implements the technique by using the Stata command *ppml* by Santos Silva and Tenreyro (2010). Apart from dealing with the zero trade flows problem, PPML provides more robust results in the presence of heteroskedasticity, which is usual in trade data. The results show that all the variables but WTO membership have the expected impacts. Most of the estimates confirm the increasing importance moving from total goods to intermediate goods exports, such as the impact of distance, colonial links, a common language, and remoteness. Although the effects of adjacency and economic mass are still positive and significant, not all the model specifications show the increased impact on intermediate goods exports.

## 6. CONCLUSION

This paper analyzed the change in the impact of trade determinants due to the fragmentation of production. The analysis of intermediate goods and total goods trade showed that exports in intermediate goods are more sensitive to trade barriers than total goods exports. The greater sensitivity of intermediate goods trade to distance, contiguity, and remoteness could justify why regional blocks form production networks. The increasing share of intermediate goods trade may also be responsible for the large impact of distance on trade despite all the advances in transportation, communication, and information technology. The large impacts of other sociocultural and historical linkages and policy variables on intermediate exports indicate the importance of more open trade policies for countries that aim to join and develop a production network. The larger influence of remoteness on intermediate goods trade is an indication that the bilateral trade relation within a production network is more sensitive to the third-country effect.

In addition, this paper focused on the comparison between EA and the EU as different sociocultural, political, historical, and institutional factors guide the production networks in these two regions. The impact of distance on intra-regional intermediate exports in EA is not significantly different from that in the EU, showing the result of reduced service link costs in EA to approach the efficiency level in the EU. The contrasting effect of the estimated coefficient for contiguity indicates that psychic distance plays a more significant role in EA than in the EU. Lastly, the effect of remoteness that the regional analysis observed signals regional interdependence. The fact that EA shows a significantly smaller effect of remoteness implies that the region is more dependent on other regions' economic conditions than the EU is.

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## APPENDIX 1: CLASSIFICATION FOR INTERMEDIATE AND TOTAL GOODS

Classification	BEC Categories
Intermediate goods	111 – Primary food and beverages, mainly for industry 121 – Processed food and beverages, mainly for industry 21 – Primary industrial supplies not elsewhere specified 22 – Processed industrial supplies not elsewhere specified 32 – Processed fuels and lubricants 42 – Parts and accessories of capital goods (except transport equipment) 53 – Parts and accessories of transport equipment
Total goods	Total of all BEC categories

## APPENDIX 2: VARIABLE DESCRIPTION

Variables	Description
$E_{ij}$	Intermediate goods/total goods export flow from exporting country $i$ to importing country $j$
$Y_i$	Economic mass of exporting country $i$ , as equation (2) expresses
$Y_j$	Economic mass of importing country $j$ , as equation (3) expresses
$d_{ij}$	Geographic distance from country $i$ to country $j$ (most populated city)
$contig_{ij}$	Dummy variable for contiguity
$colony_{ij}$	Dummy variable for pairs of countries ever in a colonial relationship
$comcol_{ij}$	Dummy variable for a common colonizer post-1945
$WTO\_both_{ij}$	Dummy variable for GATT/WTO membership of both $i$ and $j$
$comlang_{ij}$	Dummy variable for a common language (spoken by at least 9% of the population)
$smctry_{ij}$	Dummy variable for the same country origin
$RTA_{ij}$	Dummy variable for a common regional trade agreement in force
$Rem_{ij}$	Remoteness of bilateral trade partners $i$ and $j$ from the rest of their trading partners, as equations (4), (5), and (7) express

