Sapienza University of Rome

Department of Economics and Social Sciences

Essays on ACP-EU trade relations with application on trade in value added and the post-Brexit scenario

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Ph.D. Candidate:
Mohamed Hamid

Supervisors:
Prof: L. Alan Winters
Prof: Pierluigi Montalbano

SAPIENZA
UNIVERSITÀ DI ROMA

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Table 1 shows acronyms

Acronym	Meaning	Acronym	Meaning
ACP	African, Caribbean and Pacific	LDCs	Leat Developed countries
ADP	Antidumping	LI	Low Income
AGOA	African Growth and Opportunity Act	LMI	Lower Middle Income
AHS	Effectively Applied	MAST	Multi-Agency Support Team
ASEAN	Association of Southeast Asian Nations	MFN	Most Favoured Nation
CA	Central Africa	MNEs	Multilateral Enterprises
CAF	Central African Republic	MRTs	Multilateral Resistance Terms
CAP	Common Agricultural Policy	NAFTA	North American Free Trade Agreement
CARICUM	Caribbean Community	NEs	National Enterprises
CARIFORUM	Caribbean Forum	NTMs	Non-tariff Measures
CCT	Common Customs Tariff	OCT	Overseas Countries and Territories
CEF	Connecting Europe Facility	OECD	Organisation for Economic Co-operation and Development
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales	OECS	Organisation of Eastern Caribbean States
CES	Constant Elasticity of Substitution	OLS	Ordinary Least-Squares
CRNM	Caribbean Regional Negotiating Machinery	OMR	Outward Multilateral Resistance
CU	Customs Union	ONS	Office for National Statistics
CVD	Countervailing duties	PPML	Poisson Pseudo-Maximum Likelihood
DC	Domestic Content	PTA	Preferential Trade Agreement
DCs	Developing countries	QF	Quota-Free
DDC	Domestic Double-Counted	QRS	Quantitative Restrictions
DF	Duty-Free	RoO	Rules of Origin
DRC	Democratic Republic of the Congo	RTA-IS	Regional Trade Agreement Information System
DVA	Domestic Value-added	SACUM	Southern African Customs Union
EAC	East African Community	SADC	Southern African Development Community
EBA	Everything But Arms	SFG	Safeguards
ECJ	European Court of Justice	SM	Single Market
EEC	European Economic Community	SPS	Sanitary and Phytosanitary
EF	Fixed Effects	SPS_STC	specific trade concern raised against an SPS
EPA	Economic Partnership Agreements	SSA	Sub-Saharan Africa
ESA	Eastern and Southern Africa	SSG	Special Safeguards
EU	European Union	STE	State trading enterprises
EXS	Export subsidies	TBT	Technical Barriers to Trade
FAO	Food and Agriculture Organization	TBT_STC	Specific Trade Concern raised Against a TBT
FC	Foreign Content	TCA	Trade and Cooperation Agreement
FD	Final Deman	TCAs	Trade Continuity Agreements
FDC	Foreign Double-Counted	TEU	Treaty on European Union
FDI	Foreign Direct Investment	TiVA	Trade in Value-added
FTA	Free Trade Agreement	TRQ	Tariff-Rate Quotas
FVA	Foreign Value-Added	TTIP	Transatlantic Trade and Investment Partnership
GDP	Gross Domestic Product	UK	United Kingdom
GSP	Generalized Scheme of Preference	UMI	Upper Middle Income
GVC	Global Value Chain	UNCTD	United Nations Conference on Trade and Developmen
GVCB	Backward-GVC	UNIDO	United Nations Industrial Development Organization
GVCF	Forward-GVC	USA	United States of America
HI	High Income	USD	United States Dollar
ICIO	Inter-Country Input-Output	VA	Value-Added
IMF	International Monetary Fund	VS	Vertical Specialization
IMR	Inward Multilateral Resistance	WA	Western Africa
IO	Input-Output	WB	World Bank
ITC	International Trade Centre	WBG	World Group Bank
I-TIP	Integrated Trade Intelligence Portal	WITS	World Integrated Trade Solution
Lao PDR	Lao People's Democratic Republic	WTO	World Trade Organization

INTRODUCTION

This thesis consists of three essays. They are all related and investigate trade (at aggregate and value-added level) relations between African, Caribbean, and Pacific (ACP), and the European Union (EU) with a focus on the post-Brexit scenario. The first goal of the analysis is to understand how all preference arrangements (Economic Partnership Agreements (EPAs), Free Trade Agreement (FTAs), and Generalized Scheme of Preferences (GSPs)) have affected the ACP-EU trade (at aggregate level) relationships. This ex-post assessment will be used to make predictions about the post-Brexit scenario. Then the thesis investigates in depth the notion of trade in value-added, this thesis analyzes the trade in value-added (TiVA) providing an overview of the participation of these regions in international network production. Finally, this thesis investigates further how non-tariff measures (NTMs) affect ACP's agriculture and food sectors' participation in backward and forward Global Value Chains (GVC).

This first essay focuses on the policy analysis of Brexit impact on ACP-UK gross trade flows to better understand the historical and institutional setting that have been governing trade relations between the two regions (ACP & UK) since the 1970s within the context of EU-ACP EPAs framework with a focus on Caribbean Forum (Cariforum) countries. This study's contribution to the literature is the first on an empirical analysis of Brexit's impact on the UK-ACP (Cariforum) trade relation post-Brexit. To do this, this work applies the empirical gravity model on unbalanced panel data from 248 importing countries. The estimation will be carried out using a framework of advanced econometrics techniques that control for endogeneity issues and observations of zero trade flows. Where the dummy variables (EPA, FTA, GSP, Lomé) for bilateral trade flows between 248 exporters and 248 importers over the period from 1976 to 2019, enter additively (table 32). The innovative specifications of building up of the dummy variables allow to know how much a country enjoys EPA to access the UK/EU market, will be better off than a country without EPA but enjoys other preferential access (FTA, GSP, GSP+) to the UK/EU market. Also to know how much LDC country enjoys EBA & EPA to access the UK/EU market will be better off than LDC country without EPA but enjoys GSP, GSP+, EBA to access the UK/EU market. This study covers the period from 1976 to 2019.

The first essay shows that the overall impact of Economic Partnership Agreements (EPAs) on trade flows from ACP to the UK is nonsignificant for the majority of ACP countries, specifically African and Pacific blocs. These outcomes provide some useful tips for post-Brexit policymaking: 1) Most developing countries lack the necessary pre-conditions to take advantage of the free market access granted to them by the EU. 2) Not to treat all the developing countries as one group rather implement trade and development policy that addresses their different social and economic needs. 3) It is necessary that the UK revises the vulnerability thresholds (eligibility to the GSP plus regime) and the graduation thresholds upwards to ensure that pre-Brexit beneficiaries are not removed from the UK's GSP post-Brexit (Borchert & Di Ubaldo, 2020).

The second essay provides an overview of methodologies employed to measure trade in value-added and compute measures of backward and forward GVCs. It further investigates their similarities and differences and then applies the most appropriate method to analyze the ACP-UK/EU-27 trade in global value-added and participation in international network production. This essay compares the most common methodologies on the decomposition of gross exports e.g; Hummels et al., (2001), approach, Koopman et al., (2014), and Borin & Mancini (2019). After a rigorous comparison, this study finds similarities and disparities between these approaches, and finds that Borin & Mancini (2019) is the most appropriate approach for this study because it refines the vertical specialization measure of Hummels

et al., (2001), refines and extends Koopman et al., (2014), and addresses the limitations of other previous studies.

Therefore this study uses Borin & Mancini (2019) to analyze the ACP-UK/EU-27 trade in global value-added. To this end, given the limitation of traditional trade statistics, EORA tables combine standard trade statistics with national Input-Output (IO) tables to form production and consumption linkages among industries and countries. Thus EORA tables allow us to evaluate global networks production activities based on gross exports and value-added trade relations of goods between sectors, countries, and regions. This essay's contribution to the literature is the first on an empirical investigation of ACP-UK/EU-27 trade in global value-added and participation in international networks production, using a robust methodology developed by Borin & Mancini (2019) to overcome the limitations of all previous methodologies.

The results show that the ACP blocs with the highest level of overall GVC-related trade activities in bilateral exports to the UK/EU-27 are the Southern African Development Community (SADC) and Caribbean (Cariforum countries). The ACP blocs GVC-related trade activities in bilateral exports to the UK are mainly driven by upstream linkages between ACP blocs and the UK except for the Eastern and Southern Africa (ESA) countries. The ESA countries' GVC-related trade activities in bilateral exports to the UK are based on downstream linkage between the UK and ESA countries. Similarly, the ACP blocs GVC-related trade activities in bilateral exports to the EU-27 are mainly driven by upstream linkages between ACP blocs and the EU-27 except for ESA countries. Conversely, the UK GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the UK and ACP blocs. Also, the EU-27 GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the EU-27 and ACP blocs.

At the country level, the share of Domestic Value-added (DVA) of ACP's gross exports to the UK is very high. The UK is the main destination market for some ACP countries such as Botswana, Mauritius, Guyana, Seychelles, Kenya, Jamaica, Swaziland, Belize, the Bahamas, South Africa, Ghana, Malawi, Namibia, Barbados, Gambia, and Saint Lucia. But ACP markets are not the main destination for UK exports. While the EU-27 is the main destination market for almost all ACP countries. But ACP markets are not the main destination for the EU-27 exports.

At the sector level, the share of DVA of gross exports of the UK and the EU-27 to the ACP is very high in all sectors. The UK and the EU-27 exports to ACP countries are mainly final goods and high manufactured products. ACP countries export raw materials and intermediate inputs to the UK and the EU-27. The share of DVA of ACP's gross exports to the UK and EU-27 is very high in all sectors. But ACP exports to the EU-27 and the UK are mainly dominated by agricultural products, food and beverage, mining and quarrying, and metal products. Therefore; in the subsequent essay, the focus will be on the agriculture and food & beverages sectors to carry out the empirical analysis.

The last essay studies the effect of non-tariff measures (NTMs) associated with shifts in trade regimes on ACP countries with a focus on food & agricultural sector participation in backward (the use of foreign intermediate goods for the production of goods for exports) and forward (the use of domestic inputs in third country exports) GVCs. To do so, this essay applies a gravity-like of trade in value-added proposed by Balié et al., (2019), the decomposition framework developed by Borin and Mancini (2019), and the NTMs quantity-based approach proposed by Berden et al., (2009).

This essay is the first to investigate the impact of NTMs associated with shifts in trade regimes on ACP's trade in value-added and food & agricultural forward and backward participation in GVCs. This

study contributes to the literature by applying an empirical gravity model of value-added trade to estimate the effect of trade policy on ACP's food & agricultural backward and forward participation in global network productions.

This essay focuses on the agricultural sector and food & beverage sector because ACP's exports are mainly dominated by agricultural products and food and beverage products and NTMs are higher in these two sectors. Policymakers in ACP countries should pay attention to sectors where NTMs are the highest (i.e. where the highest potential gain from trade can be achieved), like the agricultural sector and food & beverage sector.

The results show that the bilateral tariffs and NTMs are not only impeding the trade of goods between two ACP partners but also affect the participation of ACP exporting countries in food and agriculture forward-GVC (GVCF) and backward-GVC (GVCB) (where intermediate inputs cross national borders multiple times). Moreover, ACP countries' participation in GVCF & GVCB does not only rely on the trade protection level they face from all the countries in the world, but also on their own level of protection applied in the same sector. Figures and tables are presented in the appendices section.

INDICES

FIRST ESSAY

The effect of Brexit on African Caribbean and Pacific (ACP) Countries; Case Study: the Caribbean Forum (Cariforum) Countries

ABSTRACT

This essay investigates the impact of Brexit on trade relations between the UK and ACP countries post-Brexit with a focus on Cariforum. This study's contribution to the literature is the first on an empirical analysis of Brexit's impact on the UK-ACP (Cariforum) trade relation post-Brexit. To do this, this work applies the empirical gravity model on unbalanced panel data from 248 importing countries. The estimation will be carried out using a framework of advanced econometrics techniques that control for endogeneity issues and observations of zero trade flows. Where the dummy variables (EPA, FTA, GSP, Lomé) for bilateral trade flows between 248 exporters and 248 importers over the period from 1976 to 2019, enter additively (table 32). The innovative specifications of building up of the dummy variables allow to know how much a country enjoys EPA to access the UK/EU market, will be better off than a country without EPA but enjoys other preferential access (FTA, GSP, GSP+) to the UK/EU market. Also to know how much LDC country enjoys EBA & EPA to access the UK/EU market will be better off than LDC country without EPA but enjoys GSP, GSP+, EBA to access the UK/EU market. This study covers the period from 1976 to 2019.

This work started in 2017 in a way that allows making some judgments and predictions about the UK-ACP post-Brexit trade relationships. The main contribution of this work lies in the empirical investigation that allows making predictions about Brexit's impact on ACP-UK trade relations post-Brexit.

This study shows that the overall impact of Economic Partnership Agreements (EPAs) on trade flows from ACP to the UK is nonsignificant for the majority of ACP countries, specifically African and Pacific blocs. These outcomes provide some useful tips for post-Brexit policymaking: 1) Most developing countries lack the necessary pre-conditions to take advantage of the free market access granted to them by the EU. 2) Not to treat all the developing countries as one group rather implement trade and development policy that addresses their different social and economic needs. 3) the UK must revise the vulnerability thresholds (eligibility to the GSP plus regime) and the graduation thresholds upwards to ensure that pre-Brexit beneficiaries are not removed from the UK's GSP post-Brexit (Borchert & Di Ubaldo, 2020). Figures and tables are presented in the appendices section.

Keywords: Brexit, Cariforum, trade agreements, gravity model, ACP

JEL classification: F1, F13, F14, F15.

TABLE OF CONTENTS

1. INTRODUCTION

In March 2017, The United Kingdom (UK) Prime Minister, Theresa May, officially triggered Article 50 of the Treaty on European Union (TEU). While in February 2017, the UK government had mentioned, in the document entitled 'The United Kingdom's exit from and a new partnership with the EU, presented to the UK parliament by the Prime Minister, the leaving conditions of exit from the EU that should be the main points of the negotiation process with the EU.[1] On 31 January 2020, the UK left the EU, and on 24 December 2020 signed Trade and Cooperation Agreement (TCA) with the EU. The transitional period ended on 31 December 2020, and the UK exited from the single market and customs union. From 1ST January 2021, the UK trades with the EU under the new EU-UK TCA relationship. Even with the zero tariffs, zero-quotas trade, the new EU-UK TCA (i.e. free trade agreement) will involve new trade barriers between the two sides of the channel.

From 1973 to the end of 2020, developing countries access the UK market under two types of regimes: the EU's Free Trade Agreements (FTAs), mostly the EU Economic Partnership Agreements (EPAs), and the EU's Generalized Scheme of Preferences (GSPs). The future of trade relationships between the UK and developing countries (DCs) depends on the EU–UK trade relationship. From 1ST January 2021 the EU's GSPs, the EU's FTAs, and the EU's EPAs no longer apply to the UK. In the absence of a new arrangement, developing country exporters will no longer have preferential access to the UK market.

To guarantee preferential access to the UK market, the UK government expressed its intention to replicate the EU-developing countries' arrangements (FTAs, EPAs, GSPs) under Trade Continuity Agreement (TCAs)[2]. The UK-developing countries' TCAs are the UK's approach to maintaining continuity in the trade relationship between the UK and the developing countries. The UK-ACP EPAs are not exactly the same as the EU-ACP EPAs but they are very similar. Therefore; on 22 March 2019 the UK government signed EPA with fourteen Cariforum countries (Cariforum-UK EPA).[3]

The Cariforum-UK EPA covers Antigua and Barbuda, the Bahamas, Barbados, Belize, Dominica, Dominican Republic, Grenada, Guyana, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago. The Republic of Suriname has approved the agreement. The UK eliminates all tariffs on all goods imported from Cariforum countries, while they continue gradually to remove tariffs on most of the imports from the UK.

On 14 March 2019, the UK government signed EPA with two Pacific Islands (UK-Pacific EPA); Fiji and Papua New Guinea. On 31 January 2019, the UK government signed EPA with four ESA countries (UK-ESA EPA); Madagascar, Mauritius, Seychelles, and Zimbabwe. On 9th October 2019, the UK government signed EPA with Southern African Customs Union member states and Mozambique (UK-SACUM EPA) which covers six countries; Botswana, Eswatini, Lesotho, Namibia, South Africa, and Mozambique.

Similarly, in February 2019 the UK government signed trade agreements with Switzerland and Israel and expressed its intention to maintain the pre-Brexit arrangements (i.e. to replicate EU trade agreements) covering more than 70 countries which represent 11% of total UK trade. All these TCAs took effect from 1ST January 2021.

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[1] The United Kingdom's exit from and new partnership with the European Union. https://www.gov.uk/government/publications/the-united-kingdoms-exit-from-and-new-partnership-with-the-european-union-white-paper/the-united-kingdoms-exit-from-and-new-partnership-with-the-european-union--

[2] Existing UK trade agreements with non-EU countries. https://www.gov.uk/guidance/uk-trade-agreements-with-non-eu-countries

[3] UK signs trade continuity agreement with Caribbean countries on 22 March 2019. https://www.gov.uk/government/news/uk-signs-trade-continuity-agreement-with-caribbean-countries

This study examines the effect of Brexit on ACP countries with a focus on Caribbean Forum (Cariforum) countries. This work focuses on Cariforum countries as a case study because the EPA between the EU and Cariforum states is the only comprehensive EPA agreement signed so far by all parties in October 2008. Haiti signed in December 2009, not applying it yet and pending its ratification.

The treatment of developing countries within trade agreements got much more to offer than just a number of how much ACP (Cariforum) countries are going to suffer from Brexit. This work started four years ago (i.e. since 2017) and in a way that allows making some judgments and predictions about the UK-ACP (Cariforum) post-Brexit trade relationships.

The first goal of the analysis is to understand how all these preference arrangements (EPA, FTA, and GSP) have affected the UK-ACP (Cariforum) trade relationships and the estimation will be carried out in a way that will allow making predictions about Brexit's impact on ACP-UK trade relations post-Brexit.

The objective of this study is to "assess the impact of Brexit on Cariforum countries." The analysis will be carried by analyzing the possible options that will be adopted by the UK government after Brexit, and how this will affect the UK-ACP (Cariforum) trade relationship. In other words, Brexit will be seen as is a shock in trade policy potentially able to change ACP countries' level of trade flows.

This study's contribution to the literature is the first on an empirical analysis of Brexit's impact on the UK-ACP (Cariforum) trade relation post-Brexit. To do this, this work applies the empirical gravity model on unbalanced panel data from 248 importing countries. The estimation will be carried out using a framework of advanced econometrics techniques that control for endogeneity issues and observations of zero trade flows. Where the dummy variables (EPA, FTA, GSP, Lomé) for bilateral trade flows between 248 exporters and 248 importers over the period from 1976 to 2019, enter additively (table 32). The innovative specifications of building up of the dummy variables allow to know how much a country enjoys EPA to access the UK/EU market, will be better off than a country without EPA but enjoys other preferential access (FTA, GSP, GSP+) to the UK/EU market. Also to know how much LDC country enjoys EBA & EPA to access the UK/EU market will be better off than LDC country without EPA but enjoys GSP, GSP+, EBA to access the UK/EU market. This study covers the period from 1976 to 2019.

The findings show that, if Cariforum and the rest of the African & Pacific countries continue to access the UK market under EPAs (i.e. replication of the EU-ACP EPAs); on average, the volume (amount or total) of trade of High income (HI) and Upper Middle Income (UMI) Cariforum countries increases by 25%. Apart from some UMI and Least Developed countries (LDCs), no significant impact on the trade volume of African and pacific EPA member states.

If all ACP countries continue to access the UK market under EPAs, still the overall impact of EPAs on trade flows from ACP to the UK will be nonsignificant for the majority of ACP countries, namely African and Pacific blocs.

Generally speaking, the EU EPAs have a significant impact only on few HI & UMI ACP EPA countries and a nonsignificant impact on the majority of ACP countries (i.e. most ACP countries are either LI or LMI countries). So the overall impact of the EU EPAs on ACP countries is nonsignificant.

The subsequent parts of this study are organized as follows: Part two provides a State of the art: Literature Review. Part three continues to talk about the consequences of Brexit for the UK trade. Part four discusses trade policy between the UK(EU) and developing countries. Part five focuses on Caribbean countries' trade with the UK. Where part six develops a model to capture the effect of Brexit on ACP countries (Cariforum). Part seven shows the results. Part eight concludes with a brief statement of the main findings and policy recommendations of the study. Part nine lists references. Part ten reports appendices. Part eleven reports annex.

2. LITERATURE REVIEW

The EU signed EPAs with ACP countries to remove barriers to trade, improving trade cooperation, and creating a framework for free movement of goods and services to increase the global competitiveness of the ACP under the framework of the Cotonou agreement of 2000. The EU has offered free market access to exports from ACP countries since 2008. While ACP countries gradually liberalize their trade over 25 years. The EU and ACP countries agreed that they do not liberalize sensitive products. ACP countries decided not to liberalize most agricultural and important local products. The EU also agreed to protect ACP infant industries from external competition.

Before Brexit, the UK was trading with ACP countries under EU-ACP EPAs but post-Brexit the UK needs to forge its own trade policy towards ACP and developing economies in general. Mendez-Parra et al., (2016a) set out some principles to guide UK policymakers to start doing so. Firstly, different economies should be treated differently; the UK should design policies that accommodate different categories of developing countries (ranging from Least Developed Countries (LDCs) to emerging economies). Secondly, the UK will have much less influence than the EU on developing economies, except in some cases with small countries that are mainly reliant on the UK. Thirdly, the UK may keep its influence on trade and development policy through global institutions e.g., World Bank Group (WBG) and World Trade Organization (WTO), and indeed it should seek to exercise this to a greater extent than previously.

