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Effects of Trade Facilitation on Trade Costs in Developed and Developing Countries: PPML Analysis

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Abstract: *Trade facilitation reduces trade costs and eases the movement of goods and services. Studies have shown that trade flows increased by improving the trade facilitation process and reducing trade costs. The study aims to estimate the effects of trade facilitation enhancement on trade costs in 111 developed and developing countries over the 2008 to 2014 period using the Poisson-Pseudo Maximum Likelihood (PPML) estimator. The findings show that trade facilitation components such as border administration, business environment and transport and communication infrastructure reduce trade costs. This trade facilitation should have helped alleviate the effects of the financial recession and eased world trade recovery. On the other hand, the study finds that additional market access increases trade costs. The most important finding is that the effectiveness of trade facilitation is higher when more countries engage in trade and when those countries are together participating in trade facilitation.*

Keywords: Trade facilitation; Trade cost; Poisson Pseudo-Maximum Likelihood Model; Gravity model.
JEL Classification: F13, F14, F15

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1. Introduction

International trade has grown significantly over the past decades. This growth has been facilitated by reducing trade costs due to advancements in information and communication technologies, transportation, liberalisation of trade and investment regimes, and developing countries' growing industrial capacity. Trade costs are an essential determinant of the cross-country pattern of trade and production. They affect industrial specialisation and, consequently, incomes, poverty rates, and many other critical economic outcomes (World Trade Organization, 2015 p.62). Recent economic literature has stressed the importance of trade costs in determining the patterns of specialisation and trade (Markusen & Venables, 2007). Trade barriers, such as tariffs, increase production costs for the producer and the prices of the goods for the consumer, decrease economic competition, and discourage economic growth. For example, Free Trade Agreements (FTAs), and the World Trade Organization (WTO) are geared towards decreasing trade costs and increasing trade flows among its members.

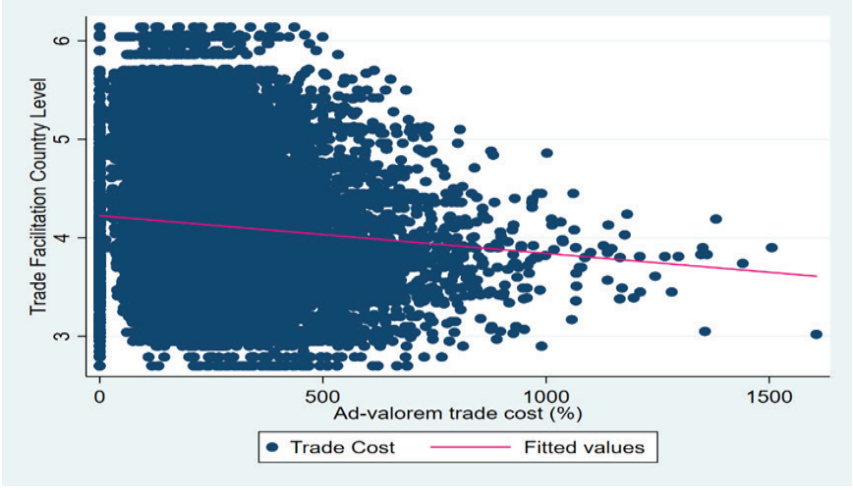
Almost all forms of economic integration (i.e., bilateral, regional and multilateral framework) involve tariff reduction. Though lower tariffs and customs duties made international trade less costly than ever, non-tariff barriers (NTBs), such as customs clearance administrative costs, national regulation, and documentary requirements for trade transaction in international trade, are causing countries to pay more (Dennis & Shepherd, 2011; Anderson & Wincoop, 2004). These trade costs may affect trade flows and the variety of products that a country can export. In 2008 to 2010, since the global financial crisis (GFC), the costs to export and import have been increasing in developed and developing countries (World Development Indicator Database, 2018). Many nations realised the need to implement measures that could facilitate trade to address the remaining trade costs and ease the movement of goods and services.

Trade facilitation refers to all procedures that governments use to reduce trade costs. According to Pomfret and Sourdin (2010a), trade facilitation is the process of reducing the remaining trade costs to increase the gains and enhance the trade flows. Trade facilitation could improve countries' trade and economic performance by increasing the coordination and cooperation among countries (Alburo, 2008). Therefore, in the first ministerial conference in December 1996 that was held in Singapore, WTO members decided to

address the restrictions in international trade by undertaking an exploratory and analytical investigation to understand the scope of the work through which countries can simplify trade procedures. In December 2013, at the outset of the Bali Ministerial Conference, ministers confirmed the negotiation of a preparatory committee to ensure the speedy application and efficient operation of a Trade Facilitation Agreement (TFA). TFA also takes into consideration the capacity and requirement of the countries in implementing trade facilitation. The agreement gives special and differential treatment to developing and less developed countries. While developed nations are bound to apply for accord upon their entry to force, more flexibility has been rendered to developing and less developing countries. Trade facilitation had been ratified by two-thirds of WTO member countries and entered into force on 22 February 2017.

Figure 1 shows the relationship between trade facilitation and trade cost for 111 sample countries (see Appendix A) from 2008 to 2014. The data show a left side trend that indicates a negative correlation between trade facilitation and trade cost. As trade facilitation increases, trade cost tends to decrease to the left. The fitted values line depicts these negative trends in the statistical data.

Figure 1: Trade Facilitation and Trade Cost in 2008-2014

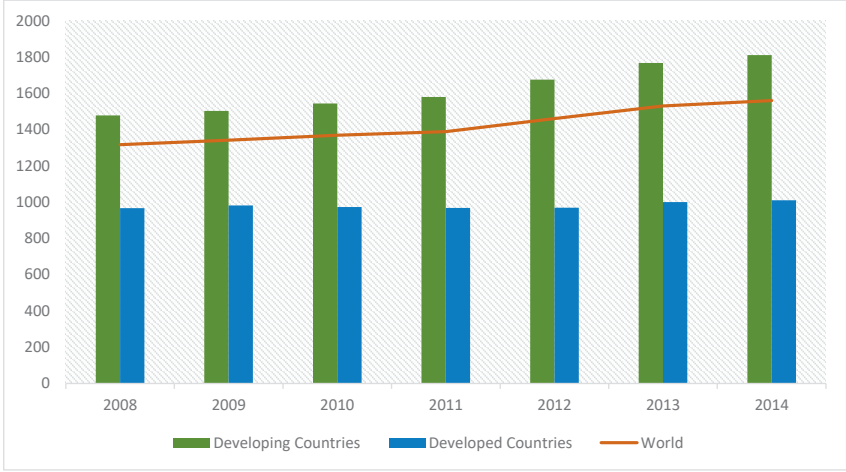


Source: Author's compilation from World Economic Forum Enabling Trade Index (ETI) and ESCAP. World Bank Trade Cost Database (2020).