## APPENDIX 3: MODEL SPECIFICATIONS

Models	Estimation Method	Estimation Form
(a)	Pooled OLS	$\ln(E_{ijt}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(Y_{jt}) + \alpha_3 \ln(d_{ij}) + \alpha_4 \text{contig}_{ij} + \alpha_5 \text{colony}_{ij} + \alpha_6 \text{comcol}_{ij} + \alpha_7 \text{WTO\_both}_{ijt} + \alpha_8 \text{comlang}_{ij} + \alpha_9 \text{smctry}_{ij} + \alpha_{10} \text{RTA}_{ijt} + \varepsilon_{ijt}$
(b)	Pooled OLS, country–time FE	$\ln(E_{ijt}) = \alpha_0 + \alpha_1 \ln(d_{ij}) + \alpha_2 \text{contig}_{ij} + \alpha_3 \text{colony}_{ij} + \alpha_4 \text{comcol}_{ij} + \alpha_5 \text{WTO\_both}_{ijt} + \alpha_6 \text{comlang}_{ij} + \alpha_7 \text{smctry}_{ij} + \alpha_8 \text{RTA}_{ijt} + F_{it} + F_{jt} + \varepsilon_{ijt}$
(c)	Pooled OLS	$\ln(E_{ijt}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(Y_{jt}) + \alpha_3 \ln(d_{ij}) + \alpha_4 \text{contig}_{ij} + \alpha_5 \text{colony}_{ij} + \alpha_6 \text{comcol}_{ij} + \alpha_7 \text{WTO\_both}_{ijt} + \alpha_8 \text{comlang}_{ij} + \alpha_9 \text{smctry}_{ij} + \alpha_{10} \text{RTA}_{ijt} + \alpha_{11} \ln(\text{Rem2}_{ijt}) + F_t + \varepsilon_{ijt}$
(d)	GLS random effect	$\ln(E_{ijt}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(Y_{jt}) + \alpha_3 \ln(d_{ij}) + \alpha_4 \text{contig}_{ij} + \alpha_5 \text{colony}_{ij} + \alpha_6 \text{comcol}_{ij} + \alpha_7 \text{WTO\_both}_{ijt} + \alpha_8 \text{comlang}_{ij} + \alpha_9 \text{smctry}_{ij} + \alpha_{10} \text{RTA}_{ijt} + \alpha_{11} \ln(\text{Rem2}_{ijt}) + F_t + \varepsilon_{ijt}$
(e)	Pooled OLS	$\ln(E_{ijt}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(Y_{jt}) + \alpha_3 \ln(d_{ij}) + \alpha_4 \text{contig}_{ij} + \alpha_5 \text{colony}_{ij} + \alpha_6 \text{comcol}_{ij} + \alpha_7 \text{WTO\_both}_{ijt} + \alpha_8 \text{comlang}_{ij} + \alpha_9 \text{smctry}_{ij} + \alpha_{10} \text{RTA}_{ijt} + \alpha_{11} \ln(\text{Rem1}_{ijt}) + F_t + \varepsilon_{ijt}$
(f)	GLS random effect	$\ln(E_{ijt}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(Y_{jt}) + \alpha_3 \ln(d_{ij}) + \alpha_4 \text{contig}_{ij} + \alpha_5 \text{colony}_{ij} + \alpha_6 \text{comcol}_{ij} + \alpha_7 \text{WTO\_both}_{ijt} + \alpha_8 \text{comlang}_{ij} + \alpha_9 \text{smctry}_{ij} + \alpha_{10} \text{RTA}_{ijt} + \alpha_{11} \ln(\text{Rem1}_{ijt}) + F_t + \varepsilon_{ijt}$
(g)	Pooled OLS	$\ln(E_{ijt}) = \alpha_0 + \alpha_1 \ln(Y_{it}) + \alpha_2 \ln(Y_{jt}) + \alpha_3 \ln(d_{ij}) + \alpha_4 \text{contig}_{ij} + \alpha_5 \text{colony}_{ij} + \alpha_6 \text{comcol}_{ij} + \alpha_7 \text{WTO\_both}_{ijt} + \alpha_8 \text{comlang}_{ij} + \alpha_9 \text{smctry}_{ij} + \alpha_{10} \text{RTA}_{ijt} + \alpha_{11} \text{Rem3}_{ijt} + \alpha_{12} \text{MRcontig}_{ij} + \alpha_{13} \text{MRcolony}_{ij} + \alpha_{14} \text{MRcomcol}_{ij} + \alpha_{15} \text{MRWTO\_both}_{ijt} + \alpha_{16} \text{MRcomlang}_{ij} + \alpha_{17} \text{MRsmctry}_{ij} + \alpha_{18} \text{MRRTA}_{ijt} + F_t + \varepsilon_{ijt}$

