A Caribbean Settlement Network: Can Blockchain Ease Intraregional Trade in the Caribbean?

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IDB

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Executive Summary

This paper analyzes the potential effects that distributed ledger technology (DLT) could have on intraregional trade volumes in the Caribbean. Using a two-step panel regression gravity model for 15 CARICOM countries, the analysis finds that non-tariff barriers (NTBs), such as distance and culture, bilateral exchange rates, transfer fees, and required documentation, have negative effects on trade. There are a rising number of pilot projects across the world that apply DLT for payment settlements and trade facilitation. These are starting to generate encouraging evidence that the application of DLT could indeed help reduce the prevalence of some of these NTBs and thus promote trade. Policy recommendations that stem from this analysis include: (i) promoting greater regional political consensus for both economic regional integration and the use of DLT; (ii) investing in the underlying infrastructure for new technologies, ensuring it is compatible with major trading partners' technological and regulatory requirements; (iii) continuing the development of regulatory frameworks that can make the use of DLT a reality in a safe manner; and (iv) encouraging more pilot projects to generate greater evidence for the region.

JEL codes: F14, F15, F17, F47, O10, O31, Y80

Keywords: Trade, non-tariff barriers, Caribbean, CARICOM, Blockchain, Distributed Ledger Technology

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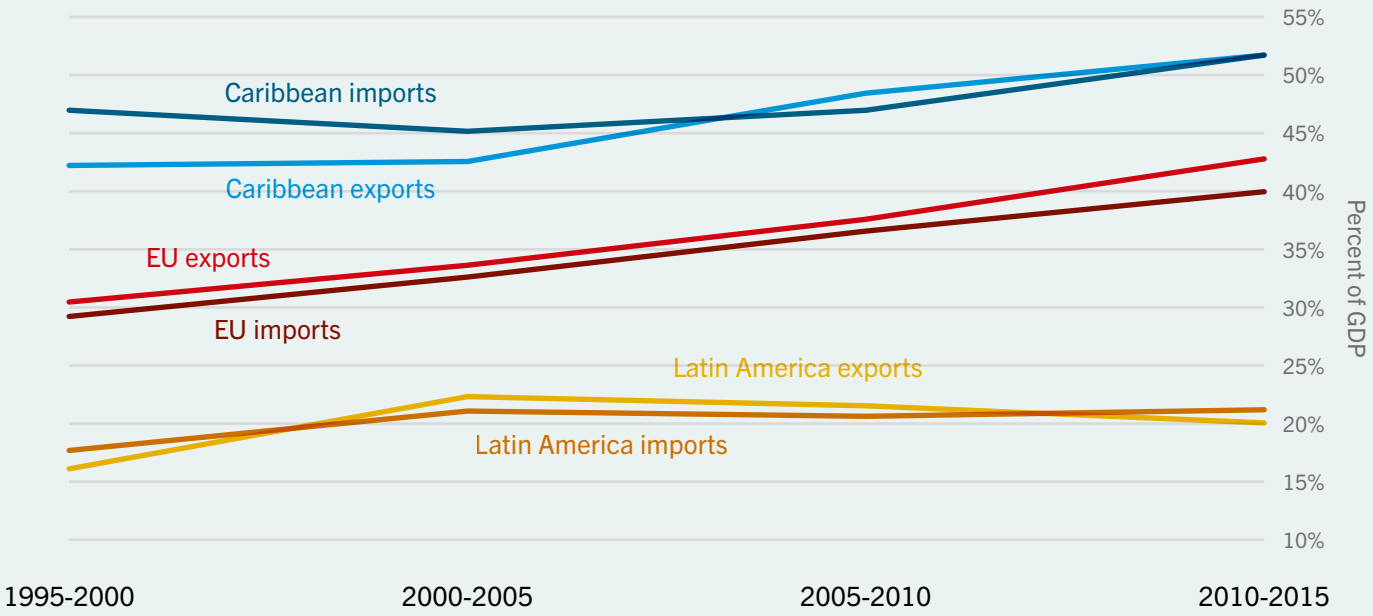


Sources: CEPAL and OECS, 2020

1. Introduction

Regional integration in the Caribbean has recently risen to the top of the policy agenda. COVID-19 has brought the urgent need for regional integration to the forefront of the political discourse as a strategic launching pad for countries to better cope with global uncertainty. Regional organizations have been essential during the pandemic to help countries better coordinate policy responses and ease access to much-needed medical supplies. However, this is only the beginning. Going forward, Caribbean countries will require a more united front to face medium- and long-term challenges in the region. Stronger trade ties are an important component of this strategy.

Trade is essential for the Caribbean. Caribbean countries are largely reliant on imports to obtain necessary goods, including fuel and food. Exports are also key for economic activity, as tourism is the main source of growth and employment in most of these countries and a number of states produce and export petroleum. Exports and imports combined have averaged 100 percent of GDP in Caribbean countries over the past two decades, higher than the volume of trade in large countries and regional blocks such as the United States of America (USA) (27 percent of GDP), the Euro Area (81 percent of GDP), or the OECD countries (36 percent of GDP).[1]

The institutional framework to promote regional integration has been evolving over the past half century. CARICOM was created in 1973 with the aim of promoting economic integration, foreign policy coordination, human and social development, and security. Twenty countries (15 members and 5 associate members) participate today. As part of this initiative, the CARICOM Single Market and Economy was

1 https://data.oecd.org/trade/trade-in-goods-and-services.htm

established in 1989 with the aim of supporting free movement of skills and labor, capital, goods, and services, and for the right of establishment. In order to promote greater regional integration through trade, 1991 CARICOM members agreed to a harmonized common external tariff (CET) for imports from outside the Common Market.[2]

Despite regional integration initiatives, intra-CARICOM trade remains low. Intraregional trade accounted for only 10 percent of total trade in the region in 2015 (compared to 13 percent in 2006). This is a noticeable disparity compared to the flow of intraregional trade in other regions. For example, the European bloc's intraregional trade share exceeds 60 percent, ASEAN's is 22 percent[3] and the Latin America and the Caribbean (LAC) region's is 17 percent. Furthermore, intra-CARICOM trade is highly concentrated. At the end of 2016, almost 70 percent of regional exports originated from Trinidad and Tobago, while Guyana and Jamaica together accounted for almost 50 percent of regional imports.

Structural factors could partially explain the region's low levels of intraregional trade. Some of the early authors on Caribbean integration argued that the CARICOM initiative was doomed to be a low-impact activity due to a lack of trade complementarity among member states (Worrell, 1994; Wint, 2005; Hornbeck, 2008). The underlying argument was that countries in the region are essentially primary producers. Therefore, tariff reductions alone will not necessarily lead to improvements in the volume or composition of trade (see Khadan and Hosein, 2013, for empirical evidence in this regard). Despite these arguments, more recent evidence has shown that there is a significant overlap between extraregional imports and intraregional exports, implying that there are opportunities to increase intraregional trade in CARICOM. For example, Alleyne, Lorde, and Moore (2018) estimated that almost 25 percent of what member countries import from extraregional sources can be obtained from within Belize, Jamaica, and The Bahamas. This raises the question of what other factors are constraining the region's ability to realize its full intraregional trade potential.

One of the main factors associated with low intraregional trade is cost, particularly relating to non-tariff trade barriers.[4,5] In 2015, the average intraregional tariff across CARICOM stood at 6 percent, well below the global average of 9 percent estimated by the World Trade Organization (WTO) (2015). However, CARICOM countries face a significantly greater burden of non-tariff costs, stemming from non-tariff barriers (NTBs), which increased from 95.4 percent (2000) to 128.6 percent (2015). NTBs are associated with stronger negative impacts on trade than tariff barriers. They can reduce trade gains that would have ordinarily been achieved through the elimination or reductions of tariffs.

Policy discussions on reducing NTBs have increasingly pointed toward the potential benefits of using distributed ledger technology (DLT) or, specifically, blockchain ledgers. This technology allows immutable and decentralized registers of transactions to be built between parties that do not need to know each other. Though still in an exploratory stage, DLT has already been piloted for international payment systems across a wide range of countries, and research in the area continues to grow, particularly regarding its application to central bank transactions. Recently, there have been growing

2 Not all CARICOM participating states apply the CET.

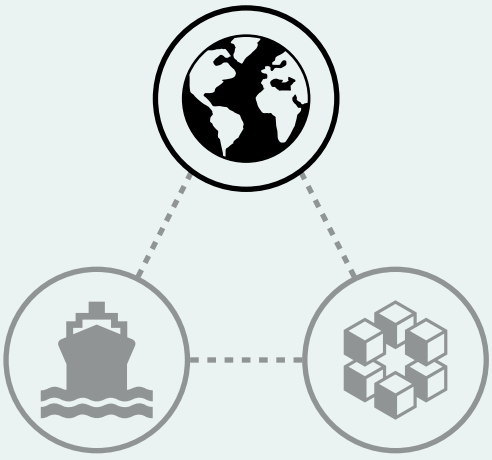
3 The EU is the world's most integrated trading bloc.

4 Trade (tariff and non-tariff) costs are the cost incurred by firms to move goods, generally referred to as total logistics costs. Trade costs include three categories: administrative, transport, and inventory costs.

5 A 2015 WTO study found that trade costs can amount to a 134 percent ad valorem tariff on a product in high-income countries and to a 219 percent tariff in developing countries (WTO, 2015).

discussions in the Caribbean on the possibility of using DLT to build a Caribbean settlement network, which could reduce costs and support greater trade promotion in the region. However, the potential scope and design of such a network is still undecided.