Winters et al., (2020) study the implications of the UK's approach to tariffs on developing countries' access to the UK market post-Brexit. Winters et al., (2020) assess the structure and the functioning of the future UK Generalized System of Preferences (GSP) taking into account the impact of the newly announced UK Global Tariff on developing countries. Moreover, this paper evaluates the loss in market access for Ghana and Kenya if they and the UK fail to maintain the same pre-Brexit EU EPAs or Market Access Regulation provisions. Winters et al., (2020) results show that, in terms of tariffs, market access will not improve for most developing countries. Winters et al., (2020) also consider scenarios where the UK can reduce tariffs for developing economies, identifying more than 1,000 GSP tariffs that could be reduced without harming imports from the poorest countries. Winters et al., (2021) show that Brexit will impinge on ACP countries that are currently governed by the EU EPAs because of the UK incomes, and the demand for ACP products will be lower than expected over at least the next decade.

Nicita et al., (2019) show that the UK market accounts for about 3.5% of global trade and represents an important trading partner for many developing economies. They focus on the changes in the UK tariff structure post-Brexit. Their results show that changes in the UK market access conditions could have important consequences for some developing economies. They suggest that to reduce the negative impact of Brexit on low-income countries' exports, the UK needs to maintain the same pre-Brexit preferential access. Their findings also show that even maintaining preferences may not be enough in the event of MFN liberalization.

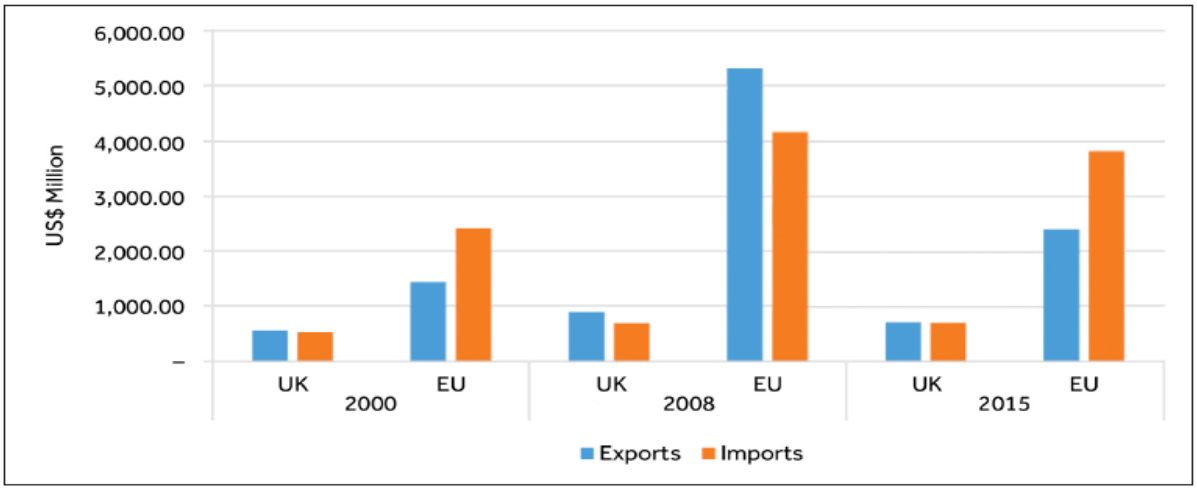
EU is the most important trading partner for the UK due to its adjacency and harmonization during the last four decades following UK accession to the EU in 1973. Dhingra et al., (2016) before the UK joining the European Economic Community (EEC) in 1973, about one-third of the UK trade was with the EEC. In 2019, the UK imported more than half of its goods from the EU and exported 43% of its goods to the EU (figure 2).

The EU-UK TCA trade relationship will determine the goals of the rest of the world-UK trade. There will be some changes to the nature of the pre-Brexit EU-UK trading stipulations; therefore the UK needs to act to mitigate the effect of these changes (e.g., tariffs and other regulations).

Some small developing economies depend mainly on the UK market. Razzaque & Brendan (2016), in 2015, almost all of the banana exports from Saint Lucia and Dominica, Jamaica's rum exports, and more than 80 percent of the sugar exports from Belize and Guyana received DFQF access into the UK market. The Dominican Republic was the major beneficiary of the EPA's DFQF market access for bananas, which account for around 75 percent of its total exports to the UK, followed by Belize, with bananas making up 54 percent of its UK exports. Sugar is a crucial export for many Caribbean and Pacific countries. The UK is the largest importer of sugar in the EU which accounts for about 95 percent of the EU's imports of sugar.

Figure (1) shows exports of goods from Cariforum to the EU is increased between 2000 and 2015 (Razzaque & Brendan, 2016). They added that exports to both the UK and the EU have contracted since 2008 when Cariforum experienced a trade surplus with Europe. The same report stated that CARIFORUM exports to the EU declined from about US$6.2 billion in 2008 to US$3.1 billion in 2015, while exports to the UK decreased from US$905 million to US$718 million during the same period. Razzaque & Brendan (2016) explain several reasons for this declining performance such as the Eurozone crisis, global financial crisis, global trade slowdown, and several Cariforum states experienced natural disasters, undermining their economic growth.

Figure 1 Cariforum merchandise trade with the UK and EU, 2000-2015



Source: Razzaque & Brendan (2016).
Notice: EU means EU28 minus UK.

The issue of Brexit has attracted the interest of two scholars. Mendez-Parra et al., (2016b) stated that the effect of Brexit on developing countries relies on the shock and the transmission channels of that

shock. They stated that in the short term Brexit affects developing countries in the way that lower UK growth will decrease the volume of UK's imports which will lead to the fall of exports of Least Developed Countries (LDCs) as a group by 6%. The most affected countries will be those who rely heavily on the UK market, such as Bangladesh, Kenya, Mauritius, Fiji, and Belize. While in the long-term, the trade effects hinge upon the types of the UK- EU arrangement, and the UK- developing countries.

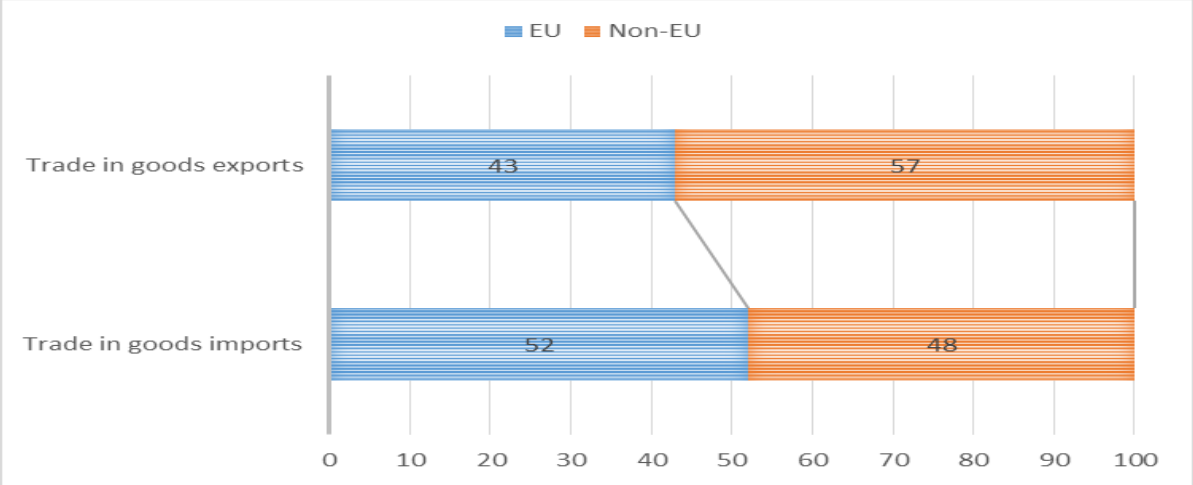
Mendez-Parra et al., (2016b) present the potential effects of a new UK trade policy on developing countries. They point out some scenarios for relationships with developing states relying on the stance the UK adopts towards trade and the nature of the agreement reached with the EU. If the UK were to decrease margins of preference for developing economies, for instance, this would increase the duties paid by those countries dependent on such preferences. They also stated that the value of concluding FTAs between the UK and major emerging markets (to which the EU does not already have duty-free access) regarding lower duties paid on the UK exports could amount to $7.3 billion.

De Benedictis and Salvatici (2011) apply different specifications of the gravity model to examine the impact of the EU preferential trade policy on trade flows from developing countries. De Benedictis and Salvatici (2011) show that the capability of the "trade as aid" model to deliver its expected benefits to these countries crucially differs between preferential schemes and sectors.

3. CONSEQUENCES OF BREXIT FOR UK TRADE

The EU is the UK's largest trade partner. Based on trade statistics from the UK Office for National Statistics (ONS), in 2019, the UK imports from the EU amounted to 52% and exported 43% of its goods to the EU (figure 2). EU membership reduces trade costs between the UK and the EU because of the creation of the customs union among the EU member states which removed all tariff barriers within the EU; creating free trade in goods. Reducing trade costs also resulting from the reduction of non-tariff barriers due to the formation of the single market within the European continent. Non-tariff barriers comprise a wide range of procedures that increase the costs of the trade such as border controls, product standards, and safety, threats of anti-dumping, and rules of origin checks.

Figure 2 UK trade in goods exports and imports percentage split by EU and non-EU countries, in 2019



Source: Author's calculation based on data from the UK Office for National Statistics (ONS) in 2019

Decreases in trade barriers have raised trade flows between the UK and the EU. Dhingra et al., (2016) before the UK joining the European Economic Community (EEC) in 1973, about one-third of the UK trade was with the EEC. In 2019, the EU accounted for almost half (47%) of the UK's total trade (Ward, 2019). Dhingra et al., (2016) explain the advantages of higher trade for the UK as follows: 1) UK's firms and workers gain from exploring new export opportunities that increase sales and profits and grant the UK to specialize in the production of goods and services in which it has a comparative advantage. 2) UK consumers enjoy access to better goods and services at lower prices. Via these channels, higher trade increases incomes, output and enhance living standards in the UK.

Although the EU-UK TCA offers some free trade benefits it also ended the benefits of free single market access that the UK enjoyed as an EU member state from 1973 to 31 December 2020. The EU-UK TCA[4] includes the following aspects:

1. Defines the post-Brexit trade relationship between the EU and UK from 1st January 2021.

2. Exports and imports of goods: TCA offers zero tariffs, zero-quotas trade, and this applies only for products complying with the agreement's Rules of Origin (RoO). Even with zero tariffs, zero-quotas trade, there will be customs paperwork and checks for products crossing the EU-UK border since the UK has exited the EU's customs union. These procedures will lead to delays and increase costs for supply chains.

3. Services: Although the financial services sector is very important for the UK economy, the agreement covers very limited provisions on trade in services. The agreement establishes some general market access principles. The UK firms are no longer enjoy EU passporting rights to provide their services in the EU and the same for the EU businesses.

4. Product standards regulation: the agreement covers very limited provisions on cooperation on the regulation of goods and product standards between the EU and the UK.

5. Movement of people: Free visas for short-term trips are required for travel between the UK and the EU.

6. Northern Ireland: Trade in Northern Ireland is covered by the Northern Ireland Protocol to the EU-UK withdrawal agreement. According to the Protocol, post-Brexit Northern Ireland continues to be part of the EU's single market. This means that Northern Ireland will adhere to EU customs rules at its ports, for instance, products crossing the Irish Sea from other parts of the UK will be subjected to the EU's customs checks. The effect of trade provisions in goods will relate to trade between the UK and Northern Ireland, not Northern Ireland and the EU.

To sum up, still, EU-UK TCA increases EU-UK trade costs, decreases trade between them, requires resources for form-filling, queuing, etc, and these will lead to changes in consumption which reduce UK residents' welfare (Fusacchia et al., 2020).

How would Brexit affect the UK's trade with Cariforum countries? This work mainly focuses on the trade effects of Brexit through which Brexit could impact the UK and Cariforum economies. The UK

[4] Trade and cooperation agreement between the European Union and the European atomic energy community, of the one part, and the united kingdom of Great Britain and Northern Ireland, of the other party 24.12.2020. GOV.UK.https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/948119/EU-UK_Trade_and_Cooperation_Agreement_24.12.2020.pdf

signed EPAs with Cariforum and some African & Pacific countries to maintain the pre-Brexit market access for ACP countries and the agreements took effect from 1st January 2021. To assess the effect of Brexit on UK-ACP (Cariforum) trade, this work analyzes some related aspects of the EU-UK TCA (table 2) as follows:

1. Before Brexit exports from ACP countries access the EU28 single market and circulate freely. But post-Brexit the EU-UK TCA creates new barriers to trade between the EU and the UK. Thus post-Brexit if an ACP country exported goods to the UK via the EU and these goods have undergone some processing in the EU then these products will face additional tariffs (subject to RoO) and non-tariff barriers to access the UK market.

Table 2 summarizes some aspects of the EU-UK TCA

Areas covered by the agreement	UK
Enjoy independent trade policy	Yes
Financial contribution to the EU (Horizen Europen 2021 to 2027)	Very limited
End the jurisdiction of the ECJ	Yes
End applicability of the EU regulations	Yes
Exit CAP and CEF	Yes
Exit EU single market	Yes
Exit EU customs union	Yes
Access the EU single market for services	Very limited
Free trade in goods with the EU	Yes
Free movement of people	Very limited
Eliminates non-tariff barriers	No
Cooperation on product standards regulation	Very limited

Source: Author's assessment based on the literature on EU trade agreements, SM and CU.

Note: ECJ denotes the European Court of Justice. CAP: Common Agricultural Policy. CAF: Connecting Europe Facility.

4. TRADE POLICY BETWEEN THE UK(EU) AND DEVELOPING COUNTRIES

From 1973 to 2020, the UK was trading with developing countries through EU EPAs/FTAs/GSP. But post-Brexit, the UK needs to form its own trade policy to trade with developing countries. As mentioned previously, so far, the UK has signed EPAs with some ACP blocs but not with all of them. The UK also signed trade agreements with other developing countries as well such as Chile, Georgia, Israel, Jordan, Lebanon, Morocco, and Tunisia.

Historically the EU EPA arrangements are dated back to the Treaty of Rome of 1957 which formed an association agreement between the six members of the European Economic Community (EEC) and former colonies of Belgium, France, Italy, and the Netherlands to increase trade and promote social and economic development. The association agreement lasted until 1963 and was substituted by the Yaoundé Convention: Yaoundé I (1964-1969); Yaoundé II (1971-1975). Yaoundé witnessed little changes in the relationship between the EEC and its former colonies: 1) most of the associated states got their independence and the EEC enlarged with the accession of Denmark, Ireland, and the UK in

1973. 2) in 1969, the EEC negotiated the Arusha Agreement with three former British colonies: Kenya, Tanzania, and Uganda entered into force in 1971. 3) the number of developing states that were enjoying the EEC preferential treatments increased from 19 to 46.

In 1975 Yaoundé agreement was replaced by Lomé Convention (I, II, III, IV from 1976 to 1999). It expanded to include the EEC plus the UK, Ireland, and Denmark, and ACP states that increased from 46 to79. Lomé Convention was replaced by the Cotonou Agreement in 2000. The association agreement of Rome, the Yaoundé, and Arusha conventions granted ACP countries reciprocal access to the EEC market while the Lomé Convention and the Cotonou Agreement granted ACP countries non-reciprocal access to the European market. The WTO rejected a waiver to allow the EC to continue on Lomé arrangements which lasted until the end of 2007. Thus the EC had to think about alternatives to non-reciprocal trade preferences for the ACP countries and finally decided to adopt a new model of reciprocal trade deals-the EPAs.

The negotiations of the EPA were planned for two stages. The first stage to be between the EU and the ACP countries as a whole; while the second stage is between the EU and regional groupings. There was a problem of identifying united regional groups in Africa because there were several regional associations and overlapping in motivations with one another. While Caribbean Community (CARICOM) had regional institutions with the capacity and experience to negotiate trade deals-the Caribbean's Regional Negotiating Machinery (CRNM)/Office of Trade Negotiations (OTN).

The CRNM is the main unit in CARICOM for negotiating external trade arrangements. The CRNM is based in Barbados and was created in 1997 when the EEC plans to liberalize trade with ACP countries. Therefore the CARICOM needed to coordinate their negotiations with a third party through the regional institution. So the first successful result for the CRNM was the negotiation in 2008 of EPA liberalizing trade between the EU and Cariforum countries. In 2009, the CRNM was replaced by OTN which has coordinated Cuba negotiations and regional trade deals with the United States of America (USA).

The Cariforum-EU EPA is the only comprehensive EPA signed so far by all parties in October 2008 except Haiti signed in December 2009. Cariforum includes 15 members: Antigua and Barbuda, The Bahamas, Barbados, Belize, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts and Nevis, Saint Lucia, St. Vincent and the Grenadines, Suriname, and Trinidad and Tobago. Cuba is also a member of Cariforum but is not part of the African Caribbean and Pacific (ACP). While the EU comprises all the 28 members. This EU- Cariforum EPA arrangement covers trade in goods and services, investment, trade-related issues, and development cooperation. The EPA grants Cariforum states free tariff access to the EU market for goods (not all goods) while Cariforum states have to gradually eliminate their tariffs on imports from the EU for up to 25 years. The EPA's main objectives are poverty reduction via trade partnership, regional integration, integration of CARICOM countries into the world economy, enhancing the capacity of CARICOM countries in trade policy and trade-related issues, create reciprocal trade preferences with the EU, increase investment and promote growth.

The main criticisms about the EPAs are Ravenhill (1985) many views the EEC shaped relations with the developing countries up until the Lomé convention was one form of neo-colonialism era. Stevens et al (2008) many studies have indicated that the development and trade regime of Europe added little to the development of ACP countries because of the preferential access designed as a disincentive to explore markets beyond the EU, besides other things, export diversification and economic growth. Here are the areas where the UK's future trade arrangement might work to enhance (the EU regimes). An alternative to the EU's EPA is a comprehensive trade preferential regime incorporated in the GSP. This

area is where the UK could design a new trade policy to improve the pre-Brexit arrangement. While any reforms to the EU EPAs will have and implications on the GSP, and vice versa.

4.1.The EU's GSP and developing countries' access to the UK market post-Brexit

In 1971, the EU adopted the GSP scheme based on the idea of granting non-reciprocal and non-discriminatory preferential market access to developing countries to increase their export earnings, promoting their industrialization, and accelerating their rates of economic growth (UNCTAD 1968). The EU GSP was designed to grant developing countries' exports lower tariffs than those applied to developed countries to access the EU market. The aim was to help developing countries to diversify their exports, increase income, and enhance their living conditions.

Since its establishment, the EU GSP evolved remarkably and experienced many changes to assist developing countries to reduce tariffs on exports to the EU market. The GSP scheme has been regularly revised with a comprehensive revision occurring every 10 years. The first revision took place in January 1981 while the second revision of 1991deferred to 1995. In 2010, the EU revised its GSP scheme including RoOs and graduating many beneficiaries and changing the benefits based on the needs of those beneficiaries remaining in the scheme. In 2010 the applied RoO regime for claiming preferences was changed from 60% (minimum local content by value) to 70% as a maximum foreign content.

Another revision took place on 31 October 2012. While the latest revision was on 1 January 2014 and the goal of the reform is to focus on those countries most in need such as the LDCs and other low and lower-middle-income countries. Some of 20 high and upper-middle-income countries such as Saudi Arabia, Argentina, Brazil, and Russia were graduated out of eligibility because they reached a point of development where nonreciprocal preferences were no longer required. Whereas, 34 counties ceased to be beneficiaries of the reformed GSP those with a preferential trade agreement including all Cariforum countries except Haiti continue to be beneficiaries of GSP under EBA. Those remaining enjoyed a more generous regime on preferential tariffs together with the new RoO regime. These changes were most important for the GSP+ and the standard GSP programs. The LDCs (EBA) already enjoy DFQF access, so, for them, the main change was just the RoO. Hoekman et al., (2016) preferences for particular products from some beneficiaries were also adjusted based on competitiveness criteria.

The GSP is subject to WTO law, based on the "Enabling Clause" which permits developed countries to create trading preferences for developing countries; allows for an exception to the WTO "most-favored-nation" principle (i.e. all WTO members should be treated equally). The GSP granted all developing countries non-reciprocal preferential access to developed country (including the EU) markets but were subject to some restrictions. GSP donors comprise Australia, Bulgaria, Canada, the EU, Japan, New Zealand, Norway, Switzerland, and the USA. The council was implementing regulations every year setting the preferential arrangement for the period from first January to 31 December for the goods covered by the GSP scheme and originated in the beneficiary countries. From 1996 the three-year agricultural scheme will be introduced. While from1995 the multiannual scheme covers only industrial products which contain general arrangements and special incentive arrangements grounded in two complementary mechanisms as following (European commission: MEMO-95-1_en.htm)[5]:

1. Tariff modulation:

[5] European commission: MEMO-95-1_en.htm http://europa.eu/rapid/press-release_MEMO-95-1_en.htm

1.1 To allow for product sensitivity, the preferential tariff will be modulated based on the type of sensitivity for each product. There are four types of product as follows:

1.1.1 Very sensitive products such as textile and ferro-alloys. They face modulated preferential tariffs at 85% of the Common Customs Tariff (CCT).

1.1.2 Sensitive products comprise various types of products such as chemicals, shoes, electronics, cars, and brushes. They face modulated preferential tariffs at 70% of CCT duty.

1.1.3 Semi-sensitive products also include a wide variety of products for which modulated preferential tariff will be 70% of the CCT duty.

1.1.4 Non-sensitive products, which will face zero tariffs.

1.2 So tariff modulation is based on product sensitivity not the competitiveness of the countries involved and it will be applied to all beneficiary countries except LDCs and beneficiaries from the special drugs arrangements.