## APPENDIX 4: IMPACT OF TRADE DETERMINANTS ON TOTAL GOODS AND INTERMEDIATE GOODS EXPORT FLOWS

	(a)		(b)		(c)		(d)	
	Tot	Int	Tot	Int	Tot	Int	Tot	Int
$Y_i$	1.221*** (0.007)	1.248*** (0.008)			1.300*** (0.007)	1.338*** (0.008)	1.182*** (0.009)	1.218*** (0.009)
$Y_j$	0.872*** (0.007)	0.906*** (0.008)			0.953*** (0.007)	0.998*** (0.008)	0.926*** (0.008)	0.947*** (0.009)
$d_{ij}$	-1.035*** (0.022)	-1.094*** (0.025)	-1.423*** (0.026)	-1.510*** (0.029)	-1.153*** (0.023)	-1.221*** (0.026)	-1.247*** (0.023)	-1.294*** (0.025)
$contig_{ij}$	1.168*** (0.120)	1.367*** (0.133)	0.605*** (0.146)	0.699*** (0.157)	0.885*** (0.126)	1.056*** (0.140)	1.133*** (0.126)	1.309*** (0.136)
$colony_{ij}$	0.867*** (0.108)	0.899*** (0.119)	0.868*** (0.117)	1.007*** (0.127)	0.837*** (0.111)	0.858*** (0.122)	1.188*** (0.119)	1.225*** (0.125)
$comcol_{ij}$	0.755*** (0.068)	0.765*** (0.077)	0.766*** (0.071)	0.808*** (0.076)	0.845*** (0.068)	0.872*** (0.076)	0.435*** (0.074)	0.405*** (0.081)
$WTO\_both_{ij}$	0.110*** (0.037)	0.202*** (0.042)	0.397*** (0.105)	0.501*** (0.117)	0.245*** (0.036)	0.358*** (0.041)	0.150*** (0.024)	0.230*** (0.027)
$comlang_{ij}$	0.749*** (0.047)	0.735*** (0.053)	0.622*** (0.051)	0.559*** (0.056)	0.651*** (0.046)	0.629*** (0.052)	0.724*** (0.051)	0.685*** (0.056)
$smctry_{ij}$	0.748*** (0.169)	0.881*** (0.180)	0.743*** (0.198)	0.807*** (0.213)	0.743*** (0.174)	0.876*** (0.187)	0.781*** (0.179)	0.855*** (0.186)
$RTA_{ij}$	0.470*** (0.049)	0.424*** (0.056)	0.402*** (0.053)	0.380*** (0.056)	0.539*** (0.047)	0.502*** (0.054)	0.269*** (0.024)	0.326*** (0.030)
$Rem_{ij}$					0.193*** (0.016)	0.209*** (0.018)	0.148*** (0.015)	0.186*** (0.017)
Cons	-26.532*** (0.319)	-28.581*** (0.357)	18.506*** (0.500)	17.683*** (0.573)	-27.842*** (0.340)	-30.101*** (0.378)	-24.198*** (0.388)	-25.874*** (0.413)
N	192,869	192,869	192,869	192,869	192,869	192,869	192,869	192,869
R2	0.68	0.63	0.776	0.743	0.703	0.656		

	(e)		(f)		(g)	
	Tot	Int	Tot	Int	Tot	Int
$Y_i$	1.309*** (0.007)	1.347*** (0.008)	1.193*** (0.009)	1.226*** (0.009)	1.325*** (0.008)	1.369*** (0.009)
$Y_j$	0.971*** (0.007)	1.017*** (0.008)	0.945*** (0.008)	0.965*** (0.009)	0.991*** (0.008)	1.045*** (0.009)
$d_{ij}$	-1.305*** (0.026)	-1.378*** (0.029)	-1.347*** (0.025)	-1.400*** (0.028)	-1.152*** (0.023)	-1.239*** (0.026)
$contig_{ij}$	0.697*** (0.127)	0.865*** (0.141)	1.010*** (0.127)	1.186*** (0.138)	0.820*** (0.128)	0.963*** (0.141)
$colony_{ij}$	0.988*** (0.114)	1.014*** (0.124)	1.256*** (0.120)	1.301*** (0.127)	0.825*** (0.111)	0.887*** (0.123)
$comcol_{ij}$	0.860*** (0.068)	0.889*** (0.076)	0.473*** (0.073)	0.448*** (0.080)	0.774*** (0.075)	0.836*** (0.083)
$WTO\_both_{ij}$	0.125*** (0.036)	0.231*** (0.041)	0.151*** (0.024)	0.227*** (0.027)	1.034*** (0.106)	1.243*** (0.120)
$comlang_{ij}$	0.482*** (0.047)	0.454*** (0.053)	0.622*** (0.051)	0.575*** (0.057)	0.750*** (0.052)	0.705*** (0.059)
$smctry_{ij}$	0.578*** (0.177)	0.704*** (0.190)	0.659*** (0.181)	0.716*** (0.187)	0.651*** (0.178)	0.753*** (0.192)
$RTA_{ij}$	0.530*** (0.047)	0.492*** (0.053)	0.280*** (0.024)	0.337*** (0.029)	0.653*** (0.051)	0.613*** (0.057)
$Rem_{ij}$	1.038*** (0.050)	1.091*** (0.056)	0.711*** (0.056)	0.821*** (0.063)	0.223*** (0.013)	0.263*** (0.015)
Cons	-46.485*** (0.886)	-49.727*** (0.993)	-37.371*** (1.035)	-41.081*** (1.166)	-32.328*** (0.381)	-35.235*** (0.428)
N	192,869	192,869	192,869	192,869	192,869	192,869
R2	0.707	0.66			0.707	0.662

Notes: Standard errors in brackets. \*, \*\*, and \*\*\* indicate significance at the levels of 10%, 5%, and 1%.