This paper contributes to the policy discussion regarding DLT and trade in the Caribbean region. We carry out a two-step panel regression gravity model for 15 CARICOM countries between 2006 and 2015, following Baier and Bergstrand (2009), and find that key factors related to NTBs have negative effects on intraregional trade. Despite the nascent stage of these types of analyses and the limitations for analysis, there is a case to be made for promoting the use of new technologies, such as DLT, for trade cost facilitation in the Caribbean. This effort should transcend CARICOM and include other major trading partners. It should also consider underlying costs relating to infrastructure and regulatory investments which are required to increase the adoption of DLT in the region. The rest of this paper unfolds as follows: Section 2 examines non-tariff trade barriers in the CARICOM region. Section 3 estimates the impact of key trade costs on intraregional trade. Section 4 provides an overview of case studies of the use of blockchain for payments and trade facilitation. Section 5 concludes.



2. Non-Tariff Barriers in the Caribbean

NTBs pose an increasing challenge to international trade flows, especially in the Caribbean region. As import tariffs continue to decrease due to the proliferation of free trade agreements, the importance of measures to reduce international transaction costs has become more apparent. Table 1 presents non-tariff intra and extraregional trade costs for key regional blocs around the world. Intraregional trade facilitation performance varies greatly across different regions, from 267.3 percent in COMESA to 118.1 percent in MERCOSUR. Intraregional non-tariff trade costs for CARICOM are on the lower end of the scale, at 138 percent. Yet they exceed those faced between Canada and the USA, which are among the lowest in the world (averaging only 30.7 percent in 2015). They also do not seem to hold a competitive edge against the region's most significant trading partner, the USA. Given the fact that CARICOM benefits from low intraregional tariff rates, the potential negative effects of these NTBs on the volume of trade are likely high, as CARICOM trade with the USA casts a significant shadow over the levels recorded intraregionally.

NTBs within CARICOM have been increasing over time and present large variances across countries. Between 2000 and 2015, the region's intraregional non-tariff costs increased by 35 percent. The growing trade costs among CARICOM countries ranged from 46.2 percent between Guyana and Trinidad and Tobago to 366.8 percent between St. Kitts and Nevis and Jamaica. However, when excluding border tariffs, the differences range from 31.9 percent between Guyana and Trinidad and Tobago to 366.2 percent between St. Kitts and Nevis and Jamaica. Only Barbados, Guyana, and Trinidad and Tobago face average bilateral non-tariff costs of less than 100 percent (see Table 2). Notably, the level of variation among CARICOM non-tariff costs vastly outweighs that of other regions. For example, the Southern Common Market (MERCOSUR) non-tariff costs range from 67.6 percent (Brazil and Argentina) to 103.8 percent (Paraguay and Argentina) for all member states. Among the East African Community (EAC) member states, costs range between 79.3 percent (Uganda and Kenya) and 181.2 percent (Rwanda and Tanzania).

Increasing evidence shows that the use of new technologies can facilitate and promote trade. International trade and technology have been historically closely interlinked (Pascali, 2017; Cosar and Demir, 2018; Steinwender, 2018). The growing use of new technologies can have implications for the types of goods and services that countries trade, the way they are traded, the values and volumes traded, and the production specialization of countries (Estevadeordal, Rodríguez Chatruc, and Volpe Martincus, 2020; WTO, 2018). While digital transformation can influence international trade through different channels, one of the most significant avenues through which it can facilitate trade is by reducing trade costs. Among others,[6] blockchain has been found to reduce logistics and transportation costs as well as those related to regulation compliance and administrative procedure compliance (Estevadeordal, Rodríguez Chatruc, and Volpe Martincus, 2020). Notwithstanding the benefits of digital technologies, they are also giving rise to several concerns. This includes market concentration, loss of privacy, security threats, and whether digital technologies have really increased productivity (WTO, 2018). These concerns are further discussed in Section 4.

6 Other new technologies include robots, artificial intelligence, and internet of things, among others.

Table 1. Non-tariff Intra and Extraregional Trade Costs in CARICOM and Other Related Regions (percent increase in trade cost), 2015

	CARICOM	ASEAN	ASN13	EAC	MERCOSUR	COMESA	Canada	UK	USA
CARICOM	138.0	353.8	321.1	571.3	266.6	495.6	168.3	154.4	130.8
ASEAN		152.1	152.5	324.0	253.6	292.9	167.6	133.2	121.6
ASN13			151.0	297.5	237.3	268.8	160.8	129.6	122.4
EAC				137.8	477.6	249.4	313.2	203.4	269.4
MERCOSUR					118.1	444.6	143.4	140.4	103.0
COMESA						267.3	261.3	163.8	231.1
Canada							-	68.3	30.7
United Kingdom								-	62.0

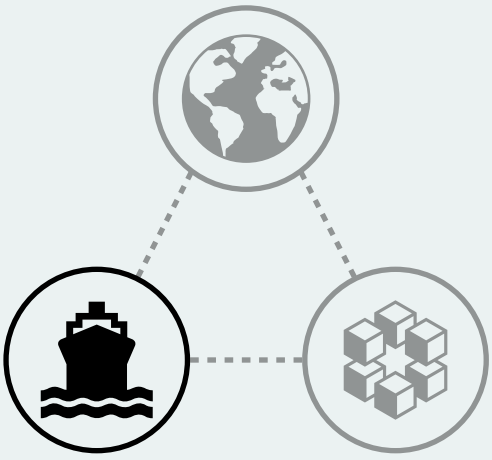
Source: ESCAP Trade Cost Database.
Note: The figures in this table show the percent increase in trade cost compared to the average domestic cost of goods. Association of Southeast Asian Nations (ASEAN), ASEAN plus China, Hong Kong and Japan (ASN13), East African Community (EAC), Southern Common Market (MERCOSUR), Common Market for Eastern and Southern Africa (COMESA). Haiti and Montserrat are excluded from the CARICOM results above.

Table 2. CARICOM Member States Bilateral Non-tariff Trade Costs (percent), 2015

	ATG	BHS	BRB	BLZ	GUY	JAM	KNA	LCA	VCT	SUR	TTO	Average
ATG	-	-	129.0	-	-		110.8	155.7	201.7	-	128.7	145.2
BHS			-	-	-	193.9		169.2	-	-	-	181.6
BRB				130.8	55.1	99.5	99.5	48.7	71.6	97.3	46.0	86.4
BLZ					124.2	103.2	192.8	153.2	230.4	275.5	88.1	162.3
GUY						64.0	140.4	78.0	121.2	47.2	31.9	82.8
JAM							366.2	132.1	157.0	79.6	69.4	140.5
KNA								104.1	112.7	-	93.8	152.5
LCA									66.3	183.8	45.3	113.6
VCT										185.6	60.6	134.1
SUR											-	144.8
TTO											-	70.5

Source: ESCAP World Bank database (2020).
Note: Antigua and Barbuda (ATG), Bahamas (BHS), Barbados (BRB), Belize (BLZ), Guyana (GUY), Jamaica (JAM), St. Kitts and Nevis (KNA), St. Lucia (LCA), St. Vincent and the Grenadines (VCT), Suriname (SUR), Trinidad and Tobago (TTO).

Blockchain technology is being used in the LAC region to support trade facilitation efforts. Since 2018, the IDB has supported the development of CADENA, a blockchain-enabled solution, which allows for automated, secure, and efficient information sharing on authorized economic operators (AEOs) among the customs administrations of Mexico, Peru, and Costa Rica to ensure the efficient implementation of Mutual Recognition Arrangements (MRAs).[7] CADENA works in real time, cutting red tape, increasing transparency and trust. By using blockchain, these customs administrations will have access to the same information, logged only once, securely, and in a single location. This also ensures that traders will enjoy the benefits associated with the MRAs from the time they receive their AEO certification.[8]



7 In 2005, the World Customs Organization came up with a framework to identify secured and trusted actors, otherwise known as authorized economic operators. Almost 80 countries have compiled lists of entities that are certified to meet AEO standards. To make the system work, customs administrations need to share their lists of AEOs with their counterpart agencies. Otherwise, an exporter would get expedited treatment on one side of the border but not the other. This sharing of lists is known as mutual recognition arrangements (MRAs).

8 See *How blockchain can make trade safer* for further details.

3. Factors Affecting Intraregional Non-tariff Trade Costs in CARICOM

This section briefly reviews the main NTB-related trade costs. As defined by Anderson and Wincoop (2004), trade costs are all costs incurred in getting a product to a final user, except the marginal cost of producing the good itself. These include transportation and information costs, tariff and non-tariff barriers, costs associated with a complex legal and regulatory environment, and transaction costs related to the use of different currencies and local distribution. The determinants of both tariff and non-tariff trade costs have been widely discussed in the literature (see, for example, United Nations, 2019).[9] Based on available international evidence, our focus is on non-tariff-related factors that affect costs and that could potentially be positively affected by the implementation of blockchain-based technology. This section focuses on the four most important NTBs affecting trade, which we include in our quantitative analysis in subsequent sections: (a) distance and culture, (b) exchange rates, (c) transfer fees, and (d) required documentation.