2. Graduation: The EU introduced graduation in 1994 to remove from the GSP scheme countries and sectors that are no longer in need of preferential arrangement to access the EU market. The graduation mechanism has experienced a series of modifications over time and the current mechanism applies for sector and country level as following:

2.1 Country-sector graduation: a certain product-sections (sectors) will be graduated if, for three consecutive years, a beneficiary country share of EU GSP imports in that sector surpasses a specific threshold set at 15% (textiles at 12.5%). This mechanism applies only to standard GSP beneficiaries only.

2.2 Country graduation: beneficiary countries will be removed from the EU's GSP if they are classified by the WB as high income or upper-middle-income countries for three consecutive years or if they formed trade agreements to access the EU market and enjoy the same or better treatment than those granted by GSP scheme.

As the needs of DCs vary widely a differentiated approach has been taken in GSP, providing a sliding scale of preferences based on different needs:

i.The EU GSP standard grants 15 beneficiary countries (European Commission, 2019) zero import duties (lower than MFN) on around 66% of the tariff lines applied by the EU. EU GSP standard is designed for low and lower-middle-income countries, as defined by the WB, cover limited sectors and grant preferences can be removed if exports of given goods are regarded to be competitive in the EU markets. The limitation aims to avoid any serious competition. Current GSP standard beneficiary countries are Africa: the Republic of Congo, Kenya, and Nigeria. Asia: India, Indonesia, Tajikistan, Uzbekistan, and Vietnam. Australia & Pacific: Cook Islands, Micronesia, Nauru, Niue, Samoa, and Tonga. Middle East: Arab Republic of Syria.

ii. EU GSP+ is a special scheme, permits duty-free imports of all the products covered by GSP standard and is designed for sustainable development and good governance for vulnerable low and lower-middle-income countries. To qualify for GSP+, the country must apply and meet the Standard GSP conditions and the following additional criteria:

Sustainable development criteria: 1) must have ratified and effectively implemented 27 specified international conventions in the fields of core human and labour rights, the environment, and good governance. 2) maintain the ratification of the conventions and their implementing legislation and measures, and accept regular monitoring and review of the implementation record in accordance with the implementation provisions of the relevant conventions

Vulnerability criteria: A vulnerable country means a country whose exports to the EU are heavily concentrated in a few products (the 7 largest sections of GSP-covered imports into the EU represent more than 75% in value of their total GSP covered exports). Current beneficiaries are 8 countries (European Commission, 2019): Africa: Cape Verde. Asia: Armenia, Kyrgyzstan, Mongolia, Pakistan, Philippines, and Sri Lanka. South America: Bolivia.

iii. EBA is the largest group in GSP comprising 48 LDCs (European Commission, 2019) and offering Duty-Free (DF) Quota-Free (QF) trade for all products from LDCs (except weapons). Current beneficiary countries of EBA are Africa: Angola, Benin, Burkina Faso, Burundi, Central African Republic, Chad, Comoros, Congo (DRC), Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Sao Tome & Principe, Senegal, Sierra Leone, Somalia, South Sudan, Sudan, Tanzania, Togo, Uganda, and Zambia. Asia: Afghanistan, Bangladesh, Bhutan, Cambodia, Lao (PDR), Myanmar, Nepal, Timor-Leste, and Yemen. Pacific: Kiribati, Solomon Islands, Tuvalu, and Vanuatu. Caribbean: Haiti.

Since 2001 the EBA initiative has granted all LDCs free products access into the EU market except exports of arms and armaments. Gradeva & Martínez-Zarzoso (2016) the EBA initiative made a slight impact on LDC exports with notable differences among LDCs; some, like Bangladesh, have experienced noticeable gains whereas the others, especially African LDCs, has been experienced little gains. So the overall impact of the EBA initiatives on LDCs is little which resulted from the limited capacity of LDCs to take advantage of the free market access granted to them and also due to the restrictive RoOs.

Before Brexit, the EU was regulating the UK's trade relations in goods and services with all developing countries, and the policy is managed by the European Commission. According to a speech by Liam Fox the Secretary of State for International Trade Geneva, in July 2017, the UK government has committed itself to continue on pre-Brexit arrangements of the EU post-Brexit[6]. But the extension of the EU GSP scheme might negatively affect developing countries that need preferential treatments. Therefore, to design its own trade policy, the UK needs to take the followings aspects into account:

1. The adjustment should include the level of preferences for LDCs and other classes of developing countries and which product should grant preference.

2. Complete evaluation of the performance of the EU GSP scheme particularly after the 2014 GSP reform to address any limitations. For instance, there is only one Cariforum country (Haiti) enjoying the EU GSP preference under EBA, the UK should pay attention to Cariforum (e.g Jamaica) and other developing countries that are currently enjoying several reduced tariffs on products to access the UK's market.

[6] See Beyond Liam Fox speech at the Graduate Institute in Geneva highlights the importance of free trade to the global economy 'Brexit: Britain and the global economy'.

3. Most developing countries lack policy and institutional coherence to take advantage of the free market access granted to them by the EU.

4. Not to treat all the developing countries as one group rather implement trade and development policy that addresses their different social and economic needs.

5. Some ACP countries were mainly dependent on the EU market because the EU's preferential access was designed as a disincentive to exploit markets beyond the EU, besides other things, export diversification and economic growth. Therefore, it's necessary that the UK government should adopt a trade and development policy to assist these countries to develop and not to be attached to the UK.

6. To ensure continuity in market access to developing countries post-Brexit implies that the UK will roll over the pre-Brexit EU's graduation mechanism. But the EU import-share thresholds could involve loss of preferences without improvement in the competitiveness of beneficiary countries, e.g. some developing countries' import-shares may exceed the graduation thresholds, either in the UK market or the EU27 market post-Brexit particularly countries that are close to the graduation threshold (counties with larger import-shares pre-Brexit). Therefore the UK must revise the vulnerability thresholds (eligibility to the GSP+ regime) and the graduation thresholds upwards to ensure that pre-Brexit beneficiaries are not removed from the UK's GSP post-Brexit (Borchert & Di Ubaldo, 2020).

5. CARIBBEAN COUNTRIES TRADE WITH THE UK

Due to their small market size, Caribbean economies are highly dependent on the external market. Table (3) presents Caribbean countries' top trading partners in 2019 such as the EU (second-largest trading partner after the USA), where Caribbean exports enjoy preferential access under EPA, and the USA (first largest trading partner) through the Caribbean Basin Trade Partnership Act of 2000.

Caribbean countries import more goods and services from the EU than they export to the EU (trade deficit) table (3). While the EU exports more goods and services to Caribbean countries than they import from Caribbean countries (table 3). Caribbean exports to the EU are 1) Fuel and mining products, particularly petroleum gas and oils. 2) Bananas, sugar, and rum. 3) Minerals, especially gold, corundum, aluminum oxide and hydroxide, and iron ore products. 4) Fertilizers.

Table 3 total goods: Caribbean countries top trading partners 2019

	Imports			Exports			Total trade		
No	Partner	Milion €	% world	Partner	Milion €	% world	Partner	Milion €	% world
	World	50,324	100.0	World	22,237	100.0	World	72,561	100.0
1	USA	20,375	40.5	USA	9,015	40.5	USA	29,390	40.5
2	EU-27	6,727	13.4	EU27	3,374	15.1	EU27	10,102	13.9
3	China	6,120	12.2	Canada	1,259	5.7	China	6,607	9.1
4	Mexico	1,676	3.3	Switzerland	1,222	5.5	Canada	2,306	3.2
5	Japan	1,645	3.3	Namibia	1,003	4.5	Mexico	1,850	2.6
6	Brazil	1,484	2.9	Angola	677	3.0	Japan	1,753	2.4
7	Canada	1,047	2.1	United Arab Emirates	494	2.2	Brazil	1,546	2.1
8	Colombia	825	2.0	China	487	2.2	Switzerlan	1,434	2.0
9	UK	635	1.3	India	454	2.0	Namibia	1,003	1.4
10	Argentina	571	1.1	Panama	343	1.5	Colombia	983	1.4

Source: European Commission.
https://webgate.ec.europa.eu/isdb_results/factsheets/region/details_acp-caribbean-countries_en.pdf

Caribbean imports from the EU are 1) Boats and ships, cars, construction vehicles, and engine parts. 2) Phone equipment, milk and cream, and spirit drinks. For all Cariforum countries this work analyzes their trade at the aggregate level when this study uses gravity model estimation but to get a better understanding of each Cariforum country trade with the UK, we have to recognize the details at disaggregated level e.g. HS-6 digits & HS-2 digits which will be discussed in details in the following sections.

5.1. Cariforum-UK trade

Antigua and Barbuda:

UK market represents the main destination for Antigua and Barbuda exports. In 2016, 64 percent of the top 10 exports at the HS-6 digits level of Antigua and Barbuda went to the UK (annex table 4). 70 percent of these commodities enjoyed free tariff access to the UK market while the UK (EU) imposed a 1.71 percent AHS Weighted Average (%) tariffs on the rest. Antigua and Barbuda exports to the UK at the HS-6 digits level were mainly dominated by sailboats (annex table 4). At the same time, 64 percent of the top 5 exports at the HS-2 digits level of Antigua and Barbuda went to the UK market (annex table 4), almost 50 percent of these products enjoyed free tariff access to the UK market. Antigua and Barbuda exports to the UK at HS-2 digits level were mainly dominated by textiles (annex table 4)

On the other hand, in 2016, Antigua and Barbuda imported 18 percent of its top ten imports at the HS-6 digits level from the UK (annex table 5) and levied AHS weighted average (%) tariffs on all these products between 7 percent and 18 percent. Antigua and Barbuda imports from the UK at the HS-6 digits level were mainly dominated by whiskies (annex table 5). In the same year, Antigua and Barbuda imported 9 percent of its top 5 imports at the HS-2 digits level from the UK and imposed AHS weighted average (%) tariffs on all these products between 14 percent and 21 percent (annex table 5). Antigua and Barbuda imports from the UK at the HS-2 digits level were mainly dominated by vehicles, furniture, and textiles (annex table 5).

The Bahamas:

In 2015, 4.14 percent of the top 10 exports at the HS-6 digits level of the Bahamas went to the UK (annex table 6). 100 percent of these commodities enjoyed free tariff access to the UK market. The Bahamas exports to the UK at HS-6 digits level were mainly dominated by boring and sinking machinery, water sports equipment, and wood (annex table 6). At the same time, 3.96 percent of the top 5 exports at HS-2 digits level of the Bahamas exported to the UK (annex table 6), almost 80 percent of these products enjoyed free tariff access to the UK market**.** The Bahamas exports to the UK at HS-2 digits level were mainly dominated by toys, games, and sports requisites (annex table 6).

In 2015, the Bahamas imported 8.05 percent of its top ten imports at HS-6 digits level from the UK (annex table 7) which mainly dominated by turbines; parts of gas turbines (annex table 7), and levied tariffs on all these products between 10 percent and 15 percent. In the same year, the Bahamas imported 2.28 percent of its top 5 imports at the HS-2 digits level from the UK which was mainly dominated by pharmaceutical products and footwear (annex table 7), and imposed tariffs on all these products between 15 percent and 21 percent (annex table 7).

Barbados:

In 2013, 5.41 percent of top 10 exports at HS-6 digits level of Barbados exported to the UK (annex table 8) which were mainly dominated by Yachts, electrical resistors, and beer (annex table 8). 20

percent of these products enjoyed free tariff access to the UK market while the UK (EU) imposed between 3 percent and 4 percent tariffs on the rest. In the same year, 7.18 percent of top 5 exports at HS-2 digits level of Barbados went to the UK market (annex table 8) which were mainly dominated by ships (annex table 8), only 20 percent of these products enjoyed free tariff access to the UK market.

In 2013, Barbados imported 16.83 percent of its top ten imports at HS-6 digits level from the UK (annex table 9) which is mainly dominated by Whiskies and sucrose; chemically pure (annex table 9) and levied 15 percent tariffs on 90 % of these products. In the same year, Barbados imported 6.53 percent of its top 5 imports at HS-2 digits level from the UK which is mainly dominated by sugars and sugar confectionery, and furniture (annex table 9), and imposed tariffs on all these products between 1 percent and 31 percent (annex table 9).

Belize:

The UK market is the main destination for Belize exports. In 2016, 71.25 percent of top 10 exports at HS-6 digits level of Belize exported to the UK (annex table 10) and were subjected to tariffs between 1 percent and 9 percent. Belize exports to the UK at HS-6 digits level were mainly dominated by Sugars; cane sugar, raw, solid form, and wood (annex table 10). 42.14 percent of top 5 exports at HS-2 digits level of Belize went to the UK market which was mainly dominated by Sugars and sugar confectionery, and only 40 percent of these products enjoyed free tariff access to the UK market (annex table 10).

In 2016, Belize imported 19.71 percent of its top ten imports at HS-6 digits level from the UK (annex table 11) mainly dominated by Machine-tools; for working wood, cork, bone, hard rubber, hard plastics (annex table 11), and levied tariffs on all these products between 4 percent and 12 percent. In the same year, Belize imported 3.23 percent of its top 5 imports at HS-2 digits level from the UK which mainly dominated by Printed books, newspapers, pictures, and other products of the printing industry; manuscripts, typescripts, and plans, and imposed tariffs on all these products between 2 percent and 14 percent (annex table 11).

Dominica:

In 2012, 23.99 percent of the top 10 exports at HS-6 digits level of Dominica exported to the UK (annex table 12), and 50 percent of these products were subjected to UK tariffs. Dominica exports to the UK at the HS-6 digits level mainly dominated by oil and sauces and preparation (annex table 12). 3.96 percent of the top 5 exports at HS-2 digits level of Dominica went to the UK market which was mainly dominated by iron or steel articles, and 90 percent of these products faced UK tariffs (annex table 12).

In 2012, Dominica imported 20.11 percent of its top ten imports at HS-6 digits level from the UK mainly dominated by buildings prefabricated and whiskies and levied tariffs on all these products between 7 percent and 15 percent (annex table 13). In the same year, Dominica imported 2.28 percent of its top 5 imports at HS-2 digits level from the UK mainly dominated by Vehicles, printed books, and rubber, and imposed tariffs on all these products between 3 percent and 15 percent (annex table 13).

The Dominican Republic:

In 2016, 3.11 percent of the top 10 exports at the HS-6 digits level of the Dominican Republic went to the UK and were mainly dominated by brushes for the application of cosmetics (annex table 14). Only 30 percent of these commodities enjoyed free tariff access to the UK market while the UK (EU) imposed tariffs between 3 percent and 5 percent on the rest. At the same time 1.55 percent of the top 5 exports at HS-2 digits level of the Dominican Republic exported to the UK market and mainly dominated by

organic chemicals, only 20 percent of these products enjoyed free tariff access to the UK market (annex table 14).

On the other hand, in 2016, the Dominican Republic imported 6.26 percent of its top ten imports at the HS-6 digits level from the UK which mainly dominates by whiskies, and levied tariffs on all these products between 1 percent and 11 percent (annex table 15). In the same year, the Dominican Republic imported 2.08 percent of its top 5 imports at HS-2 digits level from the UK mainly dominated by beverages, and imposed tariffs on all these products between 1 percent and 13 percent (annex table 15).

Guyana:

In 2016, 13.73 percent of the top 10 exports at the HS-6 digits level of Guyana went to the UK which was mainly dominated by sugar and rum (annex table 16). All of these commodities enjoyed free tariff access to the UK market. At the same time, 12 percent of top 5 exports at HS-2 digits level of Guyana exported to the UK market and dominated by sugars and sugar confectionery, almost 80 percent of these products enjoyed free tariff access to the UK market (annex table 16).

On the other hand, in 2016, Guyana imported 11.61 percent of its top ten imports at the HS-6 digits level from the UK which was mainly dominated by tractors and levied tariffs on all these products between 3 percent and 12 percent (annex table 17). In the same year, Guyana imported 5.70 percent of its top 5 imports at the HS-2 digits level from the UK which was mainly dominated by vehicles, and imposed tariffs on all these products between 2 percent and 8 percent (annex table 17).

Jamaica:

In 2015, 46.11 percent of top 10 exports at HS-6 digits level of Jamaica exported to the UK which mainly dominated by Rum, fruit, and other commodities not specified according to kind (annex table 18). Almost all of these commodities faced 1 percent AHS weighted average (%) tariffs access to the UK market. At the same time, 39.04 percent of the top 5 exports at HS-2 digits level of Jamaica went to the UK market and mainly dominated by sugars and sugar confectionery, all of these products enjoyed free tariff access to the UK market (annex table 18).

In 2015, Jamaica imported 6.18 percent of its top ten imports at the HS-6 digits level from the UK mainly dominated by organic compounds, and levied AHS weighted average (%) tariffs on all these products between 4 percent and 14 percent (annex table 19). In the same year, Jamaica imported 3.21 percent of its top 5 imports at HS-2 digits level from the UK mainly dominated by printed books, newspapers, pictures, and other products of the printing industry, and imposed AHS weighted average (%) tariffs on all these products between 3 percent and 19 percent (annex table 19).

Saint Lucia:

In 2014, 26.38 percent of the top 10 exports at HS-6 digits level of St. Lucia exported to the UK and mainly dominated by oil and plastics (annex table 20). Almost all of these commodities enjoyed free tariffs access to the UK market. At the same time, 13.10 percent of the top 5 exports at HS-2 digits level of St. Lucia went to the UK market which mainly dominated by mineral fuels, mineral oils, and products of their distillation; bituminous substances; mineral waxes, and almost all of these products enjoyed free tariff access to the UK market (annex table 20).

In 2014, St. Lucia imported 20 percent of its top ten imports at HS-6 digits level from the UK which is mainly dominated by vehicles and machinery for filtering or purifying water, and levied AHS weighted average (%) tariffs on all these products between 4 percent and 16 percent (annex table 21). In the same

year, St. Lucia imported 10.19 percent of its top 5 imports at HS-2 digits level from the UK mainly dominated by printed books, newspapers, pictures, and other products of the printing industry; manuscripts, typescripts and plans and imposed AHS weighted average (%) tariffs on all these products between 3 percent and 6 percent (annex table 21).

Saint Vincent and Grenadines:

In 2015, 1.43 percent of top 10 exports at HS-6 digits level of St. Vincent and Grenadines exported to the UK mainly dominated by furniture; wooden, other than for office, kitchen or bedroom use (annex table 22). All of these commodities enjoyed free tariffs access to the UK market. At the same time, 1 percent of top 5 exports at HS-2 digits level of St. Vincent and Grenadines went to the UK market which) mainly dominated by furniture and beverages, and all of these products enjoyed free tariff access to the UK market (annex table 22).

In 2015, St. Vincent and Grenadines imported 21.86 percent of its top ten imports at HS-6 digits level from the UK mainly dominated by printed matters (books, brochures), medicaments, elevators and conveyors, machines for agglomerating, shaping, or molding solid mineral fuels, and levied AHS weighted average (%) tariffs on all these products between 5 percent and 14 percent (annex table 23). In the same year, St. Vincent and Grenadines imported 2.28 percent of its top 5 imports at HS-2 digits level from the UK which mainly dominated by furniture, electrical machinery and equipment, and imposed AHS weighted average (%) tariffs on all these products between 8 percent and 18 percent (annex table 23).

Suriname:

In 2013, 0.02 percent of top 10 exports at HS-6 digits level of Suriname exported to the UK mainly dominated by surveying equipment (annex table 24). Only 10 percent of these products enjoyed free tariffs access to the UK market. At the same time, 4.44 percent of the top 5 exports at HS-2 digits level of Suriname went to the UK market mainly dominated by cereals and beverages, only 20 percent of these products enjoyed free tariff access to the UK market (annex table 24).

In 2013, Suriname imported 5.71 percent of its top ten imports at HS-6 digits level from the UK mainly dominated by limestone and other calcareous stone turbines; parts of hydraulic turbines and water wheels, including regulators, and levied AHS weighted average (%) tariffs on all these products between 6 percent and 17 percent (annex table 25). In the same year, Suriname imported 1 percent of its top 5 imports at the HS-2 digits level from the UK mainly dominated by vehicles, and imposed AHS weighted average (%) tariffs on all these products between 6 percent and 12 percent (annex table 25).

Trinidad and Tobago:

In 2013, about 2 percent of the top 10 exports at HS-6 digits level of Trinidad and Tobago went to the UK mainly dominated by containers for transport of fluids for carriage by one or more modes of transport (annex table 26). Almost all of these products faced between 1 percent and 2 percent AHS weighted average (%) tariffs to access the UK market. At the same time, 1 percent of top 5 exports at HS-2 digits level of Trinidad and Tobago exported to the UK market mainly dominated by organic chemicals, only 20 percent of these products enjoyed free tariff access to the UK market (annex table 26).