Source: Authors' own estimates.

## APPENDIX 5: IMPACT OF TRADE DETERMINANTS ON INTERMEDIATE GOODS EXPORT FLOWS IN EA AND THE EU USING POOLED REGRESSION

	(a)		(b)		(c)		(d)	
	$\alpha$	$\beta$	$\alpha$	$\beta$	$\alpha$	$\beta$	$\alpha$	$\beta$
$Y_i$	1.272*** (0.029)	0.032 (0.060)			1.319*** (0.031)	0.062 (0.062)	1.139*** (0.033)	0.165*** (0.064)
$Y_j$	0.929*** (0.023)	0.019 (0.048)			0.970*** (0.024)	0.059 (0.050)	0.979*** (0.030)	-0.193*** (0.064)
$d_{ij}$	-1.015*** (0.094)	-0.1 (0.255)	-1.202*** (0.091)	0.440** (0.222)	-1.061*** (0.103)	-0.042 (0.272)	-1.210*** (0.104)	0.508** (0.210)
$contig_{ij}$	0.401** (0.196)	0.333 (0.360)	0.161 (0.183)	1.051** (0.462)	0.269 (0.209)	0.367 (0.432)	0.351* (0.208)	0.491 (0.392)
$colony_{ij}$	0.611** (0.258)	-0.625 (0.532)	0.781*** (0.293)	-0.403 (0.853)	0.598** (0.265)	-1.108* (0.584)	0.584** (0.247)	-0.085 (0.451)
$comcol_{ij}$	2.659*** (0.627)	-1.793** (0.743)	2.638*** (0.330)	-2.519*** (0.532)	2.929*** (0.680)	-1.977** (0.806)	2.575*** (0.571)	-1.681** (0.710)
$comlang_{ij}$	0.184 (0.273)	0.591 (0.443)	0.325 (0.333)	-0.212 (0.425)	0.174 (0.286)	0.785* (0.442)	0.144 (0.276)	1.159*** (0.442)
$smctry_{ij}$	0.403 (0.254)	-0.542 (0.508)	0.37 (0.244)	0.229 (0.637)	0.484* (0.260)	-0.684 (0.643)	0.059 (0.260)	0.079 (0.510)
$Rem_{ij}$					0.045 (0.057)	0.461*** (0.141)	-0.079 (0.071)	0.504*** (0.102)
Cons	-29.717*** (1.338)				-30.811*** (1.551)		-27.189*** (1.503)	
N	13,747		13,747		13,747		13,747	
R2	0.812		0.909		0.833			

	(e)		(f)		(g)	
	$\alpha$	$\beta$	$\alpha$	$\beta$	$\alpha$	$\beta$
$Y_i$	1.298*** (0.031)	0.191*** (0.073)	1.213*** (0.037)	0.139** (0.059)	1.437*** (0.036)	0.024 (0.052)
$Y_j$	0.938*** (0.023)	0.177*** (0.057)	1.047*** (0.034)	-0.221*** (0.068)	1.057*** (0.030)	0.052 (0.043)
$d_{ij}$	-1.237*** (0.096)	0.241 (0.223)	-1.227*** (0.099)	0.342 (0.274)	-1.077*** (0.094)	0.072 (0.188)
$contig_{ij}$	0.175 (0.203)	0.751* (0.423)	0.217 (0.207)	0.644* (0.382)	0.337** (0.172)	0.535 (0.402)
$colony_{ij}$	0.586** (0.242)	-0.858 (0.678)	0.546** (0.251)	0.256 (0.559)	0.702** (0.272)	-0.549 (0.835)
$comcol_{ij}$	2.703*** (0.747)	-1.724** (0.869)	2.900*** (0.694)	-2.149*** (0.832)	3.217*** (0.510)	-2.903*** (0.688)
$comlang_{ij}$	0.088 (0.268)	0.465 (0.418)	0.147 (0.278)	0.722 (0.461)	0.231 (0.280)	-0.382 (0.411)
$smctry_{ij}$	0.277 (0.260)	-0.476 (0.604)	0.31 (0.272)	-0.017 (0.476)	0.184 (0.245)	0.335 (0.640)
$Rem_{ij}$	1.854*** (0.497)	-0.675*** (0.167)	1.707*** (0.317)	-0.081 (0.144)	0.738*** (0.108)	-0.395*** (0.118)
Cons	-60.376*** (8.292)		-59.752*** (6.110)		-41.500*** (2.004)	
N	13,747		13,747		13,747	
R2	0.833				0.853	