A. DISTANCE AND CULTURE

Distance has been found to have a strong negative effect on trade (Disdier and Head, 2008; Leamer, 2007). Regarding the Caribbean, cost as a result of physical separation adds significant challenges to the region's trade prospects due to the region's geography. An average intraregional distance of 1,323 kilometers is estimated to reduce intraregional trade by 35.3 percent. The concern is magnified when one considers that the largest partner for any of the member countries (the USA) is on average 4,067 kilometers away. Cost due to distance includes not only geographic separation between countries but also access to appropriate transportation between islands, which is often limited and expensive.[10] Cultural proximity (common language, religion, or ethnicity) has also been widely cited as an important determinant of bilateral trade flows, which reduces trade costs related to communication (Boisso and Ferrantino, 1997; Frankel, 1997).

B. EXCHANGE RATES

Transaction costs related to bilateral exchange rates are a primary component of the relationship between exchange rates and trade. Exchange rate fluctuations derived from the prevalence of different exchange rate regimes across countries and large periodic adjustments (or smaller but more frequent changes in bilateral exchange rates) could reduce incentives to trade. Studies on cross-border transactions show that firms often decide to hedge against exchange-rate risk or to bear the cost associated with exchange rate fluctuations, thereby impacting trade flows (Klein and Shambaugh, 2006; Qureshi and Tsangarides, 2010). Currently, Guyana, Haiti, Jamaica, Suriname, and Trinidad and Tobago operate under a flexible exchange rate regime.[11] Jamaica, one of the leading intraregional traders, and Haiti present significant currency fluctuations (predominantly devaluations) against the leading vehicular currency, the U.S. dollar. This implies that transaction costs associated with the bilateral currency exchange rates could negatively impact intraregional trade flows.

9 https://unctad.org/en/PublicationsLibrary/ditctab2019d5_en.pdf

10 It is the authors' view that traditional concerns regarding spoken languages and laws governing trade are likely to be of minor significance as the CARICOM region continues to achieve deeper regional integration.

11 Suriname and Trinidad and Tobago have *de facto* managed floating arrangements.

Table 3. Commercial Bank Transaction/Transfer Fees in the CARICOM Region

CARICOM member state	International wire transfer (branch)		Regional wire transfers involving foreign currency		Currency exchange fee
	LCU	US$	LCU	US$	
Antigua and Barbuda	114.8	42.5	51.0	19.0	1% government tax
Bahamas	98.0	98.0	39.0	39.0	Foreign exchange selling rate + government stamp duty
Barbados	87.0	43.5	62.5	31.3	2%
Belize	100.0	50.0	0.0	0.0	NA
Dominica	111.5	41.3	49.5	18.3	Government tax
Grenada	123.5	45.7	37.5	14.0	No charge
Guyana			0.0	0.0	NA
Haiti			0.0	0.0	NA
Jamaica	5,503.0	42.7	0.0	0.0	NA
Montserrat	85.0	31.5	35.0	13.0	1%
St. Kitts and Nevis	124.0	45.9	49.5	18.3	No charge
St. Lucia	119.0	44.1	50.0	18.5	NA
St. Vincent and the Grenadines	122.0	45.2	49.5	18.3	NA
Suriname			0.0	0.0	NA
Trinidad and Tobago	98.00		64.0	9.5	NA

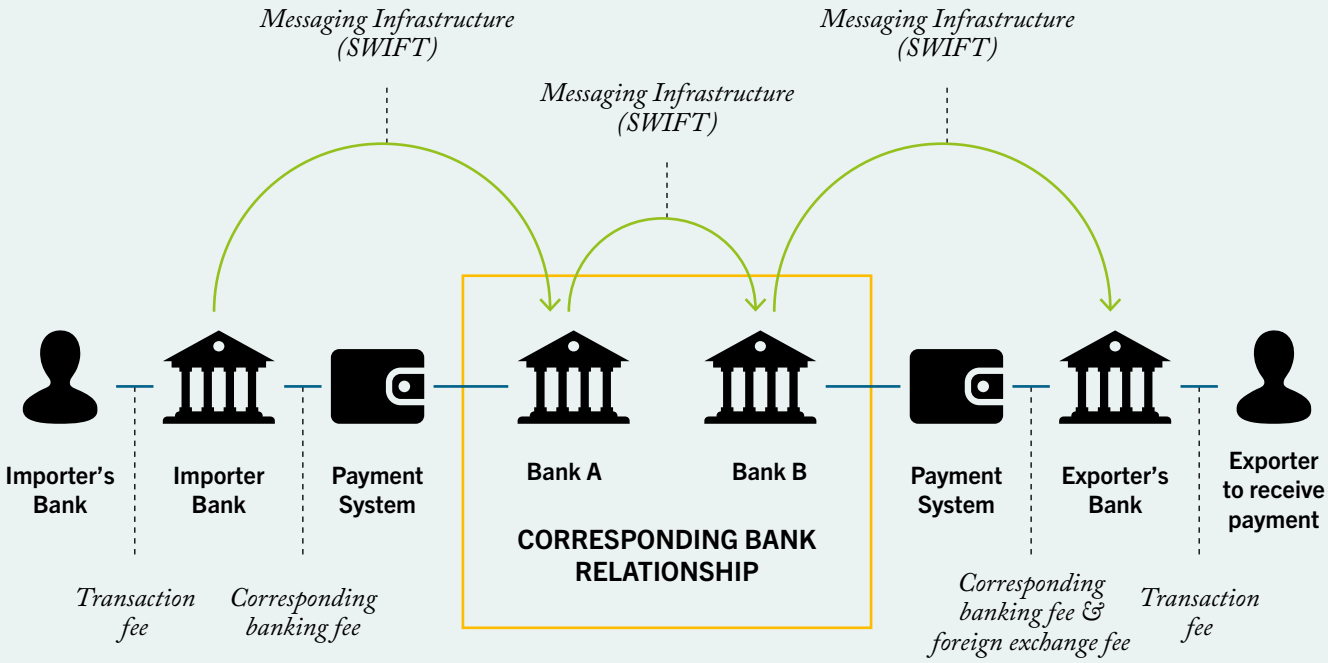
Note: Wire transfers are quoted in local currencies and US currency based on 2018 exchange rates. Bahamas, Belize and Dominica international and regional wire transfer values are based on only two banks. Montserrat international and regional wire transfer values are based on only one bank. Dominica, Grenada, St. Kitts and Nevis and Antigua currency exchange fees are based on only CIBC fees. Bahamas foreign currency exchange fee is based on two banks (CIBC and RBC). *Belize Bank International

C. TRANSFER FEES

New transfer mechanisms for cross-border transactions seem to have eased the process of trading, but they also result in a greater range of transfer fees. Some of the most common methods of conducting cross-border transactions in the Caribbean fall into three categories: (1) pre-paid credit or debit cards, (2) electronic wallet (e-wallet), and (3) digital currency. Although these methods have made it simpler for small business owners to expand their transactional reach, they all imply additional charges in the form of transaction fees.[12] Based on the table below, approximately 1-2 percent of a foreign currency transaction fee is paid to Caribbean financial institutions.

12 Some cash transfer companies have improved their technology to make it easier for the sender to digitally send funds. Depending on the amount of the transfer, the fees can be high.

Figure 2. The Flow of International Payments through Correspondent Banks



Increasingly stringent correspondent banking relationships raise transaction costs. Under correspondent banking schemes, a correspondent banking institution, usually based in richer economies, such as the USA or the European Union, holds an account on behalf of the banks located in the smaller Caribbean economies. Caribbean banks use these correspondent accounts to provide their customers with international and regional money transfer and foreign exchange services. However, this added layer of intervention not only increases the time and complexity of a bureaucratic system of transfer; it also raises the costs for businesses involved in the international exchange, as additional fees are added to the process (Figure 2). The routing mechanism of correspondent banks is to provide services for local banks or financial institutions in a foreign country. This is done for a fee, which is a combination of various regulatory cost elements that ensures compliance in the industry, known as a transaction cost.

D. REQUIRED DOCUMENTATION

Documentary compliance helps to ensure the efficient movement of goods through ports by reducing transaction costs. It entails the standardization of documentary and administrative formalities required for international trade. The burden of the documentation requirement is measured in terms of the time and cost associated with the documentary requirements of all government agencies of the origin economy, the destination economy, and any transit economies (World Bank, 2019). These factors consist of sometimes complex documentation requirements and customs procedures that increase trade cost and impede trade flows across countries. Other contributing factors include, but are not limited to, processing/transfer fees, required documentation, time delays created by back-office operations, and government control policies (prohibition of foreign exchange allocation). With international shipping and other non-tariff costs excluded, costs associated with

Table 4. Documentary Compliance

	Time to export: Documentary compliance (hours)	Time to import: Documentary compliance (hours)	Cost to import: Documentary compliance (US$)	Cost to export: Documentary compliance (US$)
Antigua and Barbuda	51.0	48.0	100.0	121.0
The Bahamas	12.0	6.0	550.0	550.0
Barbados	48.0	46.0	150.0	117.0
Belize	38.0	36.0	75.0	50.0
Dominica	12.0	24.0	50.0	50.0
Grenada	13.0	24.0	50.0	40.0
Guyana	200.0	156.0	63.0	78.0
Haiti	22.0	28.0	150.0	48.0
Jamaica	47.0	56.0	90.0	90.0
St. Kitts and Nevis	24.0	33.0	90.0	100.0
St. Lucia	19.0	14.0	98.0	63.0
St. Vincent and the Grenadines	48.0	24.0	90.0	80.0
Suriname	12.0	24.0	40.0	40.0
Trinidad and Tobago	32.0	44.0	250.0	250.0
Regional Averages				
CARICOM	41.3	40.2	131.9	119.8
East Asia and Pacific	55.6	53.7	108.4	109.4
Europe and Central Asia	25.1	23.4	85.9	87.6
Latin America and Caribbean	35.7	43.2	107.3	100.3
Middle East and North Africa	66.4	72.5	262.6	240.7
OECD high income	2.3	3.4	23.5	33.4
South Asia	73.7	93.7	261.7	157.9
Sub-Saharan Africa	71.9	96.1	287.2	172.5

Source: World Bank *Ease of Doing Business* (2019).

completing documentary and other import and export procedures for international trade could account for up to 15 percent of the value of traded goods globally (ADB/ESCAP 2009). Moreover, Choi (2011) argues that a significant contributor to trade cost comes through the process of facilitation. Specifically, these costs are the consequence of paperwork and of the number of agencies involved, resulting in burdensome procedures. The author found that the median number of government agencies directly involved in cross-border transactions is 15 and can reach 30 in some cases.