In 2013, Trinidad and Tobago imported 11 percent of its top ten imports at HS-6 digits level from the UK mainly dominated by vessels for the transport of goods and persons and levied AHS weighted

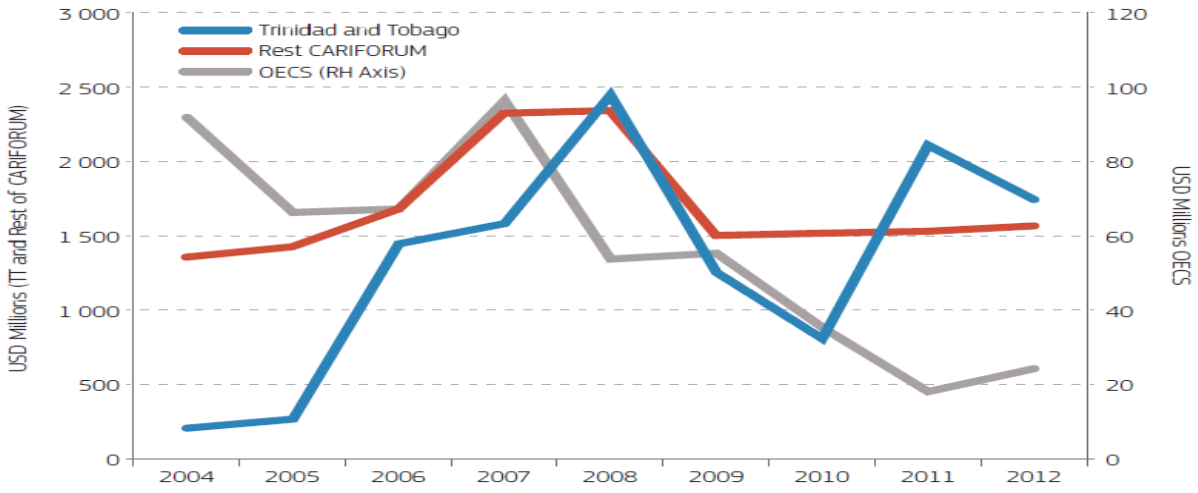
average (%) tariffs on all these products between 6 percent and 16 percent (annex table 27). In the same year, Trinidad and Tobago imported 2 percent of its top 5 imports at HS-2 digits level from the UK mainly dominated by nuclear reactor (boilers) ships, boats and floating structures, and imposed AHS weighted average (%) tariffs on all these products between 5 percent and 18 percent (annex table 27).

5.2. The EU assessment of Cariforum-EU EPA in 2014.[7]

This assessment reviewed the implementation and impact of Cariforum-EU EPA over the period of 2008-2013 (i.e. during the five years of its implementation). This agreement covers trade policy and trade-related issues, competition policy, public procurement, and commitments linking trade with sustainable development. The assessment concludes the following impacts on goods exports from Cariforum to the EU: 1) The main impact is tariff reduction commitments. Under this agreement, Cariforum countries enjoy duty-free, quota-free (DFQF) access to the EU market for all products except sugar and rice (they were subjected to transitional quotas until 2009), and arms/ammunition. 2) Changes in Rules of Origin (RoO). This agreement allows Cariforum producers to source inputs more efficiently to make their goods more competitive in the EU market. 3) Elimination of quantitative restrictions and development cooperation projects on addressing SPS and TBT barriers to enhance production. Enforcement of intellectual property rights or competition laws, to provide security for Cariforum firms in EU markets.

Cariforum's gross exports to the EU: Most Cariforum countries witnessed an increase in their gross exports to the EU post-2008 global recession but the Organisation of Eastern Caribbean States (OECS) witnessed a decline in their exports until 2011 then started to increase (figure 3). During the period from 2006-2008 before the signature of Cariforum-EU EPA, Cariforum exports began to plateau and decline in some cases because of energy and food price shocks. In an exceptional case, Trinidad and Tobago exports increased to the EU - including methanol, crude oil, ammonia, urea, and increasingly liquefied natural gas.

Figure 3 shows trends in Cariforum exports (millions USD) to the EU over the period 2004-2012



Source: Monitoring the implementation and results of the Cariforum-EU EPA final report of September 2014.

[7] Monitoring the implementation and results of the Cariforum-EU EPA. European Commission final report of September 2014. https://trade.ec.europa.eu/doclib/docs/2016/february/tradoc_154237.pdf

During the review period (2008-2013) all Cariforum member states experienced a steep decline in the value of their exports to the EU markets, mirroring a high decrease in their total exports to the world. Cariforum as a group witnessed a decline by one-third of the value of their exports to the EU. The OECS as a group experienced a 55% decline (with declines greater than 75% for Dominica, Saint Kitts and Nevis, Saint Lucia and Saint Vincent and the Grenadines); Jamaica (51 %), Suriname (42%), and the Dominican Republic (36%). Only Trinidad and Tobago experienced an export boom during the period of the global recession (2008-2010).

Actual exports versus counterfactuals and predictions: Under a no-EPA counterfactual where Cariforum countries lose access to the EU market under the Cotonou tariff scheme and are covered by the GSP regime, the assessment's model predicts significant negative impacts on Cariforum exporters. Under the EPA review scenario, the model predicts no measurable boom in EU imports from Cariforum countries. On aggregate, the switch from ACP/Cotonou to GSP tariffs would have depressed exports from Cariforum countries to the EU markets because of an increase in the average tariff (simple average, not trade-weighted) from close to zero to 3.38 %. For specific products such as banana exports (HS0803) would decrease by 75.9 %; rice (HS1006) exports, specifically, rice in the husk and milled rice, would disappear; sugar exports (HS1701) would also decrease by 100 %. Rum (HS 220840) exports would decline by 33.3 %. Other agricultural and food products were also projected to witness export declines, mainly between 11% to 50 %, with some products that would be largely priced out of the EU market such as Cigars and cigarillos (HS 240210) from Jamaica and the Dominican Republic.

Apart from agriculture food sectors, the shift to GSP tariffs would also have depressed some products, namely anhydrous ammonia (HS 281410) from Trinidad and Tobago; aluminum oxide (HS 281820), very important exports of Suriname and Jamaica; cotton t-shirts (HS 610910), from Jamaica and Suriname, and Haiti); footwear with leather soles (HS 640320), important for the Dominican Republic and Haiti; and footwear n.e.s (HS 640590) from the Dominican Republic. For these products, the switch to GSP tariffs is projected to have the following effects: 1) 3% decrease in anhydrous ammonia exports. 2) 6.2% fall in aluminum oxide exports to the EU. 3) 14.4 % decline in cotton t-shirts exports to the EU. 4) 6.8 % decline in footwear with leather soles. 5) 9 % fall in footwear exports to the EU. Although the switch to GSP tariffs would depress Cariforum exports to the EU, the main effect would have been mainly on agriculture and food products.

6. METHODOLOGY

The UK government expressed its intention to maintain the EU-developing countries' arrangements (FTAs, EPAs, GSPs) under Trade Continuity Agreements (TCAs). Under the UK-ACP EPAs, Cariforum countries and only a few African & Pacific countries will continue to enjoy QF-DF access into the UK market post-Brexit. The rest of the African & Pacific countries trade with the UK under the WTO rules/the UK's global tariffs/the UK's GSP from first January 2021 unless they sign trade agreements with the UK. This may take a considerable time because the UK's priority is to launch negotiations with the USA, Australia, and New Zealand. Essentially this study focuses on the UK-ACP (Cariforum) trade relation post-Brexit. So far the UK has signed EPAs with Cariforum and some ACP countries to maintain the pre-Brexit arrangements. Therefore; the research question is*: What is the effect of Brexit on the UK-ACP (Cariforum) trade post-Brexit?*

To answer this question, this study estimates the effect of EU preferential policies on the UK-ACP (Cariforum) trade before Brexit then uses the results of the estimation to assess the post-Brexit impact. This work uses historical data to analyze the effects of Brexit on the UK-ACP (Cariforum) future trade relationship. The ex-post approach is based on the assumption that behavioral relationships identified

from past relations (such as GSP) continue to be relevant. Indeed, under this assumption, This study uses the estimated parameters for simulation of the scenario that what will happen to the future of the UK-ACP (Cariforum) trade relationship post-Brexit. Generally, there are two main approaches 'out-of-sample' and 'in-sample'. The out-of-sample estimate uses a control group and the in-sample estimate comprises in gravity equation only the countries under consideration. Based on the out-of sample approach, the gravity model is estimated for a group of economies that are most integrated into the global trade system. This work provides an ex-ante assessment of the impact of Brexit on the UK-ACP (Cariforum) future trade relationship. To examine the research question, this work uses empirical gravity model methodology.

6.1.Gravity model: theory and measurement

This section presents the theoretical development of the gravity model from its early theoretical applications to the latest structural contributions and discusses how the theoretical contribution contributed to the development of the empirical specification of the gravity model. This work also addresses the challenges of estimation of the gravity model. Based on Baier et al., (2017), the main theoretical underpinnings of the gravity model are the following: 1) The contribution of Armington-Constant Elasticity of Substitution (CES) of Anderson (1979) gravity model demand framework. 2) Monopolistic competition model of Krugman (1979, 1980) and Bergstrand (1985, 1989). 3) Multi-country Ricardian model of Eaton and Kortum (2002). The heterogeneous firms model of Melitz (2003).

Many studies used the gravity model to study the impact of trade flows and immigration for about a century, Ravenstein (1885) was the first to apply the gravity model to study immigration, Tinbergen (1962) was the first to use the gravity model to study the effect of trade policy, while Anderson (1979) was the first to attempt a theoretical foundation for the empirical application of gravity model (Baier & Bergstrand, 2007). Recently, there is growing literature that stresses the importance of estimating the gravity model on intra-national (i.e. domestic) trade flows as well (Yotov, 2021). This study focuses on the estimation of the gravity model on data on international trade flows only.

The gravity model has become the empirical workhorse to study the effect of trade policy for more than 50 years. Commonly, the traditional gravity equation estimated using cross-section data takes the following forms

$$\ln[X_{ij}] = \beta_0 + \beta_1 \ln[d_{ij}] + \beta_2 \ln[Y_i] + \beta_3 \ln[Y_j] + \beta_4 FTA_{ij} + \sum_{i=1}^{n} \alpha_n Z^n{}_{ij} + \varepsilon_{ij} \qquad (1)$$

Where ln X_{ij} denote the natural logs of exports flows from exporter country *i* to importer country *j*, d_{ij} is the distance between country *i* and country *j*, Y_i and Y_j are the GDP of exporting and importing countries respectively, $Z^n{}_{ij}$ (n=1. . .N) indicate other observables that influence bilateral trade flows. FTA is a binary variable taking the value of one if country *i* and country *j* signed an FTA and zero otherwise, and ε_{ij} is an error term.

Estimating this traditional gravity model (1) is subject to some modeling and econometric limitations which make it not accurate to predict the bilateral trade flows. The limitations of model (1) are 1) One obvious limitation of the model (1) is the lack of Multilateral Resistance Terms (MRTs) and they are not directly observed by the researcher. Studies that fail to control for MRTs are committing "Gold Medal Mistake" (Baldwin & Taglioni, 2006). 2) Zero trade flows: a drawback of the Ordinary Least-Squares (OLS) approach is that it cannot take into account observations of zero trade flows because estimating model (1) in its log model of bilateral imports form, drops zero trade flows observations as the natural logarithm of zero is undefined. Therefore the OLS is not a reliable model. 3) Endogeneity

of trade policy: Studies show that countries select endogenously into FTAs for many reasons such as cultural, historical, besides other unobservable that are probably to be correlated with the level of trade flows. Baier & Bergstrand (2007), Egger et al., (2011), and Magee (2003) show that higher bilateral trade flows increase the likelihood that countries will sign FTAs.

Cipollina and Salvatici (2006) show that many studies have used gravity models to estimate the impact of RTAs on trade flows between partners. These studies present various estimates because they are based on different datasets, sample sizes, and independent variables used in the analysis. Cipollina and Salvatici (2006) combine, explain, and summarizes a large number of results (1827 estimates included in 85 papers), using a meta-analysis approach. Cipollina and Salvatici (2006) show that studies consistently present a positive RTAs effect on bilateral trade. They also present pooled estimates, obtained from fixed and random effects models, of the boost in bilateral trade due to RTAs.

To overcome these challenges, this work estimates the empirical gravity model framework of advanced econometrics techniques taking into account observations of zero trade flows, multilateral resistance terms, proper specification of bilateral trade costs, and control for endogeneity issues. Therefore; for the sake of concrete evidence and precision, the appendix section reproduces the work of Baier et. al (2017) of structural gravity model derived from the Armington-CES gravity model, monopolistic competition model, multi-country-Ricardian model of Eaton and Kortum (2002), and the heterogeneous firms model of Melitz (2003). But this section compares these contributions.

6.2.The Armington-CES gravity model

Anderson (1979) was the first to introduce theoretical underpinnings for the empirical application of the gravity model. This model considers a world of *N* countries; each country produces a variety of goods. Goods are differentiated by region of origin (Armington, 1969). The Armington structural gravity model is derived from the demand side. On the demand side, the model assumes homothetic and identical consumer preferences across countries. Equations (A.11; appendix A) resembles gravity equation (1) because it relates the bilateral trade flows (X_{ij}) between *i* and *j* to their economic sizes $W_i L_i$ and $W_j L_j$ respectively, and to the relative bilateral trade costs between *i* and *j*.

6.3. Monopolistic competition model of Krugman (1979, 1980) and Bergstrand (1985, 1989)

Unlike the Armington model, this model provides theoretical underpinnings of the gravity model derived from the supply-side with many identical firms in each country, each firm produces a different variety. The model assumes that consumers have Dixit-Stiglitz love-of-variety preferences, producers face a fixed cost. Equation (B.3; appendix B) resembles gravity equation (1) because it shows that the bilateral trade flows between country *i* and country *j* are proportional to their economic sizes and inversely proportional to the bilateral frictions between them.

6.4. Multi-country Ricardian model of Eaton and Kortum (2002)

This is a supply-side Ricardian model of trade that elevates the two-country Ricardian model with a continuum of goods to a world with many countries. Under this model, bilateral trade flows are given by probability distributions over technology and bilateral characteristics of the economy.

After transforming the structural gravity model of equations (C.4; appendix C)-C.6; appendix C) from their multiplicative nature to a log-linear gravity model, expand it with the additive error term, and assuming that they hold in each time *t*, to obtain a linear gravity model similar to equation (1). The

Eaton-Kortum model is very similar to the gravity model derived from the Armington model and the monopolistic competition model. In the Eaton-Kortum framework, the trade elasticity is captured by the Fréchet distribution parameter (θ) instead of the elasticity of substitution ($1-\sigma$).

The Eaton-Kortum model can be used to study the gains from trade, the effects of tariff reduction, and the role of trade in spreading the benefits of new technology. This model fits well when the focus is on industrialized countries with advanced manufacturing sectors (i.e. advanced manufactured exports) such as OECD countries. This study mainly focuses on small and developing economies with no sophisticated manufacturing sector such as Cariforum countries. Therefore; the Eaton-Kortum model is not suitable for this study.

6.5. Heterogeneous firms model of Melitz (2003)

This model assumes that firms are not identical and differ in terms of productivity and only the most productive businesses are capable to export and costs are fixed. Transform the structural gravity model of equations (D.6; appendix D)-(D.8 appendix D) from their multiplicative nature to a log-linear gravity model, expand it with the additive error term, and assuming that they hold in each time *t*, to obtain a linear gravity model similar to equation (1).

To sum up, the Armington-CES gravity model, monopolistic competition, multi-country-Ricardian model of Eaton-Kortum and heterogeneous firms model are all different approaches but all seem to deliver very similar structural gravity models. All these structural gravity systems show how trade costs are connected to factor payments in a general equilibrium setting. There are only two differences between these four gravity models. The first difference is in the interpretation of the trade cost elasticity. In the Armington model and monopolistic competition is captured by $\sigma - 1$. In the multi-country-Ricardian model of Eaton-Kortum is captured by θ and in the heterogeneous firms, the model is captured by k. The second difference is in the definition of the bilateral trade costs; in the Armington model, monopolistic competition, Eaton-Kortum models capture iceberg frictions, and in the heterogeneous firms model capture iceberg and fixed costs.

Eaton and Kortum (2002) and Anderson and van Wincoop (2003) are the most commonly used theoretical gravity models in the trade literature. Eaton and Kortum's (2002) model is not the right way of thinking about Cariforum countries. It doesn't apply to this study because it is focusing on the role of trade in spreading the new technologies and applied to OECD countries that have very advanced manufacturing sectors while this study is focusing on developing countries that their exports are dominated by agricultural products and raw materials, have no advanced manufacturing sector and there are many small economies and poor countries in this study i.e. Cariforum countries, pacific countries and African EPA blocs. Thus the Armington–CES trade model is the more appropriate one for this study because this work is focusing on the dummy on the PTAs variables.

6.6. Specification of the gravity equation

Gravity model A.11 (appendix A) can be reintroduced as follows

Assume that it holds in each time *t*, the model (A.8; appendix A) can be transformed into a linear model by taking logs of both sides of the model and expand it with an additive error term to obtain the following model:

$$lnX_{ijt} = lny_{jt} + lny_{it} - \ln y_{wt} + t_{ijt}^{1-\sigma} - ln\Pi_{it}^{\sigma-1} - ln\mathrm{P}_{jt}^{\sigma-1} + \varepsilon_{ijt} \quad (2)$$

Equation (2) resembles model A.11 (appendix A). Trade costs ($t_{ijt}^{1-\sigma}$) are difficult to behold directly. Therefore; a number of common proxy variables for trade costs will be used to measure $t_{ijt}^{1-\sigma}$, like the bilateral distance (population-weighted distance) between country *i* and country *j* is denoted by $DIST_{ij}$, whether there is an international border ADJ_{ij}, whether they share a common official language $LANG_{ij}$, whether they have a common colonial relationship after the colonial era $CORE_{ij}$, whether there is a tariff that country *j* imposes on imports from country *i* ($TARIFF_{ij}$), and whether they have a Preferential Trade Agreement PTA_{ij}. Assuming that it holds in each period of time *t*, the trade cost term $t_{ijt}^{1-\sigma}$ can be modeled as follows:

$$t_{ijt}^{1-\sigma} = \beta_1 lnDIST_{ij} + \beta_2 ADJ_{ij} + \beta_3 LANG_{ij} + \beta_4 CORE_{ij} + \beta_5 lnTARIFF_{ijt} + \kappa_1 PTA_{ijt} \quad (3)$$

Where PTA_{ijt} denotes preferential trade agreements (FTAs, EPAs, GSPs, and Lomé convention) between country *i* and country *j* at time *t*. The distance between country *i* and country *j* is calculated based on bilateral distance (in kilometers) between the biggest city of those two countries, weighted by the share of the city in the overall country's population.

The term $-\ln y_{wt}$ is world GDP, $\Pi_{it}^{\sigma-1}$ replaced by exporter-time fixed effect for country *i*, $\mathrm{P}_{jt}^{\sigma-1}$ absorbed by importer-time fixed effect for country *j*, and substitute (3) into (2) to get the following estimated equation:

$$ln\, X_{ijt} = \beta_0 + \beta_1 t_{ijt} + \varphi_{it} + \tau_{jt} + \varepsilon_{ijt} \quad (4)$$

Where β_0 is the intercept, t_{ijt} (i.e. trade cost as modeled in equation 3) denotes geographical, cultural, and political distances between country *i* and country *j*, φ_{it} indicates time-variant exporter fixed effect for country *i*, and τ_{jt} denotes time-variant importer fixed effect for country *j*, they control for MRT.

Bilateral trade between *i* and *j* doesn't only depend on trade costs between them but also on the average barriers to trading with the rest of the world (all other countries) which are captured by MRT (Anderson and van Wincoop, 2003). MRTs are not observable therefore to account for MRTs, this study uses country fixed effects for importers and for exporters. The exporter and importer fixed effects control for observable and unobservable country characteristics.

6.7. Estimation of the model

OLS model suffers from series of econometric issues such as it doesn't take into account observations of zero trade flows, heterogeneity among countries, and endogeneity of Regional Trade Agreements (RTAs)such as FTAs, EPAs, …etc. So when estimating the gravity equation (1) in its log model of bilateral imports form, drops observations of zero trade flows because the natural logarithm of zero is undefined. While removing observations of zero bilateral trade flows leads to inconsistent estimation of the model. Dropping observations of zero trade flows is the same as dropping those observations where trade costs are very high between country *i* and country *j* trade does not happen. To deal with this problem, Santos Silva and Tenreyro (2006) propose transforming the linear form (equation 4) to its

non-linear form (equation 2), and after that applying non-linear Poisson Pseudo-Maximum Likelihood (PPML) estimator which naturally includes observations of zero trade flows.

PPML with a full set of fixed-effect:

$$imp_{ijt} = exp(\beta_1 t_{ijt} + \varphi_{it} + \tau_{jt} + \varphi\tau_{ij}) + \varepsilon_{ijt} \quad (5)$$

Where $\varphi\tau_{ij}$ denotes country-pair fixed effect (exporter-importer interactions).

To address the endogeneity of RTAs membership, MRTs, and heterogeneity among countries, Magee (2003) shows that higher bilateral trade flows increase the probability that countries will sign an FTA. Thus, two countries that already trading a lot with each other are possibly more likely to sign FTA. So this kind of endogeneity might lead to a bias estimation of $k_1$in equation (3). To tackle these three (endogeneity of FTA/EPA membership, multilateral resistance terms, and heterogeneity among countries) issues this study uses panel estimation methods with a full set of fixed effects (exporter-time variant, importer-time variant, and exporter-importer interactions).

This work applies exporter-time and importer-time fixed effects to control for unobservable multilateral resistances and any other unobservable characteristics varying over time for each exporter and importer (Anderson and van Wincoop, 2003). Fally (2015) shows that estimating gravity models using the PPML with fixed effects is consistent with the introduction of multilateral resistance terms as in Anderson and van Wincoop (2003). When estimating gravity with other estimators with fixed effects is no longer consistent with the structural gravity model proposed by Anderson and van Wincoop (2003), unless the MRTs are redefined (Fally, 2015). The use of country-pair (exporter-importer interactions) fixed effect enables us to account for heterogeneity among countries, the endogeneity of trade policy variables, and the effects of all time-invariant bilateral trade costs (Baier & Bergstrand, 2007).

6.8. The Preferential Trade Agreement (PTA) variable

This study divides the PTA indicator into fifteen variables, g denotes developing countries and d denotes developed countries:

1. EPA_gd_{ijt}, for trade flows from developing countries to developed countries at time t and takes the value of one when exporting country (i) is developing country and importing country (j) is developed country and they have an EPA between them, zero otherwise. EPA variables include Cariforum EPA, EAC EPA, ESA EPA, CA EPA, WA EPA, and Pacific EPA.