The relationship between trade facilitation and trade cost can be illustrated using the Melitz (2003) model. The Melitz (2003) model with heterogeneous firms suggests that improvements in market opportunities abroad will lead to higher productivity. The model asserted that foreign market opportunity can be linked to trade facilitation procedures. It can have positive spillover effects in the sense that improvement in one area can improve other areas, i.e., reducing the number of documents required for trading goods is likely to reduce processing times and limit room for corruption and discretionary measures, and thereby lowering unnecessary trade costs (Hanouz et al., 2014). According to the WTO (2015), the full implementation of the TFA could reduce trade costs by 14.3%, on average, and improve global trade by around 1 trillion USD per year. Trade costs consist of all types of costs incurred by the producer in getting the goods to final consumers, which include both domestic and international trade costs, such as policy restriction, freight cost, time to delivery costs, different currencies and local distribution costs (Anderson & Wincoop, 2004; Hummels & Schaur, 2012).

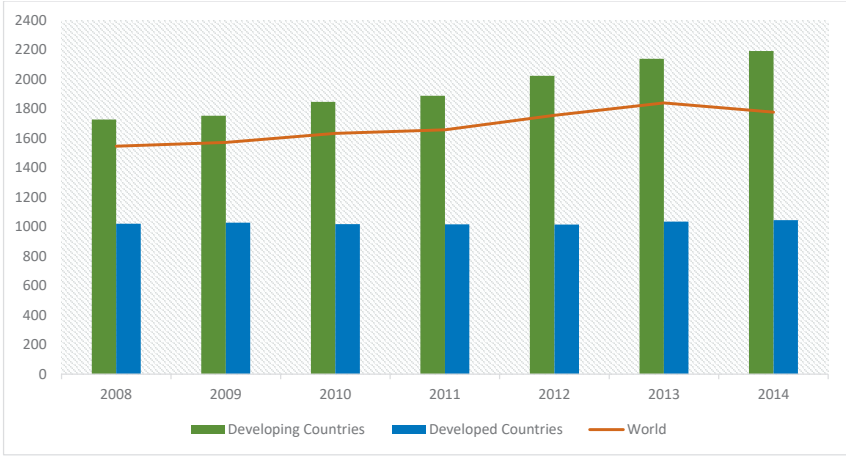
The magnitude of trade cost varies across different regions and territories. Upper-middle-income developing countries have managed to reduce trade costs faster than other groups in the world. However, Sub-Saharan African countries and low-income countries are subject to high trade costs (Arvis et al., 2016). Data shows that export and import costs have increased since the 2008 to 2010 GFC. In Figures 2 and 3, the average cost to export per container and the average cost to import per container illustrates the trade costs for the world, developed and developing countries for 2008 until 2014. These costs include the cost of preparing documents, customs clearance administrative fees and technical control, fees charged by custom brokers, terminal handling charges and domestic transportation, excluding tariffs or trade taxes (World Bank, 2018).[1] The red line in Figures 2 and 3 indicates the average magnitude of the increase in the cost to export and import for all countries globally. Although the average world trade cost to export and import per container from 2008 to 2014 has increased, the average world trade cost to export and import growth has slightly decreased by 3% and 6%, respectively, from 2013 to 2014. The world average trade cost to export has increased from USD 1341.63 per container in 2008 to USD 1559.88 in 2014 (refer to Figure 2). On the other hand, the world average trade cost to import increased from USD1,546.31 per container in 2008 to USD1,777.16 in 2014 (refer to Figure 3).

Figure 2: Average Cost to Export (USD per Container)



Source: World Development Indicator Database (2018).

Figure 3. Average Cost to Import (USD per Container)



Source: World Development Indicator Database (2018).

As for the developing countries, the average cost to export has also increased from USD1,477.89 per container in 2008 to USD1,810.70 in 2014. Meanwhile, the average cost to import has increased from USD1,727.15

per container in 2008 to USD2,191.18 in 2014. Developing countries have experienced a substantial increase in the average cost to export and import, 22% and 26% from 2008 to 2014, respectively. Figure 3 shows that the average cost to import per container has also increased, surpassing the average cost to export per container. For developing countries, the average cost to export escalated by 22% during the period 2008 to 2014, which is about four times higher than the growth of those costs in developed countries (refer to Figure 2). The average cost to import in developing countries has increased by more than five times or 26% compared to 2008 to 2014.

Few studies have examined the effects of trade facilitation on trade costs. For instance, the Organisation for Economic Co-operation and Development (OECD) used Trade Facilitation Indicators data (available since 2013) to measure the impact of the TFA on trade cost directly and shows that TFA could reduce global trade costs between 10% to 18%. Two approaches are involved in the measurement of trade costs, namely, the direct and indirect approaches. It usually raises a problem when measuring trade costs through the direct approach, in which trade cost components proxy by variables are used as regressors in the gravity model (Chen & Novy, 2012). In this regard, due to the difficulty in measuring trade costs and limitations on detailed data, it is impossible to add up the individual trade cost components at different points of time to measure trade costs and evaluate the elasticity of trade concerning trade frictions (Crozet & Koenig, 2010; Novy, 2013).[2] Also, the direct measure is available for a few components, such as transportation and insurance costs, policy barriers, such as tariff or non-tariff measures (NTMs), but not for many other components, such as bureaucratic red tape (Chen & Novy, 2012). On the other hand, the indirect approach measures trade costs by inferring from trade flows (i.e., the difference between actual and predicted trade flow to trade friction). The indirect approach measures bilateral trade costs based on observing the different patterns of trade and production. This measure is compatible with the broad range of leading theories (Novy, 2013).