Given the region's limited ability to compete or influence prices, any rise in trade-related costs is expected to reduce, or at the very least restrict, the margins of the region's trade. At the aggregate regional level, the CARICOM group shows higher levels of documentary compliance (in terms of time and cost to export and import) compared to other regional groupings such as Europe and Central Asia, high-income OECD countries, and LAC. There is significant heterogeneity in the cost to import and export among CARICOM member states, ranging from US$550 for The Bahamas to US$40 for Suriname.[13] Similarly, with respect to the time to export and import, Guyana reports the highest number of hours (200 and 156, respectively), and The Bahamas reports the lowest time in hours (12 and 6, respectively). Table 4 provides further comparisons across countries and regional groupings.

3.1. Estimating the Impact of NTBs on Intraregional CARICOM Trade

This section analyses the impact of the NTBs reviewed in Section 3 on CARICOM intraregional trade costs. A two-step panel regression gravity model for 15 CARICOM countries between 2006 and 2015 is carried out, following Baier and Bergstrand (2009).[14] This quantitative approach is used in this analysis to quantify the impact of NTBs presented in the previous section on the volume of trade between two countries. Annex 1 contains a more detailed discussion of the model.

Stage one of the model estimates the effects of distance, common colonizer, contiguity, and the OECS currency union on intra-CARICOM exports. Based on the estimated coefficients, presented in Table 1 of Annex 2, sharing borders contributes positively to the value of trade, while distance has negative externalities for trade. These results reaffirm previous findings in the literature. The diversity among the region's heritage shows no impact on the value of intraregional trade. This is unsurprising given that all countries in the analysis are signatories of the same trading agreement since 1965.[15] As discussed in the trade literature, these variables were used as control variables to the model's efficiency. The coefficients of all variables are aligned with the findings of previous researchers (e.g., Alleyne and Lorde, 2014). The results also show that being a member of OECS contributes positively to trade within CARICOM.

The findings of other identified trade costs, estimated in stage two of the model, also confirm previous findings in the literature.[16] Factors that affect intraregional trade in the CARICOM region, and which are not explained in the first stage, are analyzed in stage two. These include the exchange rate, facilitating documentation and institutional fees. As seen in Table 2 of Annex 2, average import tariff rates show no

13 Documentary compliance is a measure of the total burden of preparing the bundle of documents that will enable the completion of the international trade for the product (World Bank Doing Business Indicators, 2019).

14 Source: UN Comtrade Online Database.

15 Caribbean Free Trade Agreement.

16 Stage two provides a linear analysis of specific cost-incurring trade-related components, after the traditional factors has been accounted for in stage one.

impact on intraregional trade. This supports the case for assessing non-tariff factors. The bilateral exchange rate has an average negative impact on the volume of intraregional trade, which also supports previous findings from the literature. Cross-border transactions between firms are often based on costs associated with hedging against exchange rate fluctuations, thereby impacting the flow of trade.[17] Another negative factor for intraregional trade is the transfer-associated fee in completing transactions, which is responsible for approximately 26.1 percent of trade costs not explained in stage one. Finally, documentary requirements pose concerns on intraregional trade flows among CARICOM member countries.

The use of new technologies to promote trade could have positive effects on identified factors that constitute NTBs in the Caribbean. As discussed in Section 2, tThere is growing evidence of the positive effect of blockchain and new technologies in reducing NTBs (Estevadeordal, Rodríguez Chatruc, and Volpe Martincus, 2020). **Although the use of DLT for trade facilitation is still nascent and not widely prevalent in economic policy research, the evidence is quickly growing.** For example, as discussed by Estevadeordal, Rodríguez Chatruc, and Volpe Martincus (2020), Blockdata (2019), and shown in CADENA, costs associated with compliance with administrative procedures (for example, associated with the import and export documentation process) could decrease. Depending on the model of DLT applied, wire transfer costs could also decrease, but the evidence to date on this issue is mixed (Ganne, 2018). However, the potential simplification of transfer processes through greater use of DLT does offer a chance to lower the overall cost of each transaction simply by reducing the number of financial intermediaries involved.[18] Finally, increased automatization in checks and balances could result in shorter timeframes for transaction costs, rendering distance and contiguity effects less relevant in trade costs.[19]

The potential gains to trade from using DLT would depend on the pool of participating countries. Gains to trade from using DLT exclusively for intraregional trade would be limited, as this represents approximately only 10 percent of total trade in the CARICOM region in 2015. However, including Canada, the USA and the UK increases trade volumes approximately 19.5 times.[20] Box 1 presents various scenarios estimating the change in trade volumes for both CARICOM intraregional trade and a larger sample of countries, if DLT were to provide efficiency gains through the reduction of NTBs. Under the assumption of extreme efficiency gains (a 50 percent efficiency gain scenario), the reduction in NTBs leads to intraregional trade increases of less than 1 percent in 2015. Based on potential effects of DLT on trade cost reduction discussed in the previous paragraph, Box 1 estimates potential gains to trade that could be gained realized if trade costs were reduced due to the use of DLT. Including USA, UK and Canada could increase trade by almost 13 percent in 2015 for the same scenario. Therefore, a larger pool of countries would potentially yield greater returns to the application of this technology for trade facilitation in the CARICOM region.

17 The size of this impact is marginal but in accordance with expectations of modern theory, given the involvement of the OECS currency union arrangement. It is worth mentioning that the OECS subregion accounts for approximately 50 percent of CARICOM, and these countries have a common currency. Thus, nominal estimates derived due to currency variation are likely to be inflated, as exchange rate elimination during an intra-OECS trade offers zero benefits. An empirical assessment that excludes intra-OECS trade provides similarly significant value regarding the impact of using different currencies.

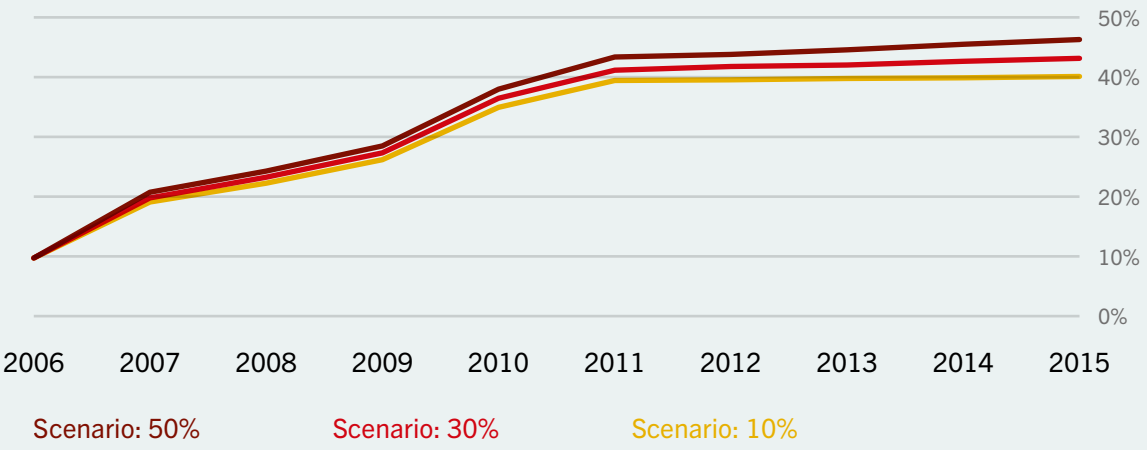
18 https://www2.deloitte.com/content/dam/Deloitte/global/Documents/grid/trade-finance-placemat.pdf

19 https://www.businessinsider.in/heres-how-blockchain-reduces-the-overall-costs-associated-with-trade/articleshow/65484887.cms

20 Based on 2000-2015 trade volumes.

Box 1. The Potential Effects of DLT on Trade in the Caribbean

Figure 3. Cumulative projected increase in intraregional trade due to the introduction of DLT, 2006–2015



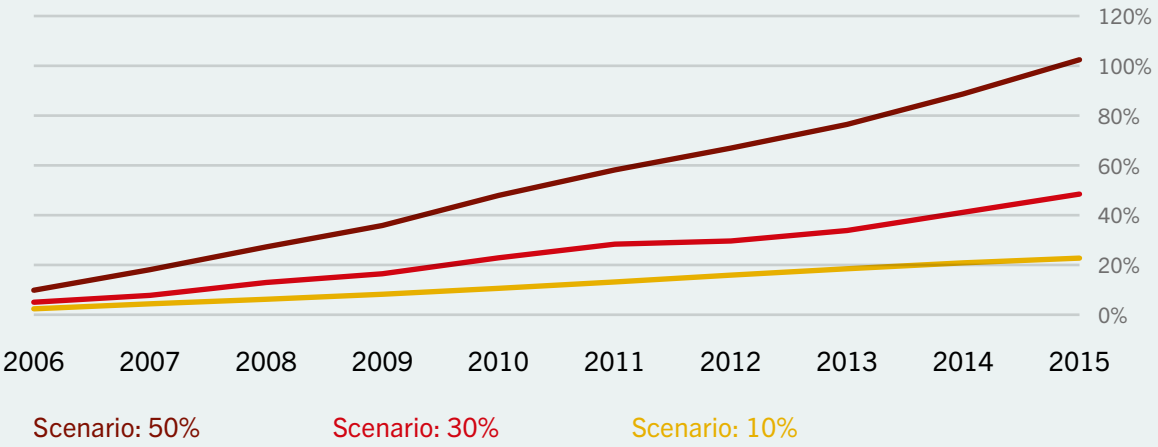
Note: The baseline is considered 0% throughout the period. Source: Based on the authors' calculations.