2. EPA_dg_{ijt}, for trade flows from developed countries to developing countries at time t and takes the value of one when exporting country (i) is developed country and importing country (j) is developing country and they have an EPA between them, zero otherwise.

3. FTA_gd_{ijt}, for trade flows from developing countries to developed countries at time t and takes the value of one when exporting country (i) is developing country and importing country (j) is developed country and they have FTA between them, zero otherwise.

4. FTA_dg_{ijt}, for trade flows from developed countries to developing countries at time t and takes the value of one when exporting country (i) is developed country and importing country (j) is developing country and they have FTA between them, zero otherwise.

5. FTA_dd_{ijt}, for trade flows from developed countries to developed countries at time t and takes the value of one when exporting country (i) is developed country and importing country (j) is developed country and they have FTA between them, zero otherwise.

6. FTA_gg_{ijt}, for trade flows from developing countries to developing countries at time t and takes the value of one when exporting country (i) is developing country and importing country (j) is developing country and they have FTA between them, zero otherwise.

7. EU_{ijt}, denotes EU FTA for intra-EU trade flows (among the EU member states only, EEA not included) at time t and takes the value of one when exporting country (i) is an EU member state and importing country (j) is EU member state as well, zero otherwise.

8. OCT_gd_{ijt}, for trade flows from Overseas Countries and Territories (OCT) to the EU at time t and takes the value of one when exporting country (i) is OCT country and importing country (j) is EU member state and they have FTA between them, zero otherwise, it does not cover intra-European trade or OCT among themselves. USA OCTs are not included.

9. OCT_dg_{ijt}, for trade flows from the EU to OCT at time t and takes the value of one when exporting country (i) is EU member state and importing country (j) is OCT country and they have FTA between them, zero otherwise.

10. $GSP+_{ijt}$, applies only for exports from developing countries to developed countries at time t and takes the value of one when exporting country (i) is a developing country and importing country (j) is a developed country (not vice versa) and both (i) and (j) covered by the GSP+ program, zero otherwise. GSP plus includes EU GSP+, Norway GSP+, and USA African Growth and Opportunity Act (AGOA).

11. GSP_{ijt}, applies only for exports from developing countries to developed countries at time t and takes the value of one when exporting country (i) is a developing country and importing country (j) is a developed country (not vice versa) and both (i) and (j) covered by the GSP program, zero otherwise. GSP standard includes Australia GSP, Canada GSP, Bulgaria GSP, EU GSP, Japan GSP, New Zealand GSP, Norway GSP, Switzerland GSP, and USA GSP.

12. EBA_{ijt}, denotes EU EBA and applies only for exports from developing countries to developed countries at time t and takes the value of one when exporting country (i) is a developing country and importing country (j) is developed country (not vice versa) and both (i) and (j) covered by the EBA program, zero otherwise.

13. $Lomé_{ijt}$ for trade flows from ACP to the EEC/EU at time t and takes the value of one when exporting country (i) is ACP country and importing country (j) is EEC/EU member state, zero otherwise, because Lomé convention does not cover intra-European trade or ACP among themselves. This study doesn't make a separate dummy variable for Cotonou (2000-2007) because Cotonou basically continued the Lomé III arrangement and it was intended to lead to the EPAs, it was not an FTA by itself.

14. $Lomé\_dg_{ijt}$ for trade flows from the EEC/EU to ACP countries at time *t* and takes the value of one when exporting country (i) is EEC/EU member state and importing country (j) is ACP country, zero otherwise.

15. Interaction term (EPA_gd*EBA). Dummies enter additively but EPA plus EBA doesn't give two benefits to a country because they overlap and the interaction term recognizes that fact. EBA members enjoy EPA benefits as well. Basically, the EPA and the EBA offer the same EU market access to ACP countries that are LDCs. The main issue is not the Cariforum countries but African & Pacific EPA members because most of them are LDCs and they don't get extra access from what they getting at EBA. This hinders the individual EPA variable to capture how much the EPA is better than FTA but rather capturing how much EPA is better than EBA and in the real world is not because EBA grants LDCs fully duty-free quota-free (DF-QF) access to the EU market for all products (except weapons). Therefore; this study is going to change the specification by introducing the interaction term between EPA member states and EBA beneficiaries .i.e. the intersection between EPA_gd and EBA.

6.9. Data

This work uses import data to build the main dependent variable because imports are monitored much more than exports by customs administrations (e.g. through import duty). This study applies the panel (unbalanced) estimation method with fixed effects. Data from 1976 to 2019 from 248 countries (including EU overseas countries and territories); 248 importers and 248 exporters (appendix table 28). Data on bilateral imports in goods comes from Comtrade via the World Integrated Trade Solution (WITS). Data on trade agreements, trade cost variables (such as distance, official language, border, and colonial ties) are taken from the Centre d'Etudes Prospectives et d'Informations Internationales (CEPII) database, the standard source. GSP data from Jeffrey Bergstrand's NSF-Kellog Institute database on economic integration agreements, and the EU website.

Table (29) presents a summary of continuous variables where total observations are 2,705,952, distance observations are 1,991,439. Missing observations of bilateral distances are 714,513. The frequency of dummy variables taking the value of one or zero is presented in table (30). For instance, the frequency of EPA_gd (for trade flows from developing countries to developed countries) variable getting the value of one is 12,474 when exporting country is developing country and importing country is developed country and they have EPA between them, zero otherwise, and the frequency of zero is 2,693,478.

Table 29 reports descriptive statistics of continuous variables from 1976-2019

Variable	Total observations	Observations > 0	Missing	Mean (in $)	Std. Dev. (in $)
Imports	2,705,952	810,666	1,895,286	410,000,000	4,500,000,000
Weighted distance (pop-wt, km)	2,705,952	1,991,439	714,513	8,437	4,682

Source: Author's calculations based on the CEPII database, WTO Regional Trade Agreements database, and the EU website.

Imports missing observations as presented in table 29 are mainly for EU-OCT, very small economies, small Islands, and countries affected by chronic war and conflicts (table 31).

Table 30 reports descriptive statistics of dummy variables from 1976-2019

Variable	Total observations	Frequency			Percent		
		0	1	Missing	0	1	Missing
Common official language	2,705,952	1,703,805	382,164	619,983	63%	14.1%	23%
Common coloniozer post 1945	2,705,952	1,828,746	257,223	619,983	68%	9.5%	23%
GSP	2,705,952	2,516,091	189,861	0	93%	7.0%	0%
GSP+	2,705,952	2,663,737	42,215	0	98%	1.6%	0%
EBA	2,705,952	2,638,084	67,868	0	97%	2.5%	0%
Trade flows from developing to developed countries under EPA agrement (EPA_gd)	2,705,952	2,693,478	12,474	0	100%	0.5%	0%
Interaction term (EPA_gd*EBA)	2,705,952	2,701,923	4,029	0	100%	0.1%	0%
Trade flows from developed to developing countries under EPA agrement (EPA_dg)	2,705,952	2,693,478	12,474	0	100%	0.5%	0%
Trade flows from developing to developed countries under FTA agrement (FTA_gd)	2,705,952	2,693,675	12,277	0	100%	0.5%	0%
Trade flows from developed to developing countries countries under FTA agrement (FTA_dg)	2,705,952	2,693,675	12,277	0	100%	0.5%	0%
Trade flows from developing to developing countries countries under FTA agrement (FTA_gg)	2,705,952	2,689,779	16,173	0	99%	0.6%	0%
Trade flows from developed to developed countries countries under FTA agrement (FTA_dd)	2,705,952	2,678,988	26,964	0	99%	1.0%	0%
EU	2,705,952	2,690,620	15,332	0	99%	0.6%	0%
Trade flows from OCT to EU (OCT_gd)	2,705,952	2,692,966	12,986	0	100%	0.5%	0%
Trade flows from EU to OCT (OCT_dg	2,705,952	2,692,966	12,986	0	100%	0.5%	0%
Trade flows from ACP countries to the EU under Lomé agreemet (Lomé_gd)	2,705,952	2,687,528	18,424	0	99%	0.7%	0%
Trade flows from the EU to ACP countries under Lomé agreemet (Lomé_dg)	2,705,952	2,687,528	18,424	0	99%	0.7%	0%

Source: Author's calculations based on the CEPII database, WTO Regional Trade Agreements database, and the EU website.

6.10. FTA membership:

This study uses the Regional Trade Agreement Information System (RTA-IS) of WTO to find out whether FTA formed between any pair of countries in the dataset. This study focuses on FTA covering goods only. The data includes all FTAs that are notified to the WTO and entered into force and this also includes the following EPAs: 1) EU-CARIFORUM EPA which entered into force 2008. 2) EU-Central Africa (CA) EPA which was signed in 2009 between EU member states and central CA. 3) EU-Eastern and Southern Africa States Interim (ESA) EPA which entered into force in 2012 between the EU

member countries and ESA. 4) EU-East African Community (EAC). In 2014, The EU and The EAC completed the negotiation but Kenya, Rwanda, and South Sudan ratified the agreement in 2016. 5) The EU-West Africa (WA) EPA (announcement has been made to the WTO in 2014). 6) EU-Pacific EPA. The EU and Papua New Guinea ratified it in 2011 and Fiji applied it in 2014. 7) The EU-Southern African Development Community (SADC) EPA agreement signed in 2016 between the EU and SADC (Botswana, Lesotho, Mozambique, Namibia, South Africa, and Swaziland). In February 2018 Mozambique joined the agreement and it became the first fully operational EPA in continental Africa. This study focuses on the agreements that pertain to EU-ACP trade only, namely GSP, GSP+, EBA, EPA_gd, EPA_dg, FTA_gd, FTA_dg, Lomé_gd, and Lomé_dg. Therefore this study is focusing on them but in the dataset, there are other agreements as well such as EU, FTA_dd, FTA_gg, OCT_gd, and OCT_dg.

6.11. Setting up the dummy variables

This study covers the period from 1976 to 2019. The dummy variables (EPA, FTA, GSP, Lomé, and Cotonou) overlap because all EPA member countries were part of the Lomé, Cotonou, GSP program, and they are not exactly the same. So for Cariforum EPA countries (except Haiti), dummy variables EPA_gd, FTA_gd, FTA_gg, GSP, and Lomé_gd take the value of one and all the other dummy variables the value of zero (table 32). For Dominica, we give the EPA_gd, FTA_gd, FTA_gg, GSP, GSP+, and Lomé_gd dummy variables the value of one and all the other dummy variables the value of zero. All Cariforum EPA members are either HI or UMI countries except Haiti. Haiti is a Low Income (LI) and LDC that signed the Cariforum EPA but not applying it yet and access the EU market under EBA.

The picture is different for countries that belong to other EPAs particularly African blocs. For instance, for Lower Middle Income (LMI) countries such as Nigeria, dummy variables EPA_gd, FTA_gd, FTA_gg, GSP, GSP+, and Lomé_gd take the value of one and all the other dummy variables the value of zero (table 32). For LDC and LI African countries like Benin, dummy variables EPA_gd, FTA_gd, FTA_gg, GSP, GSP+, interaction (EBA*EPA), EBA, and Lomé_gd take the value of one and all the other dummy variables the value of zero.

For non-EPA countries, the variations are even deeper than African blocs. For HI countries such as Chile, dummy variables FTA_gd, FTA_gg, GSP take the value of one and all the other dummy variables the value of zero. For a UMI country like Colombia, dummy variables FTA_gd, FTA_gg, GSP, and GSP+ take the value of one and all the other dummy variables the value of zero.

This study takes into account the fact that the GSP scheme changes in its coverage (country/product). The GSP is time-variant, and not an FTA but it is rather a program offered by the EU and other developed countries (Australia, Bulgaria Canada, Switzerland, Japan, Norway, New Zealand, and the USA) and applies only for exports from developing countries to developed countries. This study assumes that all GSP programs (EU, Australia, Canada, etc.) are the same, therefore; this study coded them as the same programs.

By 1 January of each year, the EU Commission reviews the GSP; regulation (EU) No. 978/2012 establishes that any developing country benefits from GSP unless: it has been classified by the World Bank as an upper-middle-income or a high-income country for 3 consecutive years, or a country that enjoys a preferential market access arrangement which offers the same tariff preferences as the GSP, or better, for substantially all trade. According to regulation (EU) No. 978/2012, GSP benefits will continue for 1 year after entry into force of a change in country status and 2 years after the date of

application of a preferential market access arrangement and this date should be specified in the list of beneficiary countries of the general arrangement.

For an LMI country like Pakistan which enjoys EU GSP+, dummy variables FTA_gg, GSP+, and GSP take the value of one and all the other dummy variables the value zero. For LDC and LMI countries like Bangladesh which enjoys EU EBA, dummy variables FTA_gg, GSP+, GSP, and EBA take the value of one and all the other dummy variables the value of zero. While for LMI GSP beneficiary countries like India, dummy variables FTA_gd, FTA_gg, and GSP take the value of one and all the other dummy variables the value of zero.

The USA is the major trading partner for Cariforum countries and it offers the African Growth and Opportunity Act (AGOA) to Sub-Saharan African (SSA) countries only. AGOA is similar to EU GSP+ in the sense that, to qualify for AGOA, a country should improve labor rights, rules of law, and human rights. Therefore this study treats AGOA as GSP+. AGOA is the USA trade act enacted in May 2000 to enhance trade relations between the USA and SSA and it has been extended in June 2015 for additional 10 years, to 2025.

AGOA's non-reciprocal preferences grant SSA countries QF-DF access to the USA markets for certain products such as textile and apparel. So for SSA countries such as Angola, dummy variables FTA_gg, GSP, GSP+ (AGOA), EBA, and Lomé _gd take the value of one and all other variables the value of Zero (table 32).

So this work continues in this manner to cover all countries in the dataset for the period of this study. In the end, this work is going to have some developing countries that are not in the EPA differ from those that are in the EPA. So, there will be some developing countries that are covered by GSP+ different from those under GSP at the same time different from countries that belong to FTA and so on. The variation among these dummy variables is going to be identifying the effect of these variables (table 32).

7. RESULTS

Table 33 presents gravity estimates for the period 1976-2019 based on model (5)

Variables	PPML imports
GSP standard	0.0615***
	(0.0211)
GSP plus	-0.0744
	(0.0509)
EBA	-0.0871*
	(0.0470)
Trade flows from developing to developed countries under EPA agreement	0.229***
	(0.0651)
Interaction term (EPA_gd*EBA)	-0.196**
	(0.0993)
Trade flows from developed to developing countries under EPA agreement	-0.156***
	(0.0354)
Trade flows from developing to developed countries under FTA agreement	-0.0227
	(0.0193)
Trade flows from developed to developing countries under FTA agreement	-0.0504***
	(0.0153)
Trade flows from developing to developing countries under FTA agreement	-0.145***
	(0.0291)
Trade flows from developed to developed countries under FTA agreement (FTA_dd)	0.150***
	(0.0162)
EU	0.133***
	(0.0114)
Trade flows from OCT to EU (OCT_gd)	0.370***
	(0.134)
Trade flows from EU to OCT (OCT_dg	0.361***
	(0.102)
Trade flows from ACP countries to the EU under Lomé agreemet (Lomé_gd)	-0.0448
	(0.0419)
Trade flows from the EU to ACP countries under Lomé agreemet (Lomé_dg)	0.320***
	(0.0278)
Observations	808,013
R-squared	0.9901

Source: Author's calculations based on the CEPII database, WTO Regional Trade Agreements database, and the EU website.

Notes: Robust standard error in parentheses: *** p<0.01, ** p<0.05, * p<0.1

248 importers and 248 exporters.

Table 34 presents the effect of PTAs and Wald Test on the significance of the sum of PTA coefficients

Exporter	Importer	Exporter WB classifi-cation of June 2020	Trade flows from developing to developed countries							Wald Test on sum of the coefficients		Sum of PTA coefficients	Effect of PTAs	Significance of the sum of the relevant PTA coefficients based on Wald Test
			epa_gd	fta_gd	gsp+	gsp	Intera-ction term	eba	lomé_gd	Chi-squared	P-value			
Cariforum:														
Antigua and Barbuda	UK	HI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
The Bahamas	UK	HI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Belize	UK	UMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Barbados	UK	HI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Dominica	France	UMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	2.93	0.09	0.15	16	Nonsignificant
Dominican Republic	France	UMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Grenada	France	UMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Guyana	France	UMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Haiti: LDC	France	LI	0	-0.02	0	0.06	0	-0.1	-0.04	0.01	0.41	-0.09	-9	Nonsignificant
Jamaica	Italy	UMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Saint Kitts and Nevis	Italy	HI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Saint Lucia	Italy	UMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Suriname	Italy	UMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Trinidad and Tobago	Italy	HI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Saint Vincent and the Grenadines	Italy	UMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Central Africa:														
Central African Republic: LDC	UK	LI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Nonsignificant
Cameroon	UK	LMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Congo	UK	LMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	2.93	0.09	0.15	16	Nonsignificant
Equatorial Guinea	UK	UMI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Nonsignificant
Sao Tome and Principe: LDC	France	LMI	0.23	-0.02	0	0	-0.2	-0.1	-0.04	4.45	0.44	-0.12	-11	Nonsignificant
Chad: LDC	France	LI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Nonsignificant
Gabon	UK	UMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	2.93	0.09	0.15	16	Nonsignificant

EAC:														
Burundi: LDC	France	LI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Significant
Kenya	France	LMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	2.93	0.09	0.15	16	Nonsignificant
Rwanda: LDC	Italy	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Tanzania	Italy	LMI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Uganda: LDC	Italy	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
ESA:														
Comoros: LDC	Italy	LMI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Nonsignificant
Djibouti: LDC	Italy	LMI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Nonsignificant
Eritrea: LDC	UK	LI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Nonsignificant
Ethiopia: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Madagascar: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Mauritius	UK	HI	0.23	-0.02	-0.07	0.06	0	0	-0.04	2.93	0.09	0.15	16	Nonsignificant
Malawi: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Sudan: LDC	UK	LI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Nonsignificant
Seychelles	N/A	HI	0.23	-0.02	-0.07	0.06	0	0	-0.04	2.93	0.09	0.15	16	Nonsignificant
Zambia: LDC	UK	LMI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Zimbabwe: LDC	UK	LMI	0.23	-0.02	0	0	-0.2	-0.1	0	1.73	0.19	-0.08	-7	Nonsignificant
Pacific:														
Fiji	UK	UMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	0.38	0.54	0.15	16	Nonsignificant
Kiribati: LDC	UK	LMI	0	0	0	0.06	0	-0.1	-0.04	1.73	0.19	-0.07	-7	Nonsignificant
Marshall Islands	UK	UMI	0	0	0	0	0	0	-0.04	1.14	0.28	-0.04	-4	Nonsignificant
Papua New Guinea	UK	LMI	0.23	-0.02	0	0.06	0	0	-0.04	7.82	0.01	0.22	25	Significant
Solomon Islands: LDC	UK	LMI	0	0	0	0.06	0	-0.1	-0.04	1.73	0.19	-0.07	-7	Nonsignificant
Tonga	UK	UMI	0	0	0	0.06	0	0	-0.04	0.13	0.71	0.02	2	Nonsignificant
Tuvalu: LDC	UK	UMI	0	0	0	0	0	0	-0.04	1.14	0.28	-0.04	-4	Nonsignificant
Vanuatu: LDC	UK	LMI	0	0	0	0.06	0	-0.1	-0.04	1.73	0.19	-0.07	-7	Nonsignificant
Samoa	UK	UMI	0	0	0	0.06	0	-0.1	-0.04	1.73	0.19	-0.07	-7	Nonsignificant
SADC:														
Angola: LDC	UK	LMI	0	0	0	0.06	0	-0.1	-0.04	1.73	0.19	-0.07	-7	Nonsignificant
Botswana	UK	UMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	0.38	0.54	0.15	16	Nonsignificant
Lesotho: LDC	UK	LMI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Mozambique: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Namibia	UK	UMI	0.23	-0.02	0	0	0	0	-0.04	4.45	0.04	0.16	18	Significant
Swaziland	UK	HI	0.23	-0.02	-0.07	0.06	0	0	-0.04	0.38	0.54	0.15	16	Nonsignificant
South Africa	UK	UMI	0.23	-0.02	0	0	0	0	0	10.25	0.00	0.21	23	Significant

West Africa:														
Benin: LDC	UK	LMI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Burkina Faso: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Côte d'Ivoire	UK	LMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	0.38	0.54	0.15	16	Nonsignificant
Cape Verde	UK	LMI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Ghana	UK	LMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	0.38	0.54	0.15	16	Nonsignificant
Guinea: LDC	UK	LI	0.23	-0.02	-0.07	0.06	0	0	-0.04	0.38	0.54	0.15	16	Nonsignificant
Gambia: LDC	UK	LI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	0.38	0.54	-0.06	-6	Nonsignificant
Guinea-Bissau: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Liberia: LDC	UK	LI	0.23	-0.02	0	0.06	-0.2	-0.1	-0.04	2.19	0.14	-0.06	-6	Nonsignificant
Mali: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Mauritania: LDC	UK	LMI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Niger: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Nigeria: LDC	UK	LMI	0.23	-0.02	-0.07	0.06	0	0	-0.04	0.38	0.54	0.15	16	Nonsignificant
Senegal: LDC	UK	LMI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Sierra Leone: LDC	UK	LI	0.23	-0.02	-0.07	0.06	-0.2	-0.1	-0.04	1.53	0.22	-0.13	-13	Nonsignificant
Non EPA:														
French Polynesia-OCT	France	*HI*	0	-0.02	0	0	0	0	0	6.63	0.01	-0.02	-2	Significant
Chile	UK	*HI*	0	-0.02	0	0.06	0	0	0	1.22	0.27	0.04	4	Nonsignificant
Algeria	UK	*LMI*	0	-0.02	0	0.06	0	0	0	1.22	0.27	0.04	4	Nonsignificant
Colombia	Italy	*UMI*	0	-0.02	-0.07	0.06	0	0	0	0.01	0.93	-0.04	-3	Nonsignificant
Paraguay	Belgium	*UMI*	0	0	-0.07	0.06	0	0	0	0.06	0.80	-0.01	-1	Nonsignificant
Pakistan	Austria	*LMI*	0	0	-0.07	0.06	0	0	0	0.06	0.80	-0.01	-1	Nonsignificant
Bangladesh: LDC	Sweden	*LMI*	0	0	-0.07	0.06	0	-0.1	0	0.81	0.37	-0.10	-10	Nonsignificant

Source: Author's calculations based on CEPII database, WB, WTO Regional Trade Agreements database, and the EU website

Notes: For developing countries (i.e. Cariforum countries and other ACP blocs), this study focuses on policy variables that control for trade flows from developing to developed countries (i.e. columns from 5 to 11).