Notes: Standard errors in brackets. \*, \*\*, and \*\*\* indicate significance at the levels of 10%, 5%, and 1%.  $\alpha$  shows the impact of trade determinants in the base region (EU);  $\beta$  indicates whether the impact of these determinants is different in the other region (EA).

Source: Authors' own estimates.



## APPENDIX 6: IMPACT OF TRADE DETERMINANTS ON TOTAL GOODS AND INTERMEDIATE GOODS EXPORT FLOWS USING THE PPML ESTIMATION TECHNIQUE

	(a)		Rem2 (c) (d)		Rem1 (e) (f)		Rem3 (g)	
	Tot	Int	Tot	Int	Tot	Int	Tot	Int
$Y_i$	0.890*** (0.016)	0.880*** (0.016)	0.907*** (0.018)	0.892*** (0.018)	0.927*** (0.020)	0.918*** (0.021)	0.932*** (0.016)	0.944*** (0.018)
$Y_j$	0.816*** (0.017)	0.788*** (0.015)	0.825*** (0.015)	0.793*** (0.015)	0.856*** (0.018)	0.832*** (0.016)	0.871*** (0.015)	0.868*** (0.017)
$d_{ij}$	-0.471*** (0.056)	-0.482*** (0.067)	-0.527*** (0.059)	-0.551*** (0.075)	-0.571*** (0.047)	-0.624*** (0.054)	-0.534*** (0.040)	-0.568*** (0.045)
$contig_{ij}$	0.501*** (0.120)	0.516*** (0.133)	0.410*** (0.110)	0.415*** (0.128)	0.385*** (0.103)	0.368*** (0.113)	0.353*** (0.109)	0.338*** (0.113)
$colony_{ij}$	0.078 (0.131)	0.131 (0.155)	0.109 (0.129)	0.172 (0.145)	0.179 (0.119)	0.277** (0.117)	0.126 (0.107)	0.184* (0.108)
$comcol_{ij}$	0.647*** (0.222)	0.842*** (0.253)	0.622*** (0.235)	0.774*** (0.268)	0.555*** (0.191)	0.671*** (0.209)	0.264 (0.184)	0.323 (0.197)
$WTO\_both_{ij}$	-0.221*** (0.074)	-0.019 (0.076)	-0.188** (0.077)	0.024 (0.080)	-0.313*** (0.074)	-0.142* (0.074)	0.643*** (0.201)	1.087*** (0.213)
$comlang_{ij}$	0.431*** (0.082)	0.468*** (0.090)	0.347*** (0.083)	0.378*** (0.092)	0.266*** (0.080)	0.253*** (0.085)	0.289*** (0.087)	0.317*** (0.090)
$smctry_{ij}$	0.651** (0.274)	0.775** (0.303)	0.710** (0.305)	0.819** (0.338)	0.610** (0.266)	0.693** (0.293)	0.512*** (0.165)	0.556*** (0.165)
$RTA_{ij}$	0.333*** (0.091)	0.291*** (0.111)	0.413*** (0.083)	0.369*** (0.101)	0.436*** (0.073)	0.415*** (0.083)	0.604*** (0.067)	0.583*** (0.070)
$Rem_{ij}$			0.108*** (0.036)	0.126*** (0.042)	0.733*** (0.089)	0.982*** (0.094)	0.088*** (0.022)	0.134*** (0.023)
Cons	-19.960*** (1.045)	-19.687*** (1.003)	-19.427*** (1.070)	-18.718*** (1.186)	-33.784*** (1.769)	-37.697*** (1.921)	-22.672*** (0.902)	-23.850*** (0.942)
N	192,869	192,869	192,869	192,869	192,869	192,869	192,869	192,869
R2	0.779	0.726	0.786	0.715	0.793	0.746	0.821	0.786

Notes: Standard errors in brackets. \*, \*\*, and \*\*\* indicate significance at the levels of 10%, 5%, and 1%.

Source: Authors' own estimates.