As an illustrative example, we make use of the coefficients obtained from the two-stage gravity model (Annex 1) to show potential effects of DLT on the volume of trade in the Caribbean region. The calculations presented in this box apply the simplistic assumption that the implementation of a blockchain-based transaction system could lead to three possible scenarios: a 10 percent reduction in costs related to NTBs (low), a 30 percent reduction in costs related to NTBs (moderate) and a 50 percent reduction in costs related to NTBs (high).[21] These assumptions are merely illustrative and draw on strong assumptions regarding the potential effect of DLT in reducing trade costs and also on the subsequent increase in the volume of trade transactions. The argument is made that under the same assumptions, the conceptualization of a Caribbean Settlement Network that makes use of DLT for trade facilitation will have greater impact if it spans beyond intraregional trade alone.

When reducing trade costs associated with the use of DLT solely for intraregional trade transactions, we find marginal potential benefits for trade. Figure 3 shows the projected cumulative increase in trade stemming from the positive externalities of reducing trade costs associated with the use of DLT for trade facilitation. Assuming a 10, 30, and 50 percent efficiency gain

21 Until empirical evidence of blockchain potentials can be ascertained, the research takes a conservative approach and limits the expectations of the technology to a high of 50 percent and provides a range of scenarios to provide an illustrative example.

Figure 4. Cumulative Projected Increase in CARICOM and Major Partners' Trade due to the Introduction of DLT, 2006–2015



Source: Authors' calculations.

due to the removal of trade costs associated with the use DLT, intraregional trade would have increased by approximately 40, 43, and 46 percentage points, respectively, by 2015, compared to the baseline scenario.[22] However, the marginal returns to trade decrease over time, most likely reflecting efficiency gains to trade experienced starting in 2011 stemming from other regulatory and technological advancements in port and customs processes.

Increasing the pool of trading partners to others outside the region would result in greater gains to trade from relaxing trade costs associated with using DLT. The inclusion of the USA, the UK, and Canada in the analysis could substantially increase the benefits of relaxing trade costs associated with the use of DLT. Assuming a 30 and 50 percent efficiency gain due to the removal of trade costs associated with the use of DLT, by 2015, intraregional trade would increase by approximately 48.2 and 101.5 percentage points more than the historical values, respectively (Figure 4).[23] The effect significantly increases under this scenario, as trade volumes for the larger sample of countries were on average 19.5 times larger during the period of study than intra-CARICOM trade volumes. We also find that the annual efficiency gains are more consistent over the whole period of study, compared to an intraregional effect.

22 Until empirical evidence of blockchain potentials can be ascertained, the research takes a conservative approach and limits the expectations of the technology to a high of 50 percent.

23 Using the 10 percent efficiency gain scenario yields lower cumulative effects for the period for the greater sample. This is due to much higher returns to DLT between 2006 and 2011 for the smaller sample, presented in Figure 5. As previously argued, this would reflect the lack of other measures that have reduced NTBs and which have since been put in place.

4. The Application of DLT for Trade Facilitation: Case studies

Section 3 quantified the impact of various factors related to NTBs that affect intraregional trade in the CARICOM region, and analyzed potential effects DLT could have on trade. Based on these findings, factors such as distance, transfer fees, document requirements to trade, and bilateral exchange rates all have negative effects on intraregional trade in CARICOM, whereas contiguity and greater policy union (such as is the case in the OECS) have positive effects on intraregional trade. This section discusses and reviews examples of how DLT can reduce trade costs.

The use of blockchain has been increasing over time to ease financial transactions, particularly among financial institutions. Box 2 introduces the concept of blockchain technology. Blockchain technology was first used in 2008 as a base for the cryptocurrency Bitcoin. From 2008 to 2012, hundreds of similar crypto-based blockchain networks were launched. In 2012, with the release of Ethereum and the introduction of smart contracts, tens of new business use cases appeared, such as supply chain, automation of processes, digital identity, land registries, digital diplomas, and traceability, among others. Since 2015, a number of central banks and financial institutions have started their own proofs of concept to test blockchain technology as a trusted network for communicating payment orders and for transactions. Although the number of entities using blockchain networks to test international payments is still low, research in the area is growing. In 2019, Calibra, a new cryptocurrency announced by Facebook, further challenged regulators and central banks to discuss options to advance in the field.

Box 2. Blockchain Technology and the LACChain Regional Network

As defined in an ECLAC report (Williams, 2017), a blockchain is an implementation of cryptographic technology that enables data to be shared across a network of computers controlled by multiple organizations and individuals. The computers on the network work together to ensure that every piece of information added to the shared data set is cryptographically signed. This cryptographic signature is used to ensure that a given block of data cannot be tampered with, without detection. Each block includes information used to create the cryptographic signature of the previous block. In this way, blocks are "chained" together, such that the content of blocks within the chain cannot be altered without making a series of difficult changes to each subsequent block. This mechanism enables every network user to have assurances that they have the same information that has been agreed upon by all the other actors on the network. Thus, information can be shared among organizations that do not necessarily trust each other. This ability to share information between entities enables interesting applications.

According to the International Standard Organization (ISO/TC 307)[24] there are three types of blockchain: permissionless, permissioned private, and permissioned public. Permissionless and permissioned private networks present important disadvantages for the development of settlement networks between financial institutions. Permissionless blockchain networks are anonymous, there is no privacy, and there is generally a high transaction fee. Permissioned private blockchain networks are not decentralized and transparent enough, and governance rules and scalability are common issues.

Permissioned public networks are a very new concept. Inspired by Alastria, an association of over 500 Spanish entities that includes BBVA, Santander, Cepsa, and Repsol, the Inter-American Development Bank (IDB) and the European Union (EU) decided to launch regional networks for Latin America and the Caribbean, and the European Union, respectively. They aim to provide a decentralized, public, and regulatory compliant network where everyone can join, provided they comply with certain permissioning requirements. This requires an underlying orchestration vehicle.

The blockchain network led by the IDB Lab in a Global Alliance with many blockchain leaders around the world is called LACChain. This Alliance maintains and offers a public-permissioned network as a public good to Latin America and the Caribbean since mid-2019. Permissioning requirements are to be authenticated and must comply with regulation. Large institutions, such as the customs administrations of Chile, Colombia, Costa Rica, Mexico, and Peru, are already using it for the exchange of real-time information, as are the IDB and Citi for a cross-border payment proof of concept, and the Caribbean Examination Council for the issuance of digital diplomas in the Caribbean (for a second phase still in the design stage). This network could be leveraged for piloting a Caribbean settlement network.

24 https://www.iso.org/committee/6266604.html

Recent discussions on how to curtail trade costs, particularly NTBs, point to the potential benefits of using DLT. Some of these benefits include: (i) decentralization and immutability of the information; (ii) smart contracts for the automation of processes including verification of balances, avoidance of double spending, and the exchanges between different currencies; (iii) the promotion of digital identity for know-your-customer (KYC) and anti-money laundering (AML) processes; and (iv) a trusted, secure, and fast channel for the notification of payments. Within the context of CARICOM, Ganne (2018) asserts that effective use of blockchain technology within the region has the potential to promote monetary cooperation among participating members, which will help reduce transaction costs. Expected indirect trade and economic benefits include increased speed in the movement of goods, reduced transaction costs, reduced regulatory compliance delays (e.g., foreign exchange and

some forms of documentation),[25] better risk management practices and improved security, increased transparency, and the protection of international integrity (Ganne, 2018).

Blockchain technology provides a strong case for CARICOM to upgrade the region's financial systems. Intraregionally, a blockchain-based network could potentially offer Caribbean banks an alternative to the current system based on correspondent bank connectivity. This would reduce transaction costs and increase efficiency. According to Blockdata (2019), digital payments can reduce transaction processing costs by 70 percent. Panuparb (2019) also estimated that converting from the use of traditional invoices to smart contract could provide net savings of 13 percent.[26] However, the need to prevent money laundering will remain a burden on the region's financial institutions regardless of the type of technological systems imposed (Williams, 2017).