HI: High Income, UMI: Upper Middle Income, LMI: Lower Middle Income, LI: Lower Income.

The figures in columns from 4 to 10 represent the coefficients of their relevant PTA variables, e.g. 0.23 in column 4 is the coefficient of epa_gd (table 33).

Zambia is a beneficiary of EBA and a member of ESA EPA, therefore, it has an interaction term (i.e. the overlap between EBA and EPA).

Samoa acceded to the APA in December 2018 and is applying it since then. Kenya and Rwanda signed EPA in September 2016. SADC EPA started in 2016. Namibia has FTA with EFTA.

The PTAs (columns 4 to 10) in table (34) refer to policy variables that control for trade flows from developing countries to developed countries. Specifically, EPA_gd, FTA_gd, GSP+, GSP, EBA, and Lomé_gd. The coefficients of these policy variables are based on the gravity model of equation (5) as presented in table (33). The sum of PTAs coefficients in column 13 is calculated as the sum of coefficients of EPA_gd, FTA_gd, GSP+, GSP, EBA, and Lomé_gd. This study uses the *display STATA* command to calculate the sum of PTA coefficients. For example, for Belize, "*display _b[EPA_gd]+ _b[FTA_gd]+ _b[GSP]+ _b[Lomé_gd]"* and the output is 0.22. The trade volume effect of indicator variables in column 14 (table 34) calculated in percentage terms [$e^{\widehat{\beta}_{dummy}}$-1]*100 (Baier & Bergstrand, 2007). Where the beta hat dummy is the estimate of the effects of RTAs in the gravity model.

This study focuses on the trade effect of these policy variables. Besides the EPA agreement, each ACP EPA member state enjoys other preferential access to the UK/EU market. Therefore the intuition behind the sum of coefficients of these policy variables is to know how much a HI country enjoys EPA (such as Barbados enjoys EPA, FTA, GSP, Lomé) to access UK/EU-27 market, will be better off than a HI country without EPA but enjoys other preferential access (FTA and GSP) to the UK/EU market such as Chile.

Also, to know how much a UMI country enjoys EPA (such as Saint Lucia enjoys EPA, FTA, GSP, Lomé) to access UK/EU market, will be better off than a UMI country without EPA but enjoys other preferential access (FTA, GSP, GSP+) to the UK/EU market such as Colombia. Or how much an LDC country enjoys EBA & EPA (such as the Gambia enjoys EPA, FTA, GSP, EBA, Lomé) to access UK/EU market, will be better off than an LDC country without EPA but enjoys GSP, GSP+, EBA to access the UK/EU market such as Bangladesh.

The research questions will be answered as follows:

If, Cariforum and the rest of the African & Pacific countries continue to access the UK market under EPAs: 1) On average, the trade volume of HI Cariforum countries increases by 25%. Specifically, Antigua and Barbuda, the Bahamas, Barbados, Saint Kitts, and Nevis, Trinidad, and Tobago. 2) Also on average, the trade volume of UMI Cariforum countries increases by 25%. Namely, Belize, Dominican Republic, Grenada, Guyana, Jamaica, Saint Lucia, Saint Vincent, and the Grenadines, Suriname. 3) no significant impact on the trade volume of Dominica. Negative impact on Haiti (signed EU-Cariforum EPA but not applying it). 4) Apart from some LDCs (Cameroon, Sao Tome and Principe), Namibia, and, Papua New Guinea, and South Africa, no significant impact on the trade volume of the rest of the African and pacific EPA members states.

Based on the Wald Test on the significance of the sum of PTA coefficients (table 34), this study concludes that with exception of Cariforum (HI &UMI) countries, some LDC and very few African countries, the overall effect of EPAs on trade flows from ACP countries to the EU is nonsignificant.

Therefore; the ACP EPAs have a significant impact mainly on HI and UMI Cariforum countries. If all ACP countries continue to access the UK market under EPAs, still the overall impact of EPAs on trade flows from ACP to the UK will be nonsignificant for the majority of ACP countries, namely African and Pacific blocs because they are mostly LI and LMI countries. For example, this study covers 75 ACP countries (table 35); HI are only 8 countries and 5 of them belong to the Cariforum EPA bloc and only three are African countries.

8. CONCLUSION

Based on the findings, this study concludes that, If, Cariforum and the rest of the African & Pacific countries continue to access the UK market under EPAs: 1) On average, the trade volume of HI Cariforum countries increases by 25%. Specifically, Antigua and Barbuda, the Bahamas, Barbados, Saint Kitts, and Nevis, Trinidad, and Tobago. 2) Also on average, the trade volume of UMI Cariforum countries increases by 25%. Namely, Belize, Dominican Republic, Grenada, Guyana, Jamaica, Saint Lucia, Saint Vincent, and the Grenadines, Suriname. 3) no significant impact on the trade volume of Dominica. Negative impact on Haiti (signed EU-Cariforum EPA but not applying it). 4) Apart from

some LDCs (Cameroon, Sao Tome and Principe), Namibia, and, Papua New Guinea, and South Africa, no significant impact on the trade volume of the rest of the African and pacific EPA member states.

If all ACP countries continue to access the UK market under EPAs, still the overall impact of EPAs on trade flows from ACP to the UK will be nonsignificant for the majority of ACP countries, namely African and Pacific blocs.

Generally speaking, the EU EPAs have a significant impact only on few HI & UMI ACP EPA countries and a nonsignificant impact on the majority of ACP countries (i.e. most ACP countries are either LI or LMI countries). So the overall impact of EU EPAs on ACP countries is nonsignificant.

Similarly, the EU assessment of Cariforum-EU EPA in 2014 reviewed the implementation and impact of Cariforum-EU EPA over the period of 2008-2013 (i.e. during the five years of its implementation). This assessment shows that Cariforum's gross exports to the EU witnessed an increase in their gross exports to post-2008 global recession but the Organisation of Eastern Caribbean States (OECS) witnessed a decline in their exports until 2011 then started to increase. During the period from 2006-2008 before the signature of Cariforum-EU EPA, Cariforum exports began to plateau and decline in some cases because of energy and food price shocks. In an exceptional case, Trinidad and Tobago exports increased to the EU-including methanol, crude oil, ammonia, urea, and increasingly liquefied natural gas.

Before Brexit, the EU regulating the UK's trade relations in goods and services with all developing countries, and the policy is managed by the European Commission. The UK government has committed itself to replicate the EU agreements post-Brexit. But the extension of the EU GSP scheme might negatively affect developing countries that are in need of preferential treatments.

So the EU trade and development regime towards developing countries has led to some facts that the UK government should take into account when designing future trade and development policy for developing countries post-Brexit:

1. Most developing countries lack policy and institutional coherence to take advantage of the free market access granted to them by the EU.

2. Not to treat all the developing countries as one group rather implement trade and development policy that addresses their different social and economic needs.

3. Some ACP countries were mainly dependent on the EU market because the EU's preferential access was designed as a disincentive to exploit markets beyond the EU, besides other things, export diversification and economic growth. Therefore, the UK government must adopt a trade and development policy to assist these countries to develop and not to be attached to the UK.

4. To ensure continuity in market access to developing countries post-Brexit implies that the UK will roll over the pre-Brexit EU's graduation mechanism. But the pre-Brexit import-share thresholds could involve loss of preferences without improvement in the competitiveness of beneficiary countries, e.g. some developing countries' import-shares may exceed the graduation thresholds, either in the UK market or the EU27 market post-Brexit particularly countries that are close to the graduation threshold (counties with larger import-shares pre-Brexit). Therefore the UK must revise the vulnerability

thresholds (eligibility to the GSP+ regime) and the graduation thresholds upwards to ensure that pre-Brexit beneficiaries are not removed from the UK's GSP post-Brexit (Borchert & Di Ubaldo, 2020).

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10. APPENDIX

10.1.Appandix A: The Armington-CES gravity model

Anderson (1979) was the first to introduce theoretical underpinnings for the empirical application of the gravity model. This model considers a world of *N* countries; each country produces a variety of goods. Goods are differentiated by region of origin (Armington, 1969). The supply of each good is denoted by Q_i , factory gate price is denoted by p_i, domestic production is defined as $Y_i = p_i Q_i$, aggregate expenditure is donated by E_i, in gravity estimation expenditure E_i is proxied with GDP or Y_i. The time dimension *t* is omitted for concision. The structural gravity model introduced below is derived from the demand side. On the demand side, the model assumes homothetic and identical consumer preferences across countries and is approximated by CES-utility function for country *j*:

$$\text{CES utility function } (u_j) = \left[\sum_i \beta_i^{\frac{1-\sigma}{\sigma}} c_{ij}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \quad \text{(A.1)}$$

Where β_i is a positive distribution parameter, σ is the elasticity of substitution across countries, c_{ij} denotes consumption of varieties from country *i* in country *j*. Consumers maximize equation (2) subject to the budget constraint:

$$\sum_i p_{ij} c_{ij} = Y_j \quad \text{(A.2)}$$

Here Y_j is *j*'s GDP (value of the output), p_{ij} is the price of *i*'s goods for *j*'s consumers. Consider p_i is *i*'s price and t_{ij} is the trade cost; therefore, $p_{ij} = p_i t_{ij}$. Solving consumer's optimization problem gives the expenditure on goods from *i* to *j* as:

$$X_{ij} = \left[\frac{\beta_i p_i t_{ij}}{P_j}\right]^{1-\sigma} Y_j \quad \text{(A.3)}$$

Where X_{ij} denotes trade flows from *i* to *j* and the consumer price index (CES price aggregator) is given by:

$$P_j = \left[\sum_i \left(\beta_i p_i t_{ij}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}} \quad \text{(A.4)}$$

This model assumes iceberg trade costs, the price of goods exported from *i* to *j* is $p_{ij} = p_i t_{ij}$ where p_i is the factory gate price and t_{ij} is the trade cost.

The general equilibrium structure of the model is to impose market clearance for goods from each exporting country:

$$Y_i = \sum_j \left(\frac{\beta_i p_i t_{ij}}{P_j}\right)^{1-\sigma} Y_j \tag{A.5}$$

Equation (A.5) implies that the total value of production in country *i* equals to the sum of *i*'s exports to all countries including country *i* itself. Where the right side of equation (A.5) can be substituted with the total bilateral exports from *i* as defined in equation (A.3), so that $Y_i \equiv \sum_j X_{ij}\ \forall_j$. Defining world income $Y \equiv \sum_i Y_i$ after rearranging and dividing market clearance equation (A.5) by *Y*, yields:

$$(\beta_i p_i)^{1-\sigma} = \left[\frac{Y_i/Y}{\sum_j (t_{ij}/P_j)^{1-\sigma} Y_j/Y}\right] \tag{A.6}$$

According to Anderson and van Wincoop (2003), the denominator in equation (A.6) can be defined as outward multilateral resistance $\Pi_i^{1-\sigma} \equiv \sum_j \left(t_{ij}/P_j\right)^{1-\sigma} Y_j/Y$, and be substituted into (A.6):

$$(\beta_i p_i)^{1-\sigma} = \left[\frac{Y_i/Y}{\Pi_i^{1-\sigma}}\right] \tag{A.7}$$

Multilateral resistance terms mean that trade between country *i* and country *j* is determined by *relative* trade barriers. Therefore; trade cost between country *i* and country *j* depends on the bilateral barriers between *i* and *j* relative to average trade barriers that both *i* and *j* face with all other countries (rest of the world). Plug (A.6) into (A.3) to get Anderson and van Wincoop (2003) inward multilateral resistance defined as $P_j = \left[\sum_i \left(t_{ij}/\Pi_i\right)^{1-\sigma} Y_i/Y\right]^{1/(1-\sigma)}$. Substitute (A.7) into (A.3) and (A.4) to get the structural gravity model as:

$$X_{ij} = \left[\frac{Y_i Y_j}{Y_w}\right]\left[\frac{t_{ij}}{\Pi_i P_j}\right]^{1-\sigma} \tag{A.8}$$

$$\Pi_i = \left[\sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} Y_j/Y\right]^{\frac{1}{1-\sigma}} \tag{A.9}$$

$$P_j = \left[\sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma} Y_i/Y\right]^{\frac{1}{1-\sigma}} \tag{A.10}$$

Here X_{ij} denotes bilateral exports between country *i* and country *j*, and X_{ij} depend on: trade costs (t_{ij}) between exporting country *i* and importing country *j*, $Y_i and\ Y_j$ denote GDPs of exporting country and importing country respectively, $Y_w = \sum_j Y_j$ denotes world GDP, and the average barriers to trading with the rest of the world (all other countries), captured by the multilateral resistance terms (MRT) P_j and Π_i. Assume that the labor is the only input in the production process so that the output is expressed as $Y_i = p_i A_i L_i = W_i L_i$, and the preference parameter β_i is common across all markets. Then by substituting for price and income, the market-clearing condition generates the following relationship between factor prices, productivity, and trade frictions:

$$W_i = B_A \left(\frac{A_i}{\Pi_i}\right)^{\frac{1-\sigma}{\sigma}} \text{ where } B_A = L_i^{-1/\sigma}.$$

Given the relationship between expenditure and income, the structural gravity model can be expressed as follows:

$$X_{ij} = \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma} (W_j L_j)(W_i L_i) \quad \forall_j, j \tag{A.11}$$

$$\Pi_i = \left[\sum_j \left(\frac{t_{ij}}{P_j}\right)^{1-\sigma} W_j L_j\right]^{\frac{1}{1-\sigma}} \quad \forall_i \tag{A.12}$$

$$P_j = \left[\sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{1-\sigma} W_i L_i\right]^{\frac{1}{1-\sigma}} \quad \forall_j \tag{A.13}$$

$$W_i = B_A \left(\frac{A_i}{\Pi_i}\right)^{\frac{1-\sigma}{\sigma}} \quad \forall_i \tag{A.14}$$

Given the multiplicative structure of the structural gravity model of equations (A.11) to (A.13), and assuming that they hold in each period of time *t*, this work can log-linearize them and expand them with additive error term to get a linear gravity model as in equation (1). Equations (A.11) resembles gravity equation (1) because it relates the bilateral trade flows (X_{ij}) between *i* and *j* to their economic sizes $W_i L_i$ and $W_j L_j$ respectively, and to the relative bilateral trade costs between *i* and *j*.

10.2.Appandix B: Monopolistic competition model of Krugman (1979, 1980) and Bergstrand (1985, 1989)

Unlike the Armington model, this model provides theoretical underpinnings of the gravity model derived from the supply-side with many identical firms in each country, each firm produces a different variety. The model assumes that consumers have Dixit-Stiglitz love-of-variety preferences, producers face a fixed cost. Dixit-Stiglitz preferences are featured by

CES utility function defined as $u_j = \left[\sum_v c_j(v)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$,

Where $c_j(v)$ denotes consumption of variety v in country *j* and the demand for each variety v is given by $\left[\frac{p_j(v)}{P_j}\right]^{-\sigma} \frac{Y_j}{P_j}$. The model also assumes that producers in the country *i* have identical technology, where the production technology: $q_i(v) = A_i(l_i(v) - f_i)$, where $q_i(v)$ is the production of variety v in country *i*, A_i is technology in country *i*, $l_i(v)$ is the labor in country *i*, f_i is a fixed cost of production and goods exported from *i* to *j* are subject to iceberg trade costs. The total wage for the production of variety v in the country *i* given by $\mathrm{w}_i l_i(v) = \mathrm{w}_i \left[\frac{q_i(v)}{A_i} + f_i\right]$, substituting for the total demand $q_i(v) = \sum_k t_{ik} \left[\frac{p_j(v)}{P_j}\right]^{-\sigma} \frac{Y_j}{P_j}$, therefore; wage for the production of variety v in country *I* defined as $\mathrm{w}_i l_i(v) = \sum_k \frac{\mathrm{w}_i t_{ik}}{A_i} \left[\frac{p_j(v)}{P_j}\right]^{-\sigma} \frac{Y_j}{P_j} + \mathrm{w}_i f_i$, and the firm producing a variety of v in the country *i* maximizing: $\pi_i = max_{pi}\{\sum_k \left[\frac{p_{ik}}{P_k}\right]^{1-\sigma} Y_i - \sum_j \left[\frac{\mathrm{w}_i t_{ik}}{A_i}\right] \left[\frac{p_{ik}}{P_k}\right]^{-\sigma} \frac{Y_k}{P_k} - \mathrm{w}_i f_i\}$, this implies that $p_{ik} = \left[\frac{\mathrm{w}_i t_{ik}}{A_i \rho}\right]$ where $\rho = \frac{\sigma-1}{\sigma}$, thus the profits can be defined as $\pi_i = \sum_k \left[\frac{\mathrm{w}_i t_{ik}}{A_i \rho P_k}\right]^{1-\sigma} \frac{Y_k}{\sigma} - \mathrm{w}_i f_i$.

In equilibrium, profits are zero so that $\mathrm{w}_i f_i$ implies that q_i=$A_i f_i(1-\sigma)$, and labor market clearing has given by l_i=$\sum_i N_i \left[\frac{Q_i}{A_i}+f_i\right]$, after substituting q_i=$A_i f_i(1-\sigma)$, number of firms in each economy defined by $N_i = \frac{l_i}{\sigma f_i}$. So the bilateral trade is given by:

$$X_{ij} = N_i p_{ij} q_{ij} = N_i \left[\frac{p_i t_{ij}}{P_j}\right]^{1-\sigma} Y_j \quad \text{(B.1)}$$

The value of output (i.e. production) in the country *i* is given by $Y_i = N_i p_{ij} q_{ij}$. Replacing it in (B.1) TO get the following gravity equation:

$$X_{ij} = p_i{}^{-\sigma} \left[\frac{t_{ij}}{P_j}\right]^{1-\sigma} \frac{Y_i}{q_i} Y_j \quad \text{(B.2)}$$

Where q_i=$A_i f_i(\sigma-1)$ and assuming that the output in all use the same technologies, A_i=A, with same fixed costs, f_i=f, then the gravity model (B.2) can be re-expressed as follows:

$$X_{ij} = B_0 p_i{}^{-\sigma} \left[\frac{t_{ij}}{P_j}\right]^{1-\sigma} Y_i Y_j \quad \text{(B.3)}$$

Where $B_0 = [(\sigma-1)Af]^{-1}$

To transform the structural gravity model of equation (B.3) from its multiplicative nature to a log-linear gravity model, expand it with the additive error term, and assuming that it holds in each period of time *t*, to obtain a linear gravity model similar to equation (1). Equation (18) resembles gravity equation (1) because it shows that the bilateral trade flows between country *i* and country *j* are proportional to their economic sizes and inversely proportional to the bilateral frictions between them.

10.3.Appandix C: Multi-country Ricardian model of Eaton and Kortum (2002)

This is a supply-side Ricardian model of trade that elevates the two-country Ricardian model with a continuum of goods to a world with many countries. Under this model, bilateral trade flows given by probability distributions over technology and bilateral characteristics of the economy. The demand for variety v given by $c_j(v)$= $\left[\frac{p_j(v)}{P_j}\right]^{-\sigma} \frac{Y_j}{P_j}$. The factory gate price for the good v produced in the country *i* is determined by $p_i(v) = \frac{W_i}{z_i}$ where z_i is the technology of the firm producing commodity v in the country *i* and trade costs are subject to the iceberg trade costs assumption. Under perfect competition *j*'s consumers purchase goods from a low-cost supplier $P_i(v) = min\{p_i(v); i = 1, \dots N\}$.

Country *i*'s technical efficiency distribution is Fréchet: $F_i(z) = e^{-T_i z^{-\theta}}$. Where T_i denotes the location of productivity distribution which refers to country *i*'s state of technology. The distribution for $p_i(v)$ is given by $G_i(P)$=1- $e^{\Phi_j P^{\theta}}$where $\Phi_j = \sum_{i=1}^{N} T_i(\mathrm{w}_i t_{ij})^{-\theta}$. The probability that *i*'s shipments to *j* at the lowest price are $\left[\frac{T_i(\mathrm{w}_i t_{ij})^{-\theta}}{\Phi_j}\right]$. By assuming that the total expenditure in *j* equal income ($W_j L_j$), then imports from country *i* was given by

$$X_{ij} = \left[\frac{T_i(\mathrm{w}_i t_{ij})^{-\theta}}{\Phi_j}\right] W_j L_j \quad \text{(C.1)}$$

Imposing market-clearing implies that

$$W_i L_i = T_i W_i{}^{-\theta} \left[\sum_{k=1}(t_{ik})^{-\theta} \frac{W_k L_k}{\Phi_k}\right] \quad \text{(C.2)}$$

From equation (20), $T_i W_i{}^{-\theta} = W_i L_i / \left[\sum_{k=1}(t_{ik})^{-\theta} \frac{W_k L_k}{\Phi_k}\right]$ substitute it into equation (C.1) to get:

$$X_{ij} = \left(\frac{(t_{ij})^{-\theta}}{\left[\sum_{k=1}\left(\frac{t_{ik}}{\Phi_k}\right)^{-\theta} W_k L_k\right]\Phi_j} \right) W_i L_i W_j L_j \quad \text{(C.3)}$$

Use the market clearing condition to solve for wages to get:

$$X_{ij} = \left(\frac{t_{ij}}{\Pi_i P_j}\right)^{-\theta} (W_i L_i)(W_j L_j)\ \forall_j, j \quad \text{(C.4)}$$

$$\Pi_i = \left[\sum_j \left(\frac{t_{ij}}{P_j}\right)^{-\theta} W_j L_j\right]^{-\frac{1}{\theta}} \forall_i \quad \text{(C.5)}$$

$$P_j = \left[\sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{-\theta} W_i L_i\right]^{-\frac{1}{\theta}} \forall_j \quad \text{(C.6)}$$

$$W_i = B_{EK} \left(\frac{\bar{z}_i}{\Pi_i}\right)^{\frac{\theta}{\theta+1}} \forall_i \quad \text{(C.7)}$$

Where $\bar{z}_i = e^{\frac{0.577}{\theta}} {T_i}^{\theta}$ is the geometric mean of z_i, and $B_{EK} = exp(0.577(1-\theta))$

To transform the structural gravity model of equations (22)-(24) from their multiplicative nature to a log-linear gravity model, expand it with the additive error term, and assuming that they hold in each time *t*, to obtain a linear gravity model similar to equation (1). The Eaton-Kortum model is very similar to the gravity model derived from the Armington model and the monopolistic competition model. In the Eaton-Kortum framework, the trade elasticity is captured by the Fréchet distribution parameter (θ) instead of the elasticity of substitution ($1-\sigma$).