Trade cost is one of the important determinants for cross-country patterns of trade and production. It is crucial to understand how trade facilitation affects trade costs. Trade barriers are known to be large and because of the limitation in data, measuring total trade cost is difficult. In this sense, examining the effect of trade facilitation on trade cost is not straightforward. However, with the recent development in trade facilitation

measurement (construction of different indices) and trade cost (Novy micro-gravity measurement approach), it is possible to better examine the effect. Examining the impact of trade facilitation on trade cost can contribute to the impartial assessment of trade facilitation by understanding the influencing factors, such as market access, border administration, and other factors through which different countries can reduce their costs and increase trade.

2. Literature Review

There are several ways to measure trade facilitation. Due to the growing importance of trade facilitation at the WTO during the last 15 years, many different trade facilitation indicators have been constructed to reflect its diverse nature and scope (OECD, 2015). For instance, Persson (2013), Dennis and Shepherd (2011), Portugal-Perez and Wilson (2012) utilise the World Bank's Logistics Performance Index (LPI) and Doing Business Indicators (DBI) as proxies in measuring trade facilitation.[3] Beverelli et al. (2015) used Trade Facilitation Index from the OECD in their measurement of trade facilitation. Another measurement by Lawrence et al. (2008) is the Enabling Trade Index (ETI), a comprehensive index that measures the factors, policies, and services simplifying the free flow of goods across borders and to the destination.[4] ETI ranks the nations according to factors and policies by facilitating the free movement of goods across countries and to different destinations (Geiger et al., 2016).

In formulating a theoretical perspective for studying the linkage between trade facilitation, trade cost and trade bloc with extensive margin, the "new" new trade theory (NNTT) provides a useful baseline. This theory was developed by Melitz (2003). It was used to study the intra-industry effect of international trade. The theory indicates that resulting from increased exposure to the trade, more productive firms enter the export market and at the same time force less productive firms to exit from the international market and continue to produce only for the domestic market. Melitz (2003) stated that due to significant fixed costs, only a few highly productive firms could manage to export and make enough profits to cover their fixed costs required for export.

Trade liberalisation can induce export diversification by increasing the number of exporters in the sectors that improve export opportunities. This effect comes from the fact that each firm produces a different variety of

exported goods in a monopolistic competition model. Therefore, the Melitz model suggests a reciprocal and unilateral decrease in trade cost and market entry cost variables that are positively associated with export diversification (Dennis, 2007; Irarrazabal et al., 2010).

Research in the 1990s focused on determining other factors affecting trade costs after the enormous efforts made by the different trade organisations and countries to reduce tariff and traditional barriers to trade, such as quota. McCallum (1995) used the gravity model and attributed the existence of missing trade between US-Canada to border trade. Anderson and Van Wincoop (2003) argued that the estimation of the gravity model suffers from omitted variables. They confirmed that national borders decrease trade between industrialised countries by 20% to 50%. Moreover, they concluded that trade costs are high and significant, especially for most developing countries, and better measurement is highly valuable.

Factors that increase trade costs, recently, are mainly to linked to the time costs of trade. Nordås (2006) emphasised that time significantly affects the probability of a country's exports, especially for time-sensitive products, such as electronics and industrial input. In the same line, Djankov et al. (2010), using the gravity equation, shows that each day delays means, on average, a country distancing itself from its trading partner by 70 kilometres.

Transport costs and distance are regarded as one of the most critical barriers to international trade (Baier & Bergstrand, 2001; Huang, 2007). Transport cost and distance are negatively affected by port inefficiencies and weak infrastructure (Blyde & Iberti, 2014; Clark et al., 2004; Limao & Venables, 2001). Raballand et al. (2005) noted that Central Asia countries trade less with the European Union (EU) than their location would suggest, which is due to higher transportation cost. Limao and Venables (2001) give the importance of infrastructure on transport cost, especially for landlocked countries. Martinez-Zarzoso and Marquez-Ramos (2008) studied 13 exporters and 67 importers and found that trade facilitation impacts sectoral trade flows through transport cost and the number of days required to trade.

Another strand of the literature focused on border effects. Pomfret and Sourdin (2010b) found that the border effect remains crucial in differentiating international trade from domestic trade even without formal trade barriers and distance. They confirmed the robustness of transport cost, port efficiency, regulatory burden, and NTBs across various countries import datasets. Another study by Pomfret and Sourdin (2010a) shows that large

country-by-country variations in trade costs and size, weight and distance account for part of the variation in trade costs. Administrative barriers can affect trade costs and trade volume. Estimating ad-valorem comparable Spanish export data shows that a 50% reduction in per shipment cost is equivalent to a 9% reduction in tariff (Hornok & Koren, 2015).

Arvis et al. (2016) estimated the effect of trade facilitation using the LPI on the indirect approach of trade cost. Two advantages are attributed by Novy (2013) to this method over the traditional gravity model. First, gravity regression assumes trade proxy, such as geographical distance, which does not vary over time as a function to trade costs. Second, every estimated gravity equation assumes a particular trade cost function by relying on trade costs proxies, such as geographical distance as explanatory variables. Therefore, difficulties in finding empirical proxies for many trade cost components, such as NTBs, lead to their omission. However, inferring trade costs from observable trade data does not need to assume the particular trade cost function since it captures a comprehensive set of trade barriers.

Similarly, different variables were used as proxies to study the impact of trade facilitation on trade cost because it was challenging to find a comprehensive measure for trade facilitation. Duval and Utoktham (2011) attributed two advantages to this trade cost. First, this bilateral measure of trade cost comprehensively adds additional cost involved bilaterally between two trading partners (i.e., internationally) relative to those involved internally or domestically (i.e., intranationally). Second, it captures trade costs in a broader sense, including the direct and indirect costs associated with obtaining necessary information, completing trade procedures, tariffs, international transport cost, and trade cost components discussed by Anderson and van Wincoop (2004).