Although the adoption of blockchain technology promises long-term benefits, as with any new technology, there are associated challenges. The DLT is still at a very nascent stage and lacks complete control and regulation, which could create a risky financial environment.[27] Even though a blockchain only comprises a network of computers connected using traditional internet protocols, using that network to host digital tokens that represent e-money, sending cross-border payment data over it, and leveraging blockchain-based identity for KYC and AML processes requires new regulatory policies if full compliance is to be achieved. Therefore, collaboration between regulators and the private sector, as well as among regulators, governments, and financial institutions, is essential. The disruptive nature of this technology can also reverse the current trends of banking sector de-risking. Important considerations must be given to the potential of this technology in addressing stringent regulatory frameworks relating to AML, which has been increasing costs and compliance requirements for financial transactions in the region. Finally, the merit of different blockchain platforms in the context of the Caribbean must be thoroughly investigated. This space has evolved rapidly over the past three years, and there are now thousands of options with different characteristics and implications. Therefore, a comprehensive analysis of the cost and benefits of blockchain technologies must be conducted before seriously considering its implementation for the facilitation of regional cross-border payments.

Caution is also advised regarding the implications of blockchain for governance.[28] Given the rapid evolution of this technology, literature and best practices in this area remain sparse. Currently, the establishment of blockchain-based transfer of records has a number of difficulties, ranging from privacy to legal concerns. Blockchain technology will likely affect the laws and policies within a country and require partnering nations to harmonize varied domestic policies to prevent risky practices and optimize benefits.

25

26 Using a cost-benefit model and commercial bank data, the author proposed operating processes of the traditional and blockchain-based supply chain financing. Both the model and the processes were applied in a case study, based on three scenarios: (1) using traditional invoices; (2) blockchain smart contracts; and (3) the internet of things and a blockchain-based system.

27 A related concern pertains to the limited literature or proven evidence of the various expressed potentials, which indicates insufficient knowledge to resolve future issues from both a technical and financial standpoint.

28 Understanding the vulnerabilities and risks associated with blockchain technology, risk management, privacy, and security concerns will aid in developing an adequate cost benefit analysis. As noted by the president of Blockchain at Columbia University, attacks on the larger cryptocurrencies are no longer out of reach. In January 2019, Ethereum's decentralized autonomous organization was hacked, causing the loss of millions of dollars' worth of assets (Ganne 2018).

In addition, more research is needed to properly assess the initial cost of establishing a blockchain network in the Caribbean. The software needs initial investment. However, at this stage, it is difficult to estimate the size and potential cost, as it would depend on the number of countries and the range on financial institutions involved in such a transition. Most proofs of concept have not delved into the potential investment costs countries would face when further applying such a technology in cross-country financial transactions for trade.[29] Moreover, specialized personnel are required to maintain efficient operability. This will require countries in the region to either seek expertise from abroad or further promote skills development in this area. Information regarding the financing details of blockchain (proof-of-concept) projects do not reveal details about how costly it is.

4.1. Examples of DLT Projects for Payments and Trade Facilitation

Although the applied use of blockchain technology within the banking industry remains largely in the testing phases, the potential for its application continues to increase (Chapman, et al. 2017). Since 2015, some central banks around the world have started testing DLT to issue and transfer digital currencies. These digital currencies fall into the category of e-money and receive the name of central bank digital currencies (CBDC). Notable examples of CBDC projects are highlighted in Table 5. Note that all these projects are only proofs of concept.

Most of the initiatives in Table 5 are well documented and provide useful lessons. All of them share a common purpose of exploring the use of DLT as an alternative for financial messages, storage of balances, transaction mechanisms, and settlement. These financial institutions also foresee benefits in terms of cost, time, and tax administration, among others.

Three main open-source DLT technologies have been used for proofs of concept: Corda, Quorum, and Hyperledger Fabric. Corda is a technology developed by R3 with the goal of reducing operational costs and risks in the financial system.[30] Quorum is an Ethereum client developed by JP Morgan. Quorum was the preferred technology for permissioned blockchain in the Ethereum community in 2018 and 2019. Presently, Hyperledger Besu appears to be the most used Ethereum client, as the biggest permissioned blockchain networks—Alastria, EBSI, and LACChain—are using it. Hyperledger Fabric is the oldest of the three and is the most modular and versatile. IBM has been one of the most important contributors.

Most of these initiatives have been for domestic payments, and some of them did not even leverage smart contracts. Projects Jasper-Ubin and LBChain seem to be especially good references for this paper, as they tested cross-border payments. As the lessons learned documented by the owners reveal, much still needs to be done to use DLT for digital payments regularly, but it is worth advancing toward it due to the potential to reduce costs, save time, facilitate settlements, and improve tax administration.

29 Other interesting initiatives in 2018 provide insight into the level of financial commitment required by the region: (1) IBM successfully tendered a 1 billion Australian dollar bid to introduce blockchain technology in Australia's public administration systems; (2) European Union and Norway (300 million euros) entered into an agreement on the creation of the European Blockchain Partnership; and (3) Singapore budgets US$100 million in trade finance via blockchain platform for a 12-months.

30 https://www.r3.com/corda-platform/

Table 5. Examples of Advanced CBDC Projects

Project/ Country/Year	Application	Participating actors	Blockchain technology used	Type of network use	Is currency exchanged?	Do they use smart contracts?	Used for cross-border trade?
Project Jasper/ Canada/2016	Potential benefits to interbank payments, focusing on a wholesale payment system.	Payments Canada, the Bank of Canada, TXM Group, the R3 consortium, and Accenture	Corda	Permissioned private	Yes	No	No
Project Ubin/ Singapore/2016	Implications for the financial ecosystem of using a tokenized Singapore Dollar on DLT.	Monetary Authority of Singapore, Bank of America, Merrill Lynch, Credit Suisse, DBS Bank, Hongkong and Shanghai Banking Corporation Limited, JP Morgan, Mitsubishi UFJ Financial Group, OCBC, R3, Singapore Exchange, United Overseas Bank	Ethereum & Quorum	Permissionless & Permissioned private	Yes	Yes	No
Project Jasper-Ubin /Singapore & Canada/2019	Promoting settlements between the Bank of Canada and the Monetary Authority of Singapore without intermediaries.	Bank of Canada, R3, Monetary Authority of Singapore, Accenture, and JP Morgan	Corda & Quorum	Permissioned private	Yes	Yes	Yes
Project Khokha/ South Africa/2018	Use of wholesale payment system for interbank settlement using a tokenised South African rand on DLT.	South African Reserve Bank, Absa, Capitec, Discovery Bank, FirstRand, Investec, Nedbank, and Standard Bank.	Quorum	Permissioned private	Yes	Yes	No
RTGS Renewal Programme/ England/2017	Renew the existing real-time gross settlement service.	Bank of England, Baton Systems, Clearmatics Technologies, R3 and Token	Cloud-based	Permissioned private	Yes	No	No
Project Stella/ Japan & Europe/2016	Testing performance, resilience, and auditability of DLT-based market infrastructures.	Joint research project with the Bank of Japan and the European Central Bank	Interledger js, Hyperledger Quilt, & Hyperledger Fabric	Permissioned private	Yes	No	No
LBChain Platform-Service/ Lithuania/2018	Research and test fintech business solutions in a controlled environment.	Bank of Lithuania, Deloitte, IBM, and Tieto	Hyperledger Fabric & Corda	Permissioned private	Yes	Yes	Yes

Project/ Country/Year	Application	Participating actors	Blockchain technology used	Type of network use	Is currency exchanged?	Do they use smart contracts?	Used for cross-border trade?
Brazil/2016	Testing alternative transaction mechanisms between financial institutions through smart contract, without the supervision of a central bank.	Central Bank of Brazil	BlockApps (phase 1). Hyperledger Fabric, Corda, & Quorum (phase 2)	Permissioned private	Yes	Yes	No
Project Inthanon/ Thailand/2018	Domestic wholesale fund transfer using wholesale CBDC.	Bank of Thailand, R3, Bangkok Bank Public Company Limited, Krung Thai Bank Public Company Limited, Bank of Ayudhya Public Company Limited, KasikornbankPublic Company Limited, Siam Commercial BankPublic Company Limited, Thanachart Bank Public Company Limited, Standard Chartered Bank (Thai) Public Company Limited, and The Hongkong and Shanghai Banking Corporation Limited	Corda	Permissioned private	Yes	Yes	No
E-Krona/ Switzerland/2020	Increase its knowledge of a central bank-issued digital krona.	Riskbank, Accenture, and R3	Corda	Permissioned private	Yes	Yes	No

Although they are not as advanced as the initiatives listed in Table 5, there are two projects in the design phase in the Caribbean that are worth mentioning. The first is Project Sand Dollar, in The Bahamas, led by the Central Bank in partnership with NZIA Limited. The goal is to "explore the use of DLT for potential suppression of economic costs associated with cash usage, and benefits to the Government from improved expenditure and tax administration systems" (Central Bank of The Bahamas, 2019). The second one is led by the Eastern Caribbean Central Bank, aimed at ascertaining the "suitability of blockchain technology to help advance economic growth, resilience, competitiveness and financial inclusion in the ECCU consistent with the Eastern Caribbean Central Bank's monetary and financial stability objectives." [31]

31 https://www.eccb-centralbank.org/files/Blockchain_Technical_Advisor_-_Description_of_Requirements_and_Responsibilities.pdf

5. Conclusion and Next Steps

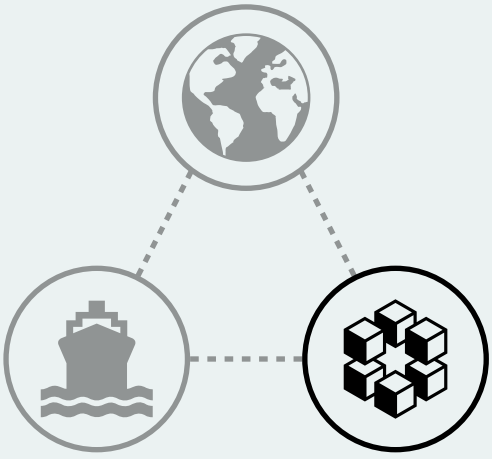
In recent years, intraregional trade has fallen hand in hand with rising trade costs, particularly non-tariff trade costs. During the period under study, intraregional trade fell from 13 percent to 10 percent of total trade in the region. While tariffs are low intraregionally, non-tariff bilateral trade costs in CARICOM countries have been increasing, from 95.4 percent in 2000 to 128.6 percent in 2015. NTBs are linked to stronger adverse impacts on trade than tariff barriers. In fact, they can erase any trade gains that would have normally been achieved through the removal or reductions of tariffs.