The Eaton-Kortum model can be used to study the gains from trade, the effects of tariff reduction, and the role of trade in spreading the benefits of new technology. This model fits well when the focus is on industrialized countries with advanced manufacturing sectors (i.e. advanced manufactured exports) such as OECD countries. This study mainly focuses on small and developing economies with no sophisticated manufacturing sector such as Cariforum countries. Therefore; the Eaton-Kortum model is not suitable for this study.

10.4.Appandix D: Heterogeneous firms model of Melitz (2003)

This model assumes that firms are not identical and differ in terms of productivity and only the most productive businesses are capable to export and costs are fixed. The demand for commodity v by *j*'s consumer is determined by $c_j(v)=\left[\frac{p_j(v)}{P_j}\right]^{-\sigma}\frac{Y_j}{P_j}$, where P_j is the CES price index. *i*'s Producers maximizing: $\pi_{ij}(v)$ = max {0, $p_j(v)\left[\frac{p_j(v)}{P_j}\right]^{-\sigma}\frac{Y_j}{P_j} - \frac{W_i t_{ij}}{A_i\varphi}\left[\frac{p_j(v)}{P_j}\right]^{-\sigma}\frac{Y_j}{P_j} - W_i f_{ij}^X$ }, where the model assumes labor is the only input, A_i is the aggregate productivity and φ is firm-specific productivity which implies that the marginal cost is determined by $\frac{W_i t_{ik}}{A_i\varphi}$. Profit maximization implies: $p_{ij}(\varphi)=\frac{W_i t_{ik}}{\rho A_i\varphi}$, where $\rho = \frac{\sigma-1}{\sigma}$, therefore; profits of a firm in country *i* shipment to *j*'s market are given by $\pi_{ij}(v)= max\{0,\left(\frac{W_i t_{ij}}{\rho A_i\varphi P_j}\right)^{1-\sigma}\frac{Y_j}{\sigma} - W_i f_{ij}^X\}$. Melitz (2003) establishes that cut-off productivity as φ_{ij}^* at which $\pi_{ij}(\mathrm{C})$ equals to zero or

$$\left(\frac{W_i t_{ij}}{\rho A_i P_j}\right)^{1-\sigma} \frac{Y_j}{\sigma} = (\varphi_{ij}^*)^{1-\sigma} W_i f_{ij}^X \quad \text{(D.1)}$$

The expected profits for *i*'s firms that are active in country *j* are given by $E[\pi_{ij}|\, \varphi \succeq \varphi_{ij}^*]$ $=\int_{\varphi_{ij}^*} \left(\left(\frac{W_i t_{ij}}{\rho A_i P_j}\right)^{1-\sigma} \frac{Y_j}{\sigma} \varphi^{1-\sigma} - W_i f_{ij}^X \right) \frac{g(\varphi)}{1-G(\varphi_{ij}^*)}\, d\varphi,$ where $G(\varphi)$ is the cumulative density function, $g(\varphi)$ is the density function, and $\frac{g(\varphi)}{1-G(\varphi_{ij}^*)}$ is conditional density function. Following Chaney (2008) and assuming a Pareto distribution $G(\varphi)$=1− $\left(\frac{\bar{\varphi}}{\varphi}\right)^k$ and defined on [$\bar{\varphi}$, ϖ). So the expected profits $E[\pi_{ij}|\, \varphi \succeq \varphi_{ij}^*]$=$\left(\frac{W_i t_{ij}}{\rho A_i \varphi_{ij}^* P_j}\right)^{1-\sigma} \frac{Y_j}{\sigma} - W_i f_{ij}^X$.

Using equation (26), the expected profits for firms *i*'s firms that are active in country *j* as $E[\pi_{ij}|\, \varphi \succeq \varphi_{ij}^*] = \frac{\sigma-1}{k-\sigma+1} W_i f_{ij}^X$ where the expected profits from sales in *j*'s market are $E[\pi_{ij}|\, \varphi \succeq \varphi_{ij}^*] = [1 - G(\varphi_{ij}^*)]\ \frac{\sigma-1}{k-\sigma+1} W_i f_{ij}^X = \left(\frac{\bar{\varphi}}{\varphi_{ij}^*}\right)^k \frac{\sigma-1}{k-\sigma+1} W_i f_{ij}{}^x$. The total firm's expected total profits can be expressed as $E(\pi_i) = \frac{\sigma-1}{k-\sigma+1} \sum_j \left(\frac{\bar{\varphi}}{\varphi_{ij}^*}\right)^k W_i f_{ij}^X$ and the domestic labor units $[1 - G(\varphi_{ii}^*)]\, E(\pi_{ij}|\, \varphi \succeq \varphi_{ii}^*) = W_i f_i^E$ or $\frac{\sigma-1}{k-\sigma+1} \sum_j \left(\frac{\bar{\varphi}}{\varphi_{ij}^*}\right)^k W_i f_{ij}{}^x = \frac{W_i f_i^E}{\left(\bar{\varphi}/\varphi_{ij}^*\right)^k}$. Labor market-clearing imply that $M_i = \frac{(\sigma-1)L_i}{k\sigma F_i^E)} \left(\frac{\bar{\varphi}}{\varphi_{ii}^*}\right)^k$ where the bilateral trade can be expressed as

$$X_{ij} = M_i \frac{1-G(\varphi_{ij}^*)}{1-G(\varphi_{ii}^*)} = \int_{\varphi_{ij}^*}^{\infty} \left(\frac{W_i t_{ij}}{\rho A_i P_j}\right)^{1-\sigma} Y_{jk\varphi^{-(k-\sigma+2)}}\ (\varphi_{ii}{}^*)^K d\varphi \quad \text{(D.2)}$$

Replacing $\left(\frac{W_i t_{ij}}{\rho A_i P_j}\right)^{1-\sigma} EY_j = \left(\varphi_{ij}^*\right)^{1-\sigma} W_i f_{ij}^X \sigma$ so that;

$$X_{ij} = \left[\frac{(\sigma-1)L_i}{k\sigma F_i^E)} \left(\frac{\varphi_{ij}^*}{\bar{\varphi}^k}\right)^{-k}\right] \left(\frac{W_i f_{ij}^X k\sigma}{k-\sigma+1}\right) \quad \text{(D.3)}$$

Replacing from zero cut-off productivity equation $\left(\varphi_{ij}^*\right)^k = \left(\frac{W_i t_{ij}}{\rho A_i P_j}\right)^{-k} \left(\frac{EY_j}{W_i f_{ij}^X}\right)^{\frac{k}{\sigma-1}}$, to obtain the gravity model of Anderson van Wincoop (2003) as follows:

$$X_{ij} = \tilde{B}_M \left(W_j L_j\right)^{\frac{k}{\sigma-1}} (W_i L_i) W_j^{\frac{-k\sigma}{\sigma-1}} A_i^{-k} \left(\frac{t_{ij}}{P_j}\right)^{-k} \left(f_{ij}^X\right)^{\frac{-k}{\sigma-1}-1} \quad \text{(D.4)}$$

Where $\tilde{B}_M = \left(\frac{(\sigma-1)^{k+1} \sigma^{\frac{k\sigma}{\sigma-1}}}{k-\sigma+1}\right)$, so that the market-clearing implies:

$$W_i L_i = \tilde{B}_M (W_i L_i) W_j^{\frac{-k\sigma}{\sigma-1}} A_i^{-k} \left[\sum_j \left(\frac{t_{ij}}{P_j}\right)^{-k} \left(f_{ij}^X\right)^{\frac{-k}{\sigma-1}-1} \left(W_j L_j\right)^{\frac{k}{\sigma-1}}\right] \quad \text{(D.5)}$$

The outward multilateral resistance (OMR) can be defined as:

$$\Pi_i = \left[\sum_j \left(t_{ij} / \breve{P}_j\right)^{-k} \left(f_{ij}^X\right)^{\frac{-k}{\sigma-1}+1} W_j L_j\right]^{\frac{-1}{k}} \ \forall_i \quad \text{(D.6)}$$

Where $\breve{P}_j = \left(W_j L_j\right)^{\frac{(k-\sigma+1)}{(\sigma-1)k}} P_j$ so that the structural Melitz gravity model of bilateral trade can be expressed as:

$$X_{ij} = \left(\frac{t_{ij}}{\Pi_i \breve{P}_j}\right)^{-k} \left(f_{ij}^X\right)^{\frac{-k}{\sigma-1}+1} (W_i L_i) \left(W_j L_j\right)\ \forall_j, j \quad \text{(D.7)}$$

The inward multilateral resistance (IMR) $\breve{P}_j$ can be written as:

$$\breve{P}_j = \left[\sum_i \left(\frac{t_{ij}}{\Pi_i}\right)^{-k} \left(f_{ij}^X\right)^{\frac{-k}{\sigma-1}+1} W_i L_i\right]^{\frac{-1}{k}} \forall_j \quad \text{(D.8)}$$

And the price index is $P_j = \left(W_j L_j\right)^{\frac{-(k-\sigma+1)}{(\sigma-1)k}} \breve{P}_j$. Substitute (D.6) into (D.5) to obtain the wage equation:

$$W_j = B_M \left(\frac{A_i}{\Pi_i}\right)^{\frac{\sigma-1}{\sigma}} \quad \text{(D.9)}$$

Where $B_M = \left(\tilde{B}_M\right)^{\frac{\sigma-1}{k\sigma}}$

Transform the structural gravity model of equations (D.6)-(D.8) from their multiplicative nature to a log-linear gravity model, expand it with the additive error term, and assuming that they hold in each time *t*, to obtain a linear gravity model similar to equation (1).

10. ANNEX

Table 4 Antigua and Barbuda top exports (USD) to the UK and AHS weighted average (%) tariff for 2016

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	890391	6	Sailboats; with or without auxiliary motor, for pleasure or sports, other than inflatable	34,606,852	23,352,420	67	0
2	630630	6	Sails; of synthetic fibres or other textile materials	10,424,346	5,030,266	48	0
3	890399	6	Yachts and other vessels; for pleasure or sports, rowing boats and canoes, n.e.c. in heading no. 8903, other than inflatable	1,102,472	1,085,123	98	0
4	843110	6	Machinery; parts of the machinery of heading no. 8425	433,121	294,545	68	2
5	843149	6	Machinery; parts of machines handling earth, minerals or ores and n.e.c. in heading no. 8431	494,834	191,627	39	2
6	870333	6	Vehicles; compression-ignition internal combustion piston engine (diesel or semi-diesel), cylinder capacity exceeding 2500cc	165,277	161,573	98	0
7	630619	6	Tarpaulins, awnings and sunblinds; of textile materials other than synthetic fibres	171,542	159,308	93	0
8	560890	6	Twine, cordage or rope; knotted netting, of other than man-made textiles	141,859	141,859	100	0
9	940360	6	Furniture; wooden, other than for office, kitchen or bedroom use	260,014	135,835	52	0
10	853690	6	Electrical apparatus; n.e.c. in heading no. 8536, for switching or protecting electrical circuits, for a voltage not exceeding 1000 volts	219,114	120,184	55	2
			Total	48,019,431	30,672,740	64	
1	89	2	Ships, boats and floating structures	33,022,329	24,510,349	74	0
2	63	2	Textiles, made up articles; sets; worn clothing and worn textile articles; rags	10,879,476	5,302,634	49	No data
3	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	3,018,538	674,383	22	2
4	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	1,350,037	272,054	20	2
5	94	2	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, n.e.c.; illuminated signs, illuminated name-plates and the like; prefabricated buildings	536,297	260,185	49	0
			Total	48,806,677	31,019,605	64	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2016

Table 5 Antigua and Barbuda top imports (USD) from the UK and AHS weighted average (%) tariff for 2016

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in Antigua and Barbuda
1	630630	6	Sails; of synthetic fibres or other textile materials	6,154,500	2,475,411	40	18
2	220830	6	Whiskies	2,882,456	2,455,756	85	18
3	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	5,625,211	803,734	14	18
4	220210	6	Waters; including mineral and aerated, containing added sugar or other sweetening matter or flavoured	6,917,457	714,343	10	18
5	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	22,197,866	612,287	3	18
6	940360	6	Furniture; wooden, other than for office, kitchen or bedroom use	3,265,853	523,989	16	18
7	721661	6	Iron or non-alloy steel; angles, shapes and sections, cold-formed or cold-finished, obtained from flat-rolled products	393,607	393,607	100	8
8	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.c. in item no. 4901.10 or 4901.91	1,515,094	384,328	25	18
9	392330	6	Plastics; carboys, bottles, flasks and similar articles, for the conveyance or packing of goods	912,612	379,338	42	18
10	843110	6	Machinery; parts of the machinery of heading no. 8425	423,251	293,323	69	7
			Total	50,287,907	9,036,116	18	
1	22	2	Oil seeds and oleaginous fruit	23,204,618	3,745,219	16	19
2	63	2	Textiles, made up articles; sets; worn clothing and worn textile articles; rags	9,077,785	2,604,617	29	15
3	94	2	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, n.e.c.; illuminated signs, illuminated name-plates and the like; prefabricated buildings	17,608,782	1,526,145	9	21
4	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	49,433,060	1,149,326	2	22
5	30	2	Pharmaceutical products	7,388,663	903,122	12	14
			Total	106,712,908	9,928,429	9	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2016

Table 6 Bahamas top exports (USD) to the UK and AHS weighted average (%) tariff for 2015

No	Commo-dity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	390311	6	Styrene polymers; expansible polystyrene, in primary forms	86,472,044	3,133,330	3.62	0
2	293359	6	Heterocyclic compounds; containing a pyrimidine ring (whether or not hydrogenated) or piperazine ring in the structure, (other than malonylurea and its derivatives, loprazolam, mecloqualone, methaqualone, zipeprol, and salts thereof) n.e.c. in 2933.5	48,985,798	1,276,091	2.61	0
3	950629	6	Water sport equipment; water-skis, surf-boards and other water-sport equipment, excluding sailboards	769,515	755,500	98.18	0
4	880330	6	Aircraft and spacecraft; parts of aeroplanes or helicopters n.e.c. in heading no. 8803	548,780	300,309	54.72	0
5	442090	6	Wood; marquetry and inlaid wood, caskets and cases for jewellery or cutlery and similar articles of wood, wooden articles of furniture not falling in chapter 94	79,657	77,342	97.09	0
6	121190	6	Plants and parts (including seeds and fruits) n.e.c. in heading no. 1211, used primarily in perfumery, pharmacy or for insecticidal, fungicidal purposes; fresh or dried, whether or not cut, crushed or powdered	275,432	75,432	27.39	0
7	630900	6	Clothing; worn, and other worn articles	1,961,675	74,580	3.80	0
8	843049	6	Boring and sinking machinery; not self-propelled	36,000	36,000	100.00	0
9	903149	6	Optical instruments and appliances; for measuring or checking, n.e.c. in chapter 90	98,162	28,678	29.21	0
10	851769	6	Communication apparatus (excluding telephone sets or base stations); machines for the transmission or reception of voice, images or other data (including wired/wireless networks), n.e.c. in item no. 8517.6	215,328	21,500	9.98	0
			Total	139,442,391	5,778,762	4.14	
1	39	2	Plastics and articles thereof	87,365,126	3,133,580	3.59	3
2	29	2	Organic chemicals	48,987,776	1,276,091	2.60	0
3	95	2	Toys, games and sports requisites; parts and accessories thereof	1,005,067	760,450	75.66	0
4	88	2	Aircraft, spacecraft and parts thereof	1,482,627	300,309	20.26	0
5	63	2	Textiles, made up articles; sets; worn clothing and worn textile articles; rags	2,206,449	108,808	4.93	0
			Total	141,047,045	5,579,238	3.96	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2015

Table 7 Bahamas top imports (USD) from the UK and AHS weighted average (%) tariff for 2015

No	Commo-dity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in Bahamas
1	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	23,373,701	2,296,732	9.83	15
2	854419	6	Insulated electric conductors; winding wire, (of other than copper)	7,184,772	2,064,015	28.73	15
3	190531	6	Food preparations; sweet biscuits, whether or not containing cocoa	6,561,750	1,410,386	21.49	15
4	848490	6	Gasket sets or assortments of gaskets and similar joints; dissimilar in composition, put up in pouches, envelopes or similar packings	8,629,396	1,103,480	12.79	10
5	841199	6	Turbines; parts of gas turbines (excluding turbo-jets and turbo-propellers)	1,655,051	784,996	47.43	10
6	843149	6	Machinery; parts of machines handling earth, minerals or ores and n.e.c. in heading no. 8431	7,243,868	657,267	9.07	10
7	190590	6	Food preparations; bakers' wares n.e.c. in heading no. 1605, whether or not containing cocoa; communion wafers, empty cachets suitable for pharmaceutical use, sealing wafers, rice papers and similar products	37,217,842	582,822	1.57	15
8	851712	6	Telephones for cellular networks or for other wireless networks	26,532,557	581,399	2.19	10
9	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.c. in item no. 4901.10 or 4901.91	8,550,671	474,747	5.55	15
10	490700	6	Unused postage, revenue or similar stamps of current or new issue in the country in which they have, or will have, a recognised face value; stamp-impressed paper; cheque forms; banknotes, stock, share or bond certificates and the like of similar title	2,318,684	450,744	19.44	15
			Total	129,268,292	10,406,588	8.05	
1	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	199,597,704	3,352,380	1.68	15
2	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	228,135,084	3,171,451	1.39	15
3	30	2	Pharmaceutical products	55,080,200	3,170,309	5.76	15
4	19	2	Preparations of cereals, flour, starch or milk; pastrycooks' products	63,488,280	2,038,569	3.21	21
5	64	2	Footwear; gaiters and the like; parts of such articles	21,574,020	1,241,400	5.75	17
			Total	567,875,288	12,974,109	2.28	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2015

Table 8 Barbados top exports (USD) to the UK and AHS weighted average (%) tariff for 2013

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	853339	6	Electrical resistors; wirewound variable, including rheostats and potentiometers, for a power handling capacity exceeding 20W (excluding heating)	5,182,166	1,638,845	31.62	4
2	220840	6	Rum and tafia	43,143,724	1,326,749	3.08	3
3	999999	6	Commodities not specified according to kind	3,148,424	659,136	20.94	No data
4	890399	6	Yachts and other vessels; for pleasure or sports, rowing boats and canoes, n.e.s. in heading no. 8903, other than inflatable	1,926,439	657,187	34.11	3
5	170111	6	Sugars; cane sugar, raw, in solid form, not containing added flavouring or colouring matter	7,974,408	576,144	7.22	0
6	300490	6	Medicaments; consisting of mixed or unmixed products n.e.s. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	40,756,766	473,522	1.16	3
7	220300	6	Beer; made from malt	1,280,100	278,120	21.73	3
8	240220	6	Cigarettes; containing tobacco	1,264,995	260,263	20.57	3
9	902139	6	Artificial parts of the body; excluding artificial joints	9,952,951	183,800	1.85	3
10	880330	6	Aircraft and spacecraft; parts of aeroplanes or helicopters n.e.s. in heading no. 8803	327,055	164,217	50.21	0
			Total	114,957,028	6,217,983	5.41	
1	22	2	Beverages, spirits and vinegar	52,668,967	1,757,852	3.34	2
2	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	9,016,892	1,746,599	19.37	2
3	99	2	Commodities not specified according to kind	3,148,424	659,136	20.94	0
4	89	2	Ships, boats and floating structures	2,178,665	657,187	30.16	4
5	17	2	Sugars and sugar confectionery	8,182,918	577,159	7.05	2
			Total	75,195,866	5,397,933	7.18	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2013

Table 9 Barbados top imports (USD) from the UK and AHS weighted average(%) tariff for 2013