3. Research Methodology

The basic model of the gravity model of trade states the bilateral trade flow between countries as an interaction between economic size and geographical distance, as shown in below:

$$Y_{ij} = G\frac{M_i M_j}{D_{ij}} \tag{1}$$

$$Y_{ij} = GM_iM_jD_{ij} \tag{2}$$

Consider the econometric formulation of the traditional gravity equation:

$$lnY_{ij} = \beta_0 + \beta_1 X_i + \beta_2 X_j + D_{ij} + \varepsilon_{ij} \tag{3}$$

Where Y_{ij} is the dollar value of exports from i to j, X_j denotes all importer-specific factors (such as the importing country's gross domestic product or GDP), and X_i comprises exporter-specific (such as the exporter's GDP) that represent the total amount exporters are willing to supply. β_0 is a constant that does not depend on i or j, such as the level of world liberalisation. D_{ij} represents the ease of exporter i to access market j (that is, the inverse of bilateral trade costs or multilateral resistance term). ε_{ij} is an error term.

The conditional mean y_{ij} is linked to an exponential function of a set of regressors explaining the constant elasticity:

$$y_{ij} = exp\,(x_{ij}\beta) + \varepsilon_{ij} \tag{4}$$

Where y_{it} represents bilateral trade; X_{ij} is a row vector of explanatory variables with corresponding parameters, vector β, that represent different dimensions of transaction distance, like physical distance and common language between countries. ε represents a random error term that is uncorrelated with X.

A dependent variable should not be in log form because the log of zero is undefined; the logarithmic transformation of the dependent variable creates an estimation problem when trade is zero (Martin & Pham, 2020). Also, deleting observations with zero trade is inefficient because it ignores the information that exists in the deleted observations.

The standard estimator for equation (4) is the maximum likelihood estimator (MLE), which can be written in log-likelihood form function:

$$\mathrm{L}(\beta) = \sum_{i=1}^{n}\{y_i\, x_i\beta - \exp(x_i\beta) - lny_i!\} \tag{5}$$

Differentiating β, the following is the Poissson-Pseudo Likelihood (PPML)[5] first-order equation used by Silva and Tenreyro (2006):

$$\sum_{i=1}^{n}[y_i - \exp(x_i\beta)]\, x_i = 0 \tag{6}$$

According to Silva and Tenreyro (2006), a PPML estimator can be applied and gives consistent outcomes even when the dependent variable is a non-integer. Moreover, this estimator is consistent and efficient with a wide range of heteroscedasticity patterns, also, unlike the nonlinear least-square (NLS) and Gamma Quasi-Maximum Likelihood estimator (GQMLE) which both give respectively more and less weight to larger observations. The PPML accords equal weights to all observations. Therefore, it takes into account heteroscedasticity by not overweighting the noisier observations. Silva and Tenreyro (2006) argued that the gravity model should be estimated to deal with zero trade values in its multiplicative form. Moreover, they emphasise that in the gravity model, the PPML can perform well in most situations, and has all the characteristics needed to make it the workhorse for estimating the gravity model (see also Silva & Tenreyro, 2009).

This section uses the traditional gravity model augmented with trade facilitation elements to analyse better the impact on the total trade costs of developed and developing countries. We seek to identify the effects of improvements in the trade facilitation process in 111 countries on the changes in total trade costs from 2008 to 2014 (i.e., the years that have witnessed an increase in trade costs). The value of total trade costs between country i and j in a given year is according to the following expression:

$$\begin{aligned}(TTC)_{ijt} = \exp\,[&\beta_0 + \beta_1 ln(TF)_{ijt} + \beta_2 ln(GDPPC)_{ijt} + \beta_3 ln(DIST)_{ij} + \\ &\beta_4(Border)_{i,j} + \beta_5(Colony)_{i,j} + \beta_6(Colony\ 1945)_{i,j} + \beta_7(CU)_{i,j} + \\ &\beta_8(LANG)_{i,j} + \beta_9(FTA)_{i,j} + \beta_{10}(RTA)_{i,j} + \beta_{11}(EU)_{i,j} + \beta_{12} ln(LPI)_{ij}] \\ &+ \lambda t + \varepsilon_{ijt}\end{aligned} \tag{7}$$

where;

$(TTC)_{ijt}$ indicates total trade cost from the export of country *i* to country *j* in year *t*.

TF_{ij} is the overall index of trade facilitation.

$GDPPC_{ij}$ is GDP per capita between country *i* and *j*.

$DIST_{ij}$ is the distance between nation *i* and *j*.

Border (dummy) is whether countries share the same borders.

Colony (dummy) is whether the country had a colonial relationship with its trade partners.

Colon 1945 (dummy) is whether countries have a common coloniser post-1945.
CU (dummy) shows whether two countries *i* and *j* are participating in the same Custom Union. *LANG* (dummy) is whether they have a common official language.
Free Trade Agreement (*FTA*), Regional trade agreement (*RTA*) and *EU* are dummies that show whether two countries share the same agreement.
λ_t is a vector with year-specific dummies.
ε_{ijt} is the random error term.

The key variable of interest, the overall index of Trade Facilitation (TF) consists of sub-indices of market access, border administration, transport and communication infrastructure and business environment. Market Access (MA) defines the extent to which the policy and cultural framework of the country welcome foreign goods into the country, and its improvement expects to have a positive sign on trade and reduce trade cost. Border Administration (BA) is the extent to which the administration at the border facilitates the entry of goods and is also expected to affect trade positively. Transport and Communication Infrastructure (TCI) is necessary to facilitate the movement of goods from the border to the destination. Business Environment (BE) is defined as a regulatory and security environment impacting the transport business in the country.

4. Data Sources

This study uses ETI, namely MA, BA, TCI and BE as proxies for trade facilitation in different countries. The variable to be explained is TTC_{ijt}, the multiplicative form of total trade costs between countries *i* and *j* at time *t* definition based on Novy (2013). Our core explanatory variables are measures for trade facilitation factors besides basic variables of the gravity model of economic size and distance.