Through a two-step panel regression, following Baier and Bergstrand (2009), we find that NTBs, such as distance and culture, exchange rates, transfer fees, and required documentation, have negative effects on trade. In the first stage estimation of the model, we find that having contiguous borders positively contributes to the value of trade, while distance has negative externalities to trade. Being a member of the OECS region also positively contributes to the flow of intraregional trade within CARICOM. This result suggests that being a member of a currency union is highly correlated with the increasing flow of exports with other member states. At stage two, additional factors (not explained at the first stage) that affect intraregional trade in CARICOM were included. The results show that bilateral exchange rates, the number of documents required to trade, and associated fees for completing the (wire) transfer of funds all adversely affect intraregional trade flows.

Increasing empirical evidence suggests that the use of new technologies, such as DLT, could help to lower NTBs promote trade. There is a fast-growing field that is analyzing potential applications of DLT in trade, for example, through digital currencies and smart contracts. Project Jasper, Project Ubin, and E-Krona are three such examples outlined in this brief. The CARICOM region is also starting to mobilize teams and resources to explore these initiatives through project Sand Dollar in The Bahamas, or through the E-dollar in the ECCU. Though in early stages of development and with primarily theoretical outcomes, a blockchain-based outlook in trade could yield positive results and increase the region's trade competitiveness. From lower bureaucratic red tape, increased speed, and transaction efficiency to reduce procedural costs, the list of potential benefits with blockchain are wide and varied. However, important challenges include the required upfront financial investment to design and maintain blockchain applications, and there is still limited literature on the cost-benefit analysis of such initiatives, particularly in the region. Based on the illustrative example developed in Section 3, the potential returns to intraregional trade would be modest when applied solely to CARICOM countries. However, they would be much larger if the pool of countries increased, particularly to include large extraregional partners such as the USA. This result should be considered in any design of a Caribbean settlement network. Under a 50 percent efficiency gain scenario, trade between CARICOM countries, Canada, the USA and UK could increase by almost 13 percent (based on 2015 trade volumes). Therefore, a larger pool of countries would potentially yield greater returns to the application of this technology for trade facilitation. However, these results must be viewed with caution, as the evidence of the effects of DLT on trade facilitation is still nascent. This paper attempts to shed light on this issue, but scant data and evidence are available to provide definitive conclusions. We hope that this study will stimulate more interest and research in this area, particularly in the region, to support governments and policymakers.

Based on these results, policy recommendations emerge which could have profound

effects on trade in the region and in the development of any Caribbean settlement network. A prudent step forward would be to build on more advanced experiences with blockchain technologies in larger financial institutions or in other countries that are generating evidence on the matter. In particular, more homegrown evidence of how transactions could work in the region is necessary. Sand Dollar in the Bahamas and the ECCU digital currency are initial steps in the right direction. Any approach to a Caribbean settlement network should be underpinned by the lessons of the first CARICOM Multilateral Clearing Facility. Moreover, success will depend on strong and committed governance structures, public acceptance, and championing authorities for both greater regional integration through trade and an increased use of DLT. While there has been much discussion of the value of promoting intraregional trade and the importance of reducing associated trade costs, political championing and the advancement of key regulatory reforms at the regional level are required if the use of DLT in financial trade transactions is to become a reality. Moreover, some of the biggest challenges for the constitution of DLT networks to support digital currencies and cross-border payments and settlements are related to maintenance of the networks. Underlying orchestration vehicles, whether government-based or non-government-based, seem to be necessary to maintain DLT networks, as long as they comply with regulations and are economically sustainable. Last but not least, countries' regulatory frameworks must also take into consideration differences across countries to ensure harmonization and compatibility, both within the region and with major trading partners.



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Annex 1. Model

BACKGROUND CONTEXT

Assume a world with N countries and M varieties of goods. All consumers have identical constant-elasticity-of-substitution preference[32]:

$$U_j = [\sum_{i=1}^{N} C_{ij}^{\frac{\sigma-1}{\sigma}}]^{\frac{\sigma}{\sigma-1}} \qquad j = 1, \dots, N \tag{1}$$

where U_j the utility of consumers in country j is, C_{ij} is the good consumed by people in country j imported from country i, σ is the elasticity of substitution and $\sigma>1$[33]. Maximizing utility subject to a budget constraint can solve out the demand for the good consumed in country j imported from country i (X_{ij}):

$$X_{ij} = \left(\frac{p_i \tau_{ij}}{P_j}\right)^{1-\sigma} Y_j \tag{2}$$

Here p_i is the price of the good sold within the importer i. τ_{ij} is the trade cost[33] for goods shipped from country i to country j. Y_j is the GDP of country j, and P_j is the constant-elasticity-of-substitution price index that:

$$P_j = \left[\sum_{j=1}^{N} (p_i \tau_{ij})^{1-\sigma}\right]^{1/(1-\sigma)} \tag{3}$$

Assuming firms maximize profit and all markets are clear, we can write an expression for bilateral trade flow as:

$$X_{ij} = \left(\frac{\tau_{ij}}{\Pi_i P_j}\right)^{1-\sigma} \left(\frac{Y_i Y_j}{Y_w}\right) \tag{4}$$

where Y_w is the world gross GDP and

$$\Pi_i = \left[\sum_{j=1}^{N} (\theta_j / {\tau_{ij}}^{\sigma-1}) {P_j}^{1-\sigma}\right]^{1/(1-\sigma)} \tag{5}$$

$$P_j = \left[\sum_{i=1}^{N} (\theta_i / {\tau_{ij}}^{\sigma-1}) {\Pi_i}^{1-\sigma}\right]^{1/(1-\sigma)} \tag{6}$$

θ_i denotes Y_i / Y_w, that is the share of country i's GDP relative to the world. and are usually known as multilateral resistance. Π_i is the outward multilateral resistance which measures the difficulty for country *i* of exporting goods relative to the rest of the world. P_j is the inward multilateral resistance that measures how difficult it would be for country *j* to import goods relative to the rest of the world. Anderson and Van Wincoop (2004) found that when estimating trade, it is critical to include both inward and outward multilateral resistances into the regression.

Replacing Π_i and P_j in equation 4 with equations 5 and 6, respectively, and taking the natural log of both sides of equation 4, we can derive:

$$\ln(X_{ij}) = (1-\sigma)[\ln(\tau_{ij}) - \ln(\Pi_i) - \ln(P_j)] + \ln(Y_i) + \ln(Y_j) - \ln(Y_w) \tag{7}$$

This measures the relationships between trade flow on the left side and trade cost, multilateral resistance, and GDP on the right side within a given time period. When trade crosses some time periods, equation 7 can be presented as:

32 See Anderson and Van Wincoop (2004) for details.

33 We can assume the trade costs as iceberg trade costs, the cost for goods were lost in transit.

8

$$\ln(X_{ijt}) = (1-\sigma)[\ln(\tau_{ijt}) - \ln(\Pi_{it}) - \ln(P_{jt})] + \ln(Y_{it}) + \ln(Y_{tj}) - \ln(Y_{wt})$$

REGION'S UNILATERAL ESTIMATION

There are two channels through which non-tariff trade costs might influence trade flows. If these impacts occur through producers, it could be expected that there should be a negative shock impact arising via exports with a delayed effect (Manova, 2013). If the impacts occur through consumers, there should be a negative shock on trade flow at the time when importers have to face these costs. Therefore, it would be appropriate for the trade facilitation cost to be treated as a bilateral effect, defined as:

9

$$\tau_{ijt} = d_{ij} e^{\gamma_1 . g_{ij} + \gamma_2 . FI_{it} + \gamma_3 . FI_{jt} + u_{ijt}}$$

where d_{ij} is the distance between country *i* and *j*, g_{ij} is the vector of other geographic information, such as contiguity and language, and *FI* is the vector that contains the information about trade facilitation costs the can be present in several different forms. In this model, trade facilitation costs are measured separately for the importer and the exporter.