Trade cost[6] data is extracted from the ESCAP-World Bank database, which is an estimation of bilateral trade cost of total goods, agriculture, manufactured for each country pair from 1995 to 2014, built upon Inverse Gravity Framework Novy (2013) methodology. The indirect trade cost measure according to Chen and Novy (2011, 2012), which has been

derived from Anderson & Van Wincoop (2003) gravity model, is calculated according to the following formula:

$$\tau_{ijkt} \equiv \left(\frac{t_{ijkt}t_{jikt}}{t_{iikt}t_{jjkt}}\right)^{\frac{1}{2}} = \left(\frac{x_{iikt}x_{jjkt}}{x_{ijkt}x_{jikt}}\right)^{\frac{1}{2(\sigma_k-1)}}$$

Where,

τ_{ij} denotes geometric average trade costs between country *i* and country *j*
t_{ij} denotes international trade costs from country *i* to country *j*
t_{ji} denotes international trade costs from country *j* to country *i*
t_{ii} denotes intranational trade costs of country *i*
t_{jj} denotes intranational trade costs of country *j*
x_{ij} denotes international trade flows from country *i* to country *j*
x_{ji} denotes international trade flows from country *j* to country *i*
x_{ii} denotes intranational trade of country *i*
x_{jj} denotes intranational trade of country *j*
σ_k denotes sector-specific elasticity of substitution between goods in the sector *k*

In this study, ETI data was taken from World Economic Forum (WEF). This index is divided into four subindices namely: MA, BA, TCI and BE, in which each subindex measures the stage of development of an economy to streamline the movement of goods to different countries. GDP per capita data is from World Development Indicator (WDI). Distance is obtained from CEPll, measured in kilometres for country pairs. Trade openness is taken from World Integrated Trade Solution (WITS). Control variables regarding trade agreements are extracted from "Mario Larch's Regional Trade Agreements Database," which is used in Egger and Larch (2008). Table 1 demonstrates the expected signs of the relationships for the dependent variable regarding those independent variables.

Table 1. Expected Signs of Relationship between Dependent and Independent Variables

Variable	Definition	Data Treatment	Source	Expected sign
TTC	Comprehensive trade Cost	2008-2014	ESCAP-World Bank	N/A
ETI	Geometric average of trade facilitation of exporter and importer expressed as $GA_{ijji} = \sqrt[n]{\text{var1}} * \text{var2}$	2008-2014	World Economic Forum	_
DIST	Geographical distance between country *i* and country *j*	N/A	CEPII	+
Border	1 if country *i* and *j* share a common border and zero otherwise	N/A	CEPII	_
LANG	1 if country *i* and *j* use common official language and zero otherwise	N/A	CEPII	_
GDPPC	Geometric average of per capita GDP	2008-2014	World Development Indicators	–
LPI	Logistics Performance Index	Geometric average of 2010-2012-2014	World Bank	_
Colony	Dummy variable equal to unity if countries *i* and *j* were ever in a colonial relationship	N/A	CEPII	_
RTA, FTA, CU, EU	1 if country *i* and *j* have common trade agreement and zero otherwise.	N/A	Mario Larch's Database	_
Colony 1945	1 if country *i* and *j* have a common coloniser post-1945 otherwise zero	N/A	CEPII	_

5. Results and Discussion

According to Moïsé and Sorescu (2013), several reasons motivate the estimation of trade facilitation on trade cost. First, data on trade flow is abundant and more accessible to quantify than the data on estimated trade cost. Second, the available trade cost is bilateral and is the same for country-pairs, and in both directions, that do not allow to attribute the change in trade facilitation to exporters or importers. In contrast to the trade cost, the effect of trade facilitation on the trade flow is observable simultaneously for both exporter and importer, as well as separately on exporter and importer. Third, trade facilitation can increase trade flows, because according to Novy (2013), trade cost is a micro-founded measure of bilateral trade costs derived from observable trade data.

Table 2 provides descriptive statistics information on dependent and independent variables for developed and developing countries. The mean shows the average behaviour of the variables, whereas the standard deviation reveals the distribution of the corresponding variables. The data shows the high variance in the dependent variables, reflected by the variation between upper and lower limits in min and max. For example, MA in the trade facilitation components has the lowest variance, ranging from 2.7 to 6.14.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
T_{ij}	30415	189.73	168.62	0	1605.69
TF	30415	4.15	0.71	2.70	6.14
MA	30415	4.08	0.73	1.80	6.66
BA	30415	4.22	1.02	2.25	6.56
TCI	30415	3.89	1.03	2.01	6.10
BE	30415	4.39	0.76	2.60	6.29
LPI	17510	3.62	7.43	1.61	113.07
GDPPC	30412	16576.80	20583.52	186.87	117000.00
DIST	30415	7480.63	4423.01	105.80	19649.83
Border	30415	0.02	0.15	0	1
Colony	30415	0.02	0.13	0	1
Colonys 1945	30415	0.06	0.23	0	1
CU	30415	0.07	0.26	0	1
LANG	30415	0.11	0.31	0	1
FTA	30415	0.14	0.34	0	1
RTA	30415	0.28	0.45	0	1
EU	30415	0.05	0.23	0	1

Following Arvis et al. (2016), we transformed the independent variables for exporter and importer of trade facilitation to the logarithm of geometric average in order to make them varying bilaterally. To a large extent, our results confirm the finding of Arvis et al. (2016); however, they did not report the coefficient of PPML, and they based their analysis on the ordinary least squares (OLS) regression Tables 3 to 5 report the effects of trade facilitation on total trade cost.

Table 3. Regression Results on Total Trade Costs - Effects of Overall Trade Facilitation and Logistics Performance Index

	(1) OLS	(2a) PPML	(2b) PPML on Positive Trade	(3) OLS	(4a) PPML	(4b) PPML on Positive Trade
Log_ overalindex	-0.271*** (0.023)	-0.098*** (0.037)	-0.296*** (0.026)			
Log_LPI				-0.504*** (0.019)	-0.194*** (0.019)	-0.492*** (0.019)
Log_ GDPPC	-0.045*** (0.003)	-0.017*** (0.004)	-0.041*** (0.003)	-0.030*** (0.002)	-0.013*** (0.003)	-0.031*** (0.002)
Border	-0.259*** (0.045)	-0.323*** (0.057)	-0.123** (0.048)	-0.248*** (0.049)	-0.333*** (0.063)	-0.116** (0.051)
Colony	-0.220*** (0.049)	-0.209*** (0.050)	-0.121** (0.050)	-0.221*** (0.055)	-0.190*** (0.054)	-0.110* (0.056)
Colony 1945	-0.135*** (0.032)	0.057 (0.048)	-0.112*** (0.035)	-0.166*** (0.034)	0.026 (0.053)	-0.150*** (0.037)
CU	-0.061 (0.047)	0.056 (0.074)	-0.118** (0.053)	-0.033 (0.049)	0.044 (0.079)	-0.093* (0.053)
LANG	-0.104*** (0.022)	-0.004 (0.036)	-0.158*** (0.025)	-0.115*** (0.023)	-0.005 (0.038)	-0.161*** (0.026)
FTA	-0.119*** (0.025)	-0.381*** (0.042)	-0.095*** (0.028)	-0.100*** (0.025)	-0.377*** (0.046)	-0.076*** (0.028)
RTA	-0.037* (0.021)	0.080** (0.034)	-0.074*** (0.023)	-0.050** (0.021)	0.080** (0.037)	-0.077*** (0.022)
EU	-0.077 (0.054)	-0.226*** (0.081)	0.200*** (0.059)	-0.075 (0.057)	-0.182** (0.087)	0.203*** (0.061)
Constant	-14.910*** (1.097)	-3.584** (1.769)	-14.236*** (1.285)	-15.689*** (1.081)	-2.670 (1.896)	-15.330*** (1.247)
Obs.	23190	30303	23190	12255	16616	12255
R-squared	0.451	0.062	0.317	0.502	0.066	0.366

Notes: 1. Dependent variable is in three forms, log (total trade cost), level (total trade cost) and level (positive total trade cost). 2. In OLS estimation, the robust standard error is corrected and adjusted by country pair clustering. PPML is clustered by country pair. 3. Bilateral trade cost variables have been corrected for multilateral resistance according to Baier and Bergstrand (2009). 4. Time dummy is included but not reported for brevity. 5. Standard errors are in parenthesis. 6. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Regression Results on Total Trade Costs - Effects of Market Access

	(1) OLS	(2a) PPML	(2b) PPML on Positive Trade	(3) OLS	(4a) PPML	(4b) PPML on Positive Trade
log_MA	0.039***	0.019**	0.040***			
	(0.006)	(0.007)	(0.005)			
log_BA				-0.270***	-0.067***	-0.296***
				(0.014)	(0.024)	(0.016)
Log_ GDPPC	-0.072***	-0.027***	-0.070***	-0.037***	-0.017***	-0.033***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.004)	(0.003)
Log_DIST	0.265***	0.110***	0.257***	0.271***	0.110***	0.268***
	(0.013)	(0.020)	(0.015)	(0.012)	(0.020)	(0.014)
Border	-0.255***	-0.330***	-0.139***	-0.255***	-0.322***	-0.106**
	(0.046)	(0.058)	(0.049)	(0.046)	(0.057)	(0.050)
Colony	-0.223***	-0.212***	-0.134***	-0.218***	-0.208***	-0.117**
	(0.048)	(0.050)	(0.051)	(0.049)	(0.050)	(0.051)
Colony 1945	-0.136***	0.057	-0.111***	-0.144***	0.058	-0.118***
	(0.032)	(0.048)	(0.035)	(0.032)	(0.048)	(0.034)
CU	-0.058	0.055	-0.131**	-0.072	0.058	-0.117**
	(0.047)	(0.074)	(0.051)	(0.047)	(0.074)	(0.051)
LANG	-0.102***	-0.004	-0.156***	-0.107***	-0.004	-0.162***
	(0.022)	(0.036)	(0.025)	(0.022)	(0.036)	(0.025)
FTA	-0.126***	-0.378***	-0.097***	-0.110***	-0.383***	-0.096***
	(0.025)	(0.042)	(0.028)	(0.025)	(0.042)	(0.028)
RTA	-0.032	0.079**	-0.064***	-0.036*	0.081**	-0.068***
	(0.021)	(0.034)	(0.023)	(0.021)	(0.034)	(0.022)
EU	-0.082	-0.223***	0.208***	-0.057	-0.228***	0.201***
	(0.055)	(0.081)	(0.058)	(0.053)	(0.080)	(0.058)
Constant	-15.689***	-3.881**	-15.002***	-15.734***	-3.760**	-15.338***
	(1.126)	(1.781)	(1.314)	(1.084)	(1.773)	(1.264)
Obs.	23259	30413	23259	23190	30303	23190
R-squared	0.439	0.061	0.304	0.471	0.061	0.346

Notes: 1. Dependent variable is in three forms, log (total trade cost), level (total trade cost) and level (positive total trade cost). 2. In OLS estimation, the robust standard error is corrected and adjusted by country pair clustering. PPML is clustered by country pair. 3. Bilateral trade cost variables have been corrected for multilateral resistance according to Baier and Bergstrand (2009). 4. Time dummy is included but not reported for brevity. 5. Standard errors are in parenthesis. 6. *** p<0.01, ** p<0.05, * p<0.1.

Table 5. Regression Results – Effects ofTransport and Communications Infrastructure