Baier and Bergstrand (2009) introduced the method to linearly approximate the multilateral resistances. For the bilateral trade costs, those resistance terms in equations 5 and 6 can be presented as:

10

$$\ln(\Pi_{it}) = \left[\sum_{j=1}^{N} \theta_j \ln(\tau_{ijt}) - \frac{1}{2}\sum_{k=1}^{N}\sum_{m=1}^{N} \theta_k \theta_m \ln(\tau_{kmt})\right]$$

11

$$\ln(P_{jt}) = \left[\sum_{i=1}^{N} \theta_i \ln(\tau_{ijt}) - \frac{1}{2}\sum_{k=1}^{N}\sum_{m=1}^{N} \theta_k \theta_m \ln(\tau_{kmt})\right]$$

In the theoretical derivation, τ_{kmt} represents a trade cost taken from a product-industry-time dimension. Plug equations 10 and 11 back into equation 8 and take the linear expansion to $\ln(\tau_{ijt})$, and combine it with equation 9. The regression changes to:

12

$$\ln(X_{ijt}) = \alpha_0 + \beta_1 \widetilde{\ln(d_{ij})} + \beta_2 \widetilde{border}_{ij} + \beta_3 \widetilde{ccol}_{ij} + \delta_1 FI_{it} + \delta_2 FI_{jt} + \varphi_1 \ln(Y_{it}) + \varphi_2 \ln(Y_{tj}) + \varphi_3 \ln(Y_{wt}) + \beta_1 \overline{\ln(d_{ij})} + \beta_2 \overline{border}_{ij} + \beta_3 \overline{ccol}_{ij} + \varepsilon_{ijt}$$

where:

13

$$\widetilde{\ln(d_{ij})} = \ln(d_{ij}) - \sum_{j=1}^{N} \theta_j \ln(d_{ij}) - \sum_{i=1}^{N} \theta_i \ln(d_{ij})$$

14

$$\widetilde{border}_{ij} = border_{ij} - \sum_{j=1}^{N} \theta_j border_{ij} - \sum_{i=1}^{N} \theta_i border_{ij}$$

15

$$\widetilde{ccol}_{ij} = ccol_{ij} - \sum_{j=1}^{N} \theta_j ccol_{ij} - \sum_{i=1}^{N} \theta_i ccol_{ij}$$

16

$$\overline{\ln(d_{ij})} = \sum_{k=1}^{N}\sum_{m=1}^{N} \theta_k \theta_m \ln(d_{km})$$

17

$$\overline{border}_{ij} = \sum_{k=1}^{N}\sum_{m=1}^{N} \theta_k \theta_m border_{ij}$$

18

$$\overline{ccol}_{ij} = \sum_{k=1}^{N}\sum_{m=1}^{N} \theta_k \theta_m ccol_{ij}$$

$border_{ij}$ is the measurement for contiguity, and $ccol_{ij}$ measures having a common colonizer after 1945. The traditional model includes a measurement for language, although this variable is removed since 13 of the 15 member states share a common official language. Since $\overline{\ln(d_{ij})}$, $\overline{border}_{ij}$ and $\overline{ccol}_{ij}$ are the gross average of the distance, contiguity, and

common colonizer of the world, these variables are constant for the same year. Use year fixed effect to absorb all these variables and $\ln(Y_{wt})$, which is the GDP for the whole world that year. The regression will be estimated as:

19

$$\ln(X_{ijt}) = \alpha_0 + \beta_1 \widetilde{\ln(d_{ij})} + \beta_2 \widetilde{border}_{ij} + \beta_3 \widetilde{ccol}_{ij} + \delta_1 FI_{it} + \delta_2 FI_{jt} + \varphi_1 \ln(Y_{it}) + \varphi_2 \ln(Y_{tj}) + \varphi_3 I_t + \varepsilon_{ijt}$$

Here, I_t is year fixed effect, inclusive of both inward and outward multilateral resistance terms.

Acknowledging issues of zero trade and heteroscedasticity which, if unaccounted for could lead to biased results, the chosen technique of estimation is the Poission Psuedo Maximum Likelihood structured panel. Unlike linear estimators, this technique does not assume homoscedasticity, and it remains valid under general forms of heteroscedasticity. The dependent variable is not logged. For numerous reasons, some trading partners simply do not exchange a variety of products, thus indicating zero bilateral trade activity. However, the handling of zero trade has long caused empirical concerns.

The presence of zero values in trade is attributed to a variety of factors. These include a genuine lack of trade between countries, or rounding errors when recorded values between countries do meet a specified minimum value, or when rounding down equates to zero. It can also result from measurement errors where observations are mistakenly recorded as zero. Another likely rationale is the possibility of underreporting and inefficient recording of border transactions, resulting from various development concerns faced by many less developed or poorer countries like those in the Caribbean. Following works of Santos Silva and Tenreyro (2006), this research uses Poission Psuedo Maximum Likelihood technique with the robust Eicker-White estimator for the covariance matrix, which has been identified to deal with the zeroes in trade flow efficiently and any issues caused by the log-linear transformation.

TWO-STAGE UNILATERAL ESTIMATION

The regression will include country-year fixed effects. These fixed effects will absorb the inward/outward multilateral effect effects, importer's GDP, exporter's GDP and world GDP for the same year. We will also allow the trade facilitation to have a bilateral effect. In the first stage (Equation 1), bilateral trade between countries i and j in year t (X_{ijt}) is regressed on variables relating to NTBs outlined in Section 2, excluding country-pair related costs. $border_{ij}$ is the measurement for contiguity, $ccol_{ij}$ measures having a common colonizer after 1945, I_{it} is the exporter-year fixed effect, and I_{it} is the importer-year fixed effect, which captures country-specific information, including the log of GDP and the multilateral resistance that is unchanged in the country-year dimension.

20

$$\ln(X_{ijt}) = \alpha_0 + \beta_1 \ln(d_{ij}) + \beta_2 border_{ij} + \beta_3 ccol_{ij} + \delta_1 I_{it} + \delta_2 I_{jt} + \varepsilon_{ijt}$$

where I_{it} is the exporter-year fixed effect and I_{jt} is the importer-year fixed effect.

According to Baier and Bergstrand (2009), an alternate view is that all these effects have the same impact across all exporters (or importers), requiring a two-stage process when assessing the effects of such trade-facilitating indicators on exporters and importers. In the first stage, bilateral trade is regressed on all trade costs excluding FI_{ijt}. The estimates of I_{it} and I_{jt} capture the country-specific information, include the log of GDP and the multilateral resistance that is unchanged in the country-year dimension. Thus, in the second stage, the focus will be the trade- facilitating costs. These include tariffs, bilateral exchange rates, transfer fees, and red tape. Using a linear approach, costs brought about by financial intermediaries (i.e.,

commercial banks) are assessed based on the country-pair fixed effects estimated in stage one. Transfers and payments abroad through a bank incur costs for both the sender and the recipient. Therefore, the second-stage regressions, which analyze the impact from the exporters' side and the importers' side, respectively, are as follows:

1.21

$$coefficients\ from\ I_{it} - \ln(GDP_{it}) = \alpha_0 + \delta_1 FI_{it} + \beta \sum_{j=1}^{N} \theta_j \tau_{ijt} + \varphi_1 I_t + \varepsilon_{ijt}{}^4$$

1.22

$$coefficients\ from\ I_{jt} - \ln(GDP_{jt}) = \alpha_0 + \delta_1 FI_{jt} + \beta \sum_{i=1}^{N} \theta_i \tau_{ijt} + \varphi_1 I_t + \varepsilon_{ijt}{}^5$$

coefficients from $I_{it} - \ln(GTP_{it})$ and *coefficients from* $I_{jt} - \ln(GTP_{jt})$ represent the outward and inward multilateral resistance, respectively.

Annex 2. Results Tables

Table 1. Stage 1 - Dependent variables - Bilateral Exports

Stage 1 Time-Invariant/control Variables	
Contiguity	1.0291***
	(0.1517)
Common colonizer post 1945	-0.3268
	(0.5108)
Weighted distance (pop-wt, km)	-0.3534***
	(0.0449)
OECS currency states	1.2341***
	(0.1233)
Observations	1,692
R-squared	0.9866
Exporter-time fixed effects	YES
Importer-time fixed effects	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 2. Stage 2 - Bilateral Estimation Results

Stage 1 Variables	
Bilateral (geometric) average import tariff	0.1415
	(0.1163)
Bilateral currency exchange rates, annual	-0.0399**
	(0.0161)
ln(Regional wire transfer fee (USA))	-0.2607**
	(0.1155)
ln(No. of documents to trade)	-0.1364***
	(0.0322)
Constant	-13.6905***
	(1.1942)
Observations	670
Number of cross-sections	84
GDP share weighted logged distance	YES
GDP share weighted contiguity	YES
GDP share weighted contiguity	YES

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Annex 3. Empirical Assessment of CARICOM Trade including United States, United Kingdom, and Canada

Tabel 1. Stage 1 - Estimation Results

Dependent variables - Bilateral Exports	
Time-Invariant/control Variables	
Contiguity	1.1665***
	(0.2695)
Common colonizer post 1945	0.8461***
	(0.1373)
Weighted distance (pop-wt, km)	-0.4724***
	(0.0332)
OECS currency states	1.8307***
	(0.1187)
Observations	2,549
R-squared	0.978
Exporter-time fixed effects	YES
Importer-time fixed effects	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.10

Tabel 2. Stage 2 - Bilateral Estimation Results

Dependent variables - Bilateral Exports		
Variables	(1)	(2)
Bilateral (geometric) average import tariff	0.4764***	0.4864***
	(0.1205)	(0.1202)
Bilateral currency exchange rates, annual	-0.1025***	-0.0919***
	(0.0209)	(0.0234)
ln(Wire Transfer Fee (US))	0.0102	0.0058
	(0.0770)	(0.0772)
ln(No. of documents to trade)	-0.2393***	
	(0.0382)	
ln(No. of documents to export)		-0.5851***
		(0.1462)
ln(No. of documents to import)		-0.3676***
		(0.0664)
Constant	-28.4386***	-27.5982***
	(0.7859)	(0.8016)
Observations	1,186	1,186
Number of cross-sections	156	156
GDP share weighted logged distance	YES	YES
GDP share weighted contiguity	YES	YES
GDP share weighted contiguity	YES	YES

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.10