	(1) OLS	(2a) PPML	(2b) PPML on Positive Trade	(3) OLS	(4a) PPML	(4b) PPML on Positive Trade
log_TCI	-0.620***	-0.207***	-0.597***			
	(0.016)	(0.028)	(0.018)			
log_BE				-0.106***	-0.099***	-0.140***
				(0.016)	(0.025)	(0.019)
Log_ GDPPC	0.024***	0.006	0.020***	-0.062***	-0.018***	-0.058***
	(0.003)	(0.005)	(0.003)	(0.002)	(0.003)	(0.002)
Log_DIST	0.276***	0.109***	0.267***	0.264***	0.108***	0.254***
	(0.011)	(0.020)	(0.014)	(0.013)	(0.020)	(0.015)
Border	-0.251***	-0.327***	-0.131***	-0.257***	-0.323***	-0.131***
	(0.041)	(0.056)	(0.045)	(0.045)	(0.057)	(0.049)
Colony	-0.205***	-0.217***	-0.133***	-0.222***	-0.208***	-0.126**
	(0.043)	(0.049)	(0.046)	(0.049)	(0.050)	(0.051)
Colony 1945	-0.141***	0.055	-0.128***	-0.132***	0.057	-0.109***
	(0.029)	(0.048)	(0.032)	(0.032)	(0.049)	(0.035)
CU	-0.075*	0.070	-0.082*	-0.057	0.055	-0.124**
	(0.043)	(0.073)	(0.048)	(0.048)	(0.075)	(0.052)
LANG	-0.129***	-0.000	-0.163***	-0.102***	-0.004	-0.157***
	(0.020)	(0.036)	(0.023)	(0.022)	(0.036)	(0.025)
FTA	-0.101***	-0.383***	-0.086***	-0.124***	-0.381***	-0.098***
	(0.023)	(0.041)	(0.026)	(0.025)	(0.041)	(0.028)
RTA	-0.044**	0.079**	-0.076***	-0.034	0.079**	-0.070***
	(0.020)	(0.033)	(0.021)	(0.021)	(0.033)	(0.023)
EU	-0.037	-0.254***	0.143***	-0.085	-0.225***	0.203***
	(0.049)	(0.079)	(0.054)	(0.055)	(0.082)	(0.059)
Constant	-16.448***	-3.772**	-15.541***	-15.137***	-3.099*	-14.114***
	(1.009)	(1.756)	(1.201)	(1.109)	(1.750)	(1.283)
Obs.	23190	30303	23190	23190	30303	23190
R-squared	0.532	0.064	0.386	0.440	0.063	0.309

Notes: 1. Dependent variable is in three forms, log (total trade cost), level (total trade cost) and level (positive total trade cost). 2. In OLS estimation, the robust standard error is corrected and adjusted by country pair clustering. PPML is clustered by country pair. 3. Bilateral trade cost variables have been corrected for multilateral resistance according to Baier and Bergstrand (2009). 4. Time dummy is included but not reported for brevity. 5. Standard errors are in parenthesis. 6. *** p<0.01, ** p<0.05, * p<0.1

In all Tables 3, 4 and 5, columns 1, 2a, 2b report the OLS and PPML estimation results. The estimations for PPML have been undertaken two times, first on the complete sample, including zero trade, and the second time on the positive trade, which is presented in columns 2a, 2b, 4a, and 4b. Column 4b represents the robustness check for the alternative trade facilitation indicator, the LPI, which will be discussed after estimating the main models to check the power of our model's explanation. Table 3 reports the main results of the trade facilitation overall effect on total and positive total trade costs. The results of the PPML estimator on total and positive trade cost (columns 2a, 2b) have the expected negative sign. They are statistically significant at a 1% level, showing the importance of trade facilitation implementation for trade costs. However, the size of the effect is relatively small, and the improvement in overall trade facilitation by 10% will reduce the trade cost by 1%.

In Tables 3, 4 and 5, since the results for most of our control variables are similar, therefore we explain them in Table 3. GDP per capita or *GDPPC* is significant, implying that countries that are more developed and have higher productivity are likely to have less trade costs. An increase in the *GDPPC* will reduce trade costs in developed and developing countries. The distance coefficient is significant and positive, an indication that the increase in the distance will accompany a higher trade costs. Common border and colony are both found to be significant with a negative sign for each variable.

Table 3 column 1 for OLS estimates shows that a 10% decrease in the coefficient of the distance will reduce the total trade cost by 2.6% which is two and half times higher than the coefficienct based on the PPML estimates, in which a 10% decrease in the distance reduces the total trade cost to 1.1%, indicating the importance of distance in lowering total trade costs. The OLS gives a higher coefficient because zero trade cost observations carry essential information, and disregarding them suggests that countries have less trading cost; that is to say, they have more trade flows. The results of the OLS can be seen by comparing column 2a with columns 1 and 2b, where the dependent variable excludes zero-values for trade cost either through a logarithmic transformation, as in column 1, or by non-inclusion of zero values of the dependent variable and estimating PPML only on positive trade.

However, in Table 3, column 2a, the coefficients for customs union (CU) and sharing of a common language are both found to be insignificant. The effects of a CU is different from that of other agreements as common

external tariffs are imposed by participating countries on non-member countries in the former. It has been reported by Hornok and Koren (2015) that trade within a CU is higher than aFTA, and the CU effect is insignificant on the shipping cost. The effects of a RTA and the EU membership on reducing trade cost based on the PPML estimator, and PPML on a positive trade model ares significant in all the tables. Comparing column 2a with columns 1 and 2b show interesting results; trade facilitation works better when more countries participate in this process. Therefore, the coefficients for improvement in the overall trade facilitation index is higher when including countries with positive trade cost.

To ascertain robustness, the study followed two strategies. First, we used alternative proxy of LPI for the trade facilitation variable. The LPI analyses and scores countries according to their efficiency in moving goods across and within borders. The LPI overall score reflects the level of a country's logistics. It consists of six areas of logistics performance: the efficiency of customs clearance management; the quality of information technology and transport infrastructure; the ease of arranging international shipping process; the proficiency and quality of logistics industry; ability to track and trace international delivery and the punctuality of shipment in reaching the destination. Second, we regressed the independent variables on the positive trade cost to see whether there is a significant change in the outcome of the PPML estimations. The results in Tables 3, 4 and 5 columns 4a and 4b, are consistent and robust with the baseline model where most of the variables retain their signs, statistical significance and remain stable either to the introduction of alternative specifications or estimation on the positive trade cost. The improvement of a 10% in the LPI reduces trade cost by 5%, as shown in columns 4a and 4b of Table 3. This emphasises that logistics performance and trade facilitation are effective levers in reducing trade costs.

Table 4 reports the results for the effect of MA and BA on trade cost with the other control variables. MA unsurprisingly has a positive sign as the negative effect of trade facilitation on trade flow could result from acquiring new market access and having preferential trade access, especially in the Least Developed Countries (LDC) (Djankov et al., 2010). The implication is that new MA for countries engaging in other preferential trade agreements may not reduce trade costs. Although the sign of border administration is negative and significant for the OLS and PPML on positive trade, the sign turns positive when using PPML with zero trade values. This indicates that

BA requires a high degree of cooperation and organisation, which becomes more sophisticated and desired with an increased number of products traded. This result shows that a 10% improvement in BA will reduce the trade cost by 0.06%. However, the cost reduction will be more with the increase in the countries' engagement in trade facilitation, as can be seen in Table 4, column 4b.

Table 5 shows the results of the effects of TCI on trade cost. The coefficient of the primary variable reports the expected sign, and the TCI variable seems to have the largest effect among other variables in reducing trade cost. A 10% improvement in TCI reduces trade costs by 2.1% (column 2a). Iwanow and Kirkpatrick (2007) obtained similar results; TCI quality is often more critical than border-related reforms in facilitating export growth. Finally, the BE is statistically significant at 5% with an adverse effect on the total trade cost. Table 5 shows that a 10% improvement in the BE lowers trade cost by almost 1%. The increase in the coefficient by 1.4% in column 4b implies a higher reduction in trade cost when more countries engage in trade facilitation. The findings suggest that improvement in the BE and TCI will lower the trade costs among the trading partners.

6. Conclusion

In this study, we focused exclusively on the prospective effect of trade facilitation on trade cost. The major empirical finding reveals that trade facilitation has significant influence on alleviating trade costs in the developed and developing countries, albeit with relatively small magnitudes of impact for developing countries, when either fewer countries engage in trade or fewer countries participate in trade facilitation. This is true for example, the effect will be small even if the trade facilitation process applies efficiently but to a few countries. On the other hand, the effect will be small if countries have limited trading partners. Our results also demonstrate that it is not necessarily true that trade facilitation works better for developing and least developed countries when the large pair countries have no trade. Since trade cost data is extracted from observable bilateral trade, developed countries have reported less zero trade. This shows that the distribution effect of trade facilitation in reducing trade costs is higher for the developed nations.

The results indicate that better participation from all countries will significantly increase the benefit from trade facilitation implementation. This

is not unusual since zero trade is set up under a model with heterogeneous firms. As explained by Helpman et al. (2008), trade cost and fixed entry cost reduce both the amount of firm to export as well as the probability of the firms to export therefore leading to more bilateral trade cost. An additional finding is that TCI contributes to the facilitation of the movement for goods from the border to the destination and it has the largest effect in reducing the trade cost. The aid for trade policy to reduce trade costs in developing and least developed countries could be vital. Policy initiatives such as improving market access and strengthening the use of transport and communication infrastructure are crucial in enhancing trade facilitation. Moreover, the implication suggests that unleashing and strengthening the use of TCI is important for the development of logistics and transportation services, particularly in the developing countries.

Notes

1. https://www.doingbusiness.org/en/data/exploretopics/trading-across-borders/faq

2. Trade elasticity is crucial for understanding the size of the frictions to trade, the response of trade to changes in tariffs, and the welfare gains or losses from trade (Simonovska & Waugh, 2014).

3. LPI analyses the disparity between countries regarding customs procedures, logistics costs, quality of transport infrastructure for overland and maritime transport (Martíet al., 2014). Meanwhile, DBI compares the environmental regulation of businesses across economies and time, offers measurable benchmarks for reform, presents detailed subnational reports, which comprehensively cover business regulations and reform in different cities and regions across 190 economies (World Bank Doing Business). LPI has two limitations: 1. International freight forwarder's experience does not convey the broader logistics environment in developing countries with traditional operators. 2. For landlocked countries and small island states, the LPI might reflect access problems outside the country assessed. DBI also has some limitations: 1. Collected data only relate to businesses in the economy's largest city. 2. Does not consider the changes in costs of trade partners. 3. Time and costs for domestic transport are

not considered when ranking economies on the ease of trading across borders. 4. The measures of time are based on the judgment and respondents of the expert.

4. ETI is a strategic tool that covers 118 economies and aims to measure the scope of policy issues that hinder trade. It ranks nations according to the factors and policies facilitating the free flow of goods across national borders and to the destination, and provides a detailed evaluation of the trade-enhancing environments throughout the countries (Lawrence et al., 2008). The limitation of ETI is that the new data added to the report from the WEF only represents 36% of the ETI.

5. For an insightful analysis of the Poisson regression, see especially Chapters 3 and 4 of Cameron and Trivedi (2013).

6. For more information on trade cost measures and different calculation methods, refer to Chen and Novy (2011, 2012); Duval and Utoktham (2011); Jacks et al. (2008); Jacks et al. (2011); and Novy (2013).

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Appendix A: Sample of Countries

List of 111 Developed and Developing Countries			
Albania	Algeria	Argentina	Armenia
Australia	Austria	Azerbaijan	Bahrain
Bangladesh	Belgium	Benin	Bolivia
Bosnia and Herzegovina	Brazil	Bulgaria	Burkina Faso
Burundi	Cambodia	Cameroon	Canada Guyana
Chile	China	Colombia	Costa Rica
Croatia	Cyprus	Czech Republic	Denmark
Dominican Republic	Ecuador	Egypt	El Salvador
Estonia	Ethiopia	Finland	France
Germany	Greece	Guatemala	Guyana
Honduras	Hong Kong SAR	Hungary	India
Indonesia	Ireland	Israel	Italy
Jamaica	Japan	Jordan	Kazakhstan
Kenya	Korea Rep	Kuwait	Kyrgyz Republic
Latvia	Lesotho	Lithuania	Luxembourg
Madagascar	Malaysia	Mali	Mauritania
Mauritius	Mexico	Moldova	Mongolia
Morocco	Mozambique	Namibia	Nepal
Netherland	New Zealand	Nicaragua	Nigeria
Norway	Oman	Pakistan	Panama
Paraguay	Peru	Philippines	Poland
Portugal	Qatar	Romania	Russian Federation
Saudi Arabia	Senegal	Singapore	Slovenia
Slovakia	South Africa	Spain	Sri Lanka
Sweden	Switzerland	Thailand	Tunisia
Turkey	Uganda	Ukraine	United Arab Emirates
United Kingdom	United States	Uruguay	Venezuela
Vietnam	Zambia	Zimbabwe	