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in Barbados
1	170199	6	Sucrose; chemically pure, not containing added flavouring or colouring matter, in solid form	6,373,659	4,799,911	75.31	15
2	300490	6	Medicaments; consisting of mixed or unmixed products n.e.s. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	51,685,296	3,122,822	6.04	15
3	220830	6	Whiskies	2,357,470	2,123,687	90.08	15
4	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	19,525,816	1,929,167	9.88	15
5	999999	6	Commodities not specified according to kind	7,839,283	1,835,095	23.41	No data
6	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.s. in item no. 4901.10 or 4901.91	5,097,126	1,783,767	35.00	15
7	940360	6	Furniture; wooden, other than for office, kitchen or bedroom use	5,852,475	1,427,773	24.40	15
8	491199	6	Printed matter; n.e.c. in heading no. 4911	2,072,841	1,295,868	62.52	15
9	210690	6	Food preparations; n.e.s. in item no. 2106.10	17,701,655	1,292,213	7.30	15
10	732690	6	Iron or steel; articles n.e.s. in heading no. 7326	5,064,232	1,191,578	23.53	15
			Total	123,569,853	20,801,881	16.83	
1	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	126,369,529	5,272,011	4.17	1
2	17	2	Sugars and sugar confectionery	22,869,333	5,076,028	22.20	31
3	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	120,930,223	5,060,596	4.18	1
4	94	2	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, n.e.s.; illuminated signs, illuminated name-plates and the like; prefabricated buildings	35,290,385	4,615,371	13.08	22
5	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	69,379,398	4,453,326	6.42	5
			Total	374,838,868	24,477,332	6.53	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2013

Table 10 Belize's top exports (USD) to the UK and AHS weighted average (%) tariff for 2016

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	170114	6	Sugars; cane sugar, raw, in solid form, other than as specified in Subheading Note 2 to this chapter, not containing added flavouring or colouring matter	51,438,875	43,302,372	84.18	9
2	999999	6	Commodities not specified according to kind	35,529,518	21,321,350	60.01	No data
3	441860	6	Wood; posts and beams	800,679	799,580	99.86	9
4	441810	6	Wood; windows, French-windows and their frames	743,594	743,594	100.00	9
5	870899	6	Vehicle parts and accessories; n.e.c. in heading no. 8708	529,628	466,599	88.10	1
6	441820	6	Wood; doors and their frames and thresholds	320,557	311,841	97.28	9
7	200921	6	Juice; grapefruit (including pomelo), of a Brix value not exceeding 20, unfermented, (not containing added spirit), whether or not containing added sugar or other sweetening matter	4,741,866	158,772	3.35	9
8	730419	6	Iron or steel (excluding cast iron or stainless steel); seamless, line pipe of a kind used for oil or gas pipelines	135,427	49,868	36.82	1
9	870332	6	Vehicles; compression-ignition internal combustion piston engine (diesel or semi-diesel), cylinder capacity exceeding 1500cc but not exceeding 2500cc	35,437	20,175	56.93	9
10	847130	6	Automatic data processing machines; portable, weighing not more than 10kg, consisting of at least a central processing unit, a keyboard and a display	12,168	9,925	81.57	9
			Total	94,287,749	67,184,076	71.25	
1	17	2	Sugars and sugar confectionery	54,975,654	43,302,372	78.77	8
2	44	2	Wood and articles of wood; wood charcoal	5,941,855	1,855,015	31.22	0
3	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	1,628,621	486,774	29.89	0
4	20	2	Preparations of vegetables, fruit, nuts or other parts of plants	45,198,027	158,772	0.35	8
5	73	2	Iron or steel articles	1,076,075	49,868	4.63	2
			Total	108,820,232	45,852,801	42.14	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2016

Table 11 Belize's top imports (USD) from the UK and AHS weighted average (%) tariff for 2016

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in Belize
1	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.c. in item no. 4901.10 or 4901.91	3,108,107	1,581,451	50.88	12
2	870899	6	Vehicle parts and accessories; n.e.c. in heading no. 8708	3,097,209	1,424,967	46.01	4
3	846592	6	Machine-tools; planing, milling or moulding (by cutting) machines, for working wood, cork, bone, hard rubber, hard plastics or similar hard materials	899,567	784,115	87.17	4
4	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	6,893,469	630,469	9.15	12
5	940600	6	Buildings; prefabricated	4,237,867	612,660	14.46	4
6	210390	6	Sauces and preparations therefor; mixed condiments and mixed seasonings	3,570,429	558,942	15.65	12
7	870110	6	Tractors; pedestrian controlled	1,196,695	520,289	43.48	4
8	880390	6	Aircraft and spacecraft; parts thereof n.e.c. in chapter 88	393,413	362,950	92.26	4
9	392321	6	Ethylene polymers; sacks and bags (including cones), for the conveyance or packing of goods	1,221,732	301,306	24.66	12
10	210690	6	Food preparations; n.e.c. in item no. 2106.10	11,271,898	298,273	2.65	12
			Total	35,890,386	7,075,422	19.71	
1	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	66,397,736	2,121,937	3.20	14
2	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	98,912,933	1,958,347	1.98	2
3	49	2	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans	4,483,663	1,639,448	36.56	2
4	39	2	Plastics and articles thereof	38,218,965	935,233	2.45	10
5	21	2	Miscellaneous edible preparations	24,856,293	871,417	3.51	14
			Total	232,869,590	7,526,382	3.23	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2016

Table 12 Dominica top exports (USD) to the UK and AHS weighted average (%) tariff for 2012

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	330129	6	Oils, essential; n.e.c. in heading no. 3301 (terpeneless or not), including concretes and absolutes	370,483	87,835	23.71	5
2	210390	6	Sauces and preparations therefor; mixed condiments and mixed seasonings	86,275	68,449	79.34	0
3	732690	6	Iron or steel; articles n.e.c. in heading no. 7326	167,553	55,556	33.16	0
4	740400	6	Copper; waste and scrap	55,556	55,556	100.00	1
5	850300	6	Electric motors and generators; parts suitable for use solely or principally with the machines of heading no. 8501 or 8502	459,349	5,254	1.14	1
6	300190	6	Glands and other organs; heparin and its salts; other human or animal substances prepared for therapeutic or prophylactic uses, n.e.c. in heading 3001	3,704	3,704	100.00	5
7	330300	6	Perfumes and toilet waters	49,023	1,464	2.99	0
8	210690	6	Food preparations; n.e.c. in item no. 2106.10	9,453	9,453	100.00	0
9	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	1,568	792	50.51	0
10	870840	6	Vehicle parts; gear boxes and parts thereof	1,260	790	62.70	1
			Total	1,204,224	288,853	23.99	
1	33	2	Essential oils and resinoids; perfumery, cosmetic or toilet preparations	87,365,126	3,133,580	3.59	0
2	21	2	Miscellaneous edible preparations	48,987,776	1,276,091	2.60	15
3	73	2	Iron or steel articles	1,005,067	760,450	75.66	7
4	74	2	Copper and articles thereof	1,482,627	300,309	20.26	7
5	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	2,206,449	108,808	4.93	1
			Total	141,047,045	5,579,238	3.96	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2012

Table 13 Dominica imports (USD) from the UK and AHS weighted average (%) tariff for 2012

No	Commodity Code	HS Level		World	UK	UK share (%)	Tariffs in Dominica
1	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.c. in item no. 4901.10 or 4901.91	2,487,418	592,778	23.83	15
2	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	1,603,185	312,653	19.50	15
3	401120	6	Rubber; new pneumatic tyres, of a kind used on buses or lorries	1,425,892	300,111	21.05	15
4	854449	6	Insulated electric conductors; for a voltage not exceeding 1000 volts, not fitted with connectors	443,736	238,120	53.66	15
5	940600	6	Buildings; prefabricated	320,428	191,621	59.80	7
6	220830	6	Whiskies	323,971	180,959	55.86	15
7	210690	6	Food preparations; n.e.c. in item no. 2106.10	2,179,739	174,483	8.00	15
8	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	2,273,149	127,986	5.63	15
9	842952	6	Mechanical shovels, excavators and shovel loaders; with a 360 degree revolving super structure	127,262	127,262	100.00	7
10	190531	6	Food preparations; sweet biscuits, whether or not containing cocoa	563,806	116,554	20.67	15
			Total	11,748,586	2,362,527	20.11	
1	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	199,597,704	3,352,380	1.68	8
2	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	228,135,084	3,171,451	1.39	8
3	49	2	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans	55,080,200	3,170,309	5.76	3
4	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	63,488,280	2,038,569	3.21	15
5	40	2	Rubber and articles thereof	21,574,020	1,241,400	5.75	14
			Total	567,875,288	12,974,109	2.28	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2012

Table 14 Dominican Rep. top exports (USD) to the UK and AHS weighted average (%) tariff for 2016

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	293212	6	Heterocyclic compounds; with oxygen hetero-atom(s) only, containing an unfused furan ring (whether or not hydrogenated) in the structure, 2-furaldehyde (furfuraldehyde)	14,853,591	3,968,278	26.72	0
2	640399	6	Footwear; n.e.c. in heading no. 6403, (not covering the ankle), outer soles of rubber, plastics or composition leather, uppers of leather	112,635,770	2,945,520	2.62	5
3	321310	6	Colours; in sets, of a kind used by artists, students or signboard painters	10,038,135	2,039,955	20.32	5
4	960330	6	Brushes; artists' brushes, writing brushes and similar brushes for the application of cosmetics	3,591,263	1,323,034	36.84	5
5	121190	6	Plants and parts (including seeds and fruits) n.e.c. in heading no. 1211, used primarily in perfumery, pharmacy or for insecticidal, fungicidal purposes; fresh or dried, whether or not cut, crushed or powdered	4,761,248	1,130,637	23.75	3
6	300691	6	Pharmaceutical goods; appliances identifiable for ostomy use	146,051,276	1,094,160	0.75	5
7	220840	6	Rum and other spirits obtained by distilling fermented sugar-cane products	74,774,100	781,967	1.05	5
8	620342	6	Trousers, bib and brace overalls, breeches and shorts; men's or boys', of cotton (not knitted or crocheted)	66,968,817	512,201	0.76	5
9	240391	6	Tobacco; homogenised or reconstituted	31,105,743	335,669	1.08	0
10	902620	6	Instruments and apparatus; for measuring or checking pressure	454,837	317,706	69.85	0
			Total	465,234,780	14,449,127	3.11	
1	29	2	Organic chemicals	17,584,177	3,968,278	22.57	1
2	64	2	Footwear; gaiters and the like; parts of such articles	372,685,595	2,958,021	0.79	1
3	32	2	Tanning or dyeing extracts; tannins and their derivatives; dyes, pigments and other colouring matter; paints, varnishes; putty, other mastics; inks	19,453,572	2,039,955	10.49	1
4	96	2	Miscellaneous manufactured articles	9,213,615	1,442,463	15.66	0
5	30	2	Pharmaceutical products	325,597,914	1,159,667	0.36	1
			Total	744,534,873	11,568,384	1.55	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2016

Table 15 Dominican Rep. top imports (USD) from the UK and AHS weighted average (%) tariff for 2016

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in Dominican Rep.
1	220830	6	Whiskies	78,982,132	64,818,556	82.07	11
2	842230	6	Machinery; for filling, closing, sealing, capsuling or labelling bottles, cans, bags or other containers, machinery for aerating beverages	44,408,592	12,033,305	27.10	1
3	870324	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 3000cc	291,055,903	9,515,825	3.27	11
4	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	507,209,216	7,825,850	1.54	11
5	701090	6	Glass; carboys, bottles, flasks, jars, pots, phials and other containers of glass, (not ampoules), used for the conveyance or packing of goods	74,585,080	6,733,794	9.03	9
6	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	479,502,483	5,781,145	1.21	11
7	850213	6	Electric generating sets; with compression-ignition internal combustion piston engines (diesel or semi-diesel engines), of an output exceeding 375kVA	12,332,304	4,591,322	37.23	1
8	391729	6	Plastics; tubes, pipes and hoses thereof, rigid, of plastics n.e.c. in heading no. 3917	20,790,579	3,825,876	18.40	11
9	321310	6	Colours; in sets, of a kind used by artists, students or signboard painters	4,141,897	3,486,460	84.18	11
10	392690	6	Plastics; other articles n.e.c. in chapter 39	428,976,284	2,941,496	0.69	11
			Total	1,941,984,470	121,553,629	6.26	
1	22	2	Beverages, spirits and vinegar	221,543,420	66,445,477	29.99	13
2	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	1,410,467,066	21,125,520	1.50	13
3	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	1,799,361,449	17,913,753	1.00	1
4	39	2	Plastics and articles thereof	1,308,053,658	12,732,502	0.97	7
5	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	1,493,964,094	11,442,516	0.77	1
			Total	6,233,389,687	129,659,768	2.08	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2016

Table 16 Guyana top exports (USD) to the UK and AHS weighted average (%) tariff for 2016

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	170111	6	Sugars; cane sugar, raw, in solid form, not containing added flavouring or colouring matter	70,397,597	40,330,568	57.29	0
2	170390	6	Sugars; molasses, from sugar beet, resulting from the extraction or refining of sugar	20,354,928	5,448,006	26.77	0
3	220840	6	Rum and other spirits obtained by distilling fermented sugar-cane products	38,648,044	4,061,760	10.51	0
4	260600	6	Aluminium ores and concentrates	108,204,977	1,538,548	1.42	0
5	100620	6	Cereals; husked (brown) rice	147,881,352	1,243,621	0.84	0
6	100640	6	Cereals; rice, broken	5,772,988	1,034,615	17.92	0
7	440729	6	Wood, tropical; (as specified in subheading note 1, chapter 44, customs tariff), n.e.c. in item no. 4407.2, sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, thicker than 6mm	11,216,991	792,111	7.06	0
8	190220	6	Food preparations; pasta, stuffed (with meat or other substances), whether or not cooked or otherwise prepared	626,108	611,251	97.63	0
9	840999	6	Engines; parts for internal combustion piston engines (excluding spark-ignition)	435,131	239,900	55.13	0
10	843041	6	Boring or sinking machinery; self-propelled, n.e.c. in heading no. 8430	122,696	122,696	100.00	0
			Total	403,660,812	55,423,076	13.73	
1	17	2	Sugars and sugar confectionery	91,253,929	45,778,583	50.17	0
2	22	2	Beverages, spirits and vinegar	43,192,236	4,065,185	9.41	0
3	10	2	Cereals	169,314,967	2,278,237	1.35	No data
4	26	2	Ores, slag and ash	108,204,977	1,538,548	1.42	0
5	44	2	Wood and articles of wood; wood charcoal	42,368,741	847,372	2.00	8
			Total	454,334,850	54,507,925	12.00	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2016

Table 17 Guyana top imports (USD) from the UK and AHS weighted average (%) tariff for 2016

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in Guyana
1	870120	6	Tractors; road, for semi-trailers	3,539,457	2,876,355	81.27	3
2	870422	6	Vehicles; compression-ignition internal combustion piston engine (diesel or semi-diesel), for transport of goods, (of a g.v.w. exceeding 5 tonnes but not exceeding 20 tonnes), n.e.c. in item no 8704.1	6,379,415	2,609,612	40.91	3
3	310290	6	Fertilizers, mineral or chemical; nitrogenous, other kinds including mixtures not specified in the foregoing subheadings	4,587,704	2,249,266	49.03	4
4	843143	6	Boring or sinking machinery; parts of the machinery of item no. 8430.41 or 8430.41	57,731,752	1,782,603	3.09	3
5	842959	6	Mechanical shovels, excavators and shovel loaders; n.e.c. in item no. 8429.50	21,610,164	1,598,967	7.40	3
6	870421	6	Vehicles; compression-ignition internal combustion piston engine (diesel or semi-diesel), for transport of goods, (of a gvw not exceeding 5 tonnes), n.e.c. in item no 8704.1	10,543,393	1,281,596	12.16	3
7	220210	6	Waters; including mineral and aerated, containing added sugar or other sweetening matter or flavoured	17,577,664	1,052,215	5.99	12
8	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.c. in item no. 4901.10 or 4901.91	3,830,060	990,976	25.87	12
9	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	11,968,452	918,449	7.67	12
10	180690	6	Chocolate and other food preparations containing cocoa; n.e.c. in chapter 18	2,176,778	883,731	40.60	12
			Total	139,944,839	16,243,770	11.61	
1	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	92,416,440	11,131,861	12.05	8
2	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	287,183,528	9,001,351	3.13	2
3	31	2	Fertilizers	28,314,238	3,408,084	12.04	4
4	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	69,206,769	2,674,020	3.86	2
5	30	2	Pharmaceutical products	13,321,488	1,718,308	12.90	4
			Total	490,442,463	27,933,624	5.70	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2016

Table 18 Jamaica top exports (USD) to the UK and AHS weighted average (%) tariff for 2015

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	999999	6	Commodities not specified according to kind	53,085,029	48,663,775	91.67	No data
2	220840	6	Rum and other spirits obtained by distilling fermented sugar-cane products	35,025,917	7,109,000	20.30	1
3	200899	6	Fruit, nuts and other edible parts of plants; prepared or preserved, whether or not containing added sugar, other sweetening matter or spirit, n.e.c. in heading no. 2008	14,578,347	3,371,071	23.12	1
4	190590	6	Food preparations; bakers' wares n.e.c. in heading no. 1605, whether or not containing cocoa; communion wafers, empty cachets suitable for pharmaceutical use, sealing wafers, rice papers and similar products	7,733,521	1,805,210	23.34	1
5	220300	6	Beer; made from malt	9,085,501	1,639,660	18.05	1
6	210390	6	Sauces and preparations therefor; mixed condiments and mixed seasonings	13,384,978	1,051,751	7.86	1
7	200989	6	Juice; of any single fruit or vegetable n.e.c. in heading no. 2009, unfermented, not containing added spirit, whether or not containing added sugar or other sweetening matter	4,012,146	835,449	20.82	1
8	220510	6	Vermouth and other wine of fresh grapes, flavoured with plants or aromatic substances, in containers holding 2 litres or less	2,730,949	798,957	29.26	1
9	210410	6	Soups and broths and preparations therefor	2,560,082	686,189	26.80	1
10	200510	6	Vegetable preparations; homogenised vegetables, prepared or preserved otherwise than by vinegar or acetic acid, not frozen	1,998,137	523,085	26.18	1
			Total	144,194,607	66,484,147	46.11	
1	17	2	Sugars and sugar confectionery	55,070,392	48,495,305	88.06	0
2	22	2	Beverages, spirits and vinegar	60,709,903	10,191,754	16.79	0
3	20	2	Preparations of vegetables, fruit, nuts or other parts of plants	23,103,076	5,181,971	22.43	0
4	21	2	Miscellaneous edible preparations	22,236,961	2,380,496	10.71	0
5	19	2	Preparations of cereals, flour, starch or milk; pastrycooks' products	14,311,311	2,246,812	15.70	0
			Total	175,431,643	68,496,338	39.04	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2015

Table 19 Jamaica top imports (USD) from the UK and AHS weighted average (%) tariff for 2015

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in Jamaica
1	294200	6	Organic compounds; n.e.s. in chapter 29	7,363,120	4,273,306	58.04	4
2	300490	6	Medicaments; consisting of mixed or unmixed products n.e.s. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	130,965,319	3,885,535	2.97	14
3	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.s. in item no. 4901.10 or 4901.91	36,282,120	3,819,867	10.53	14
4	220210	6	Waters; including mineral and aerated, containing added sugar or other sweetening matter or flavoured	27,030,878	3,686,637	13.64	14
5	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	124,772,920	3,601,261	2.89	14
6	392330	6	Plastics; carboys, bottles, flasks and similar articles, for the conveyance or packing of goods	23,378,924	2,620,255	11.21	14
7	870333	6	Vehicles; compression-ignition internal combustion piston engine (diesel or semi-diesel), cylinder capacity exceeding 2500cc	10,429,626	2,005,501	19.23	14
8	220290	6	Non-alcoholic beverages; n.e.c. in item no. 2202.10, not including fruit or vegetable juices of heading no. 2009	18,010,208	1,870,857	10.39	14
9	210690	6	Food preparations; n.e.c. in item no. 2106.10	67,324,987	1,058,145	1.57	14
10	490110	6	Printed matter; in single sheets, whether or not folded	4,138,793	980,380	23.69	14
			Total	449,696,895	27,801,744	6.18	
1	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	313,496,198	9,023,746	2.88	17
2	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	393,385,457	8,238,220	2.09	3
3	22	2	Beverages, spirits and vinegar	141,223,017	6,330,740	4.48	19
4	39	2	Plastics and articles thereof	191,230,141	5,836,924	3.05	10
5	49	2	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans	48,815,701	5,533,207	11.33	4
			Total	1,088,150,514	34,962,837	3.21	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2015

Table 20 St. Lucia top exports (USD) to the UK and AHS weighted average (%) tariff for 2014

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	271019	6	Oils; petroleum oils and oils obtained from bituminous minerals, not crude; preparations n.e.c., containing by weight 70% or more of petroleum oils or oils obtained from bituminous minerals, (excluding waste oils), other than light oils and preparations	30,196,204	8,862,359	29.35	0
2	852550	6	Transmission apparatus for radio-broadcasting or television, whether or not incorporating sound recording or reproducing apparatus, not incorporating reception apparatus	1,560,894	648,212	41.53	0
3	220840	6	Rum and other spirits obtained by distilling fermented sugar-cane products	5,239,931	191,934	3.66	0
4	392329	6	Plastics; sacks and bags (including cones), for the conveyance or packing of goods, of plastics other than ethylene polymers	359,023	170,084	47.37	0
5	890399	6	Yachts and other vessels; for pleasure or sports, rowing boats and canoes, n.e.c. in heading no. 8903, other than inflatable	306,688	109,263	35.63	0
6	999999	6	Commodities not specified according to kind	767,933	90,704	11.81	No data
7	880320	6	Aircraft and spacecraft; under-carriages and parts thereof	152,314	90,155	59.19	No data
8	880330	6	Aircraft and spacecraft; parts of aeroplanes or helicopters n.e.c. in heading no. 8803	36,000	36,000	100.00	No data
9	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	374,323	57,368	15.33	0
10	180100	6	Cocoa beans; whole or broken, raw or roasted	88,933	55,333	62.22	No data
			Total	39,082,243	10,311,412	26.38	
1	27	2	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	30,362,243	8,862,359	29.19	No data
2	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	18,398,639	681,875	3.71	0
3	22	2	Beverages, spirits and vinegar	27,271,239	200,217	0.73	0
4	39	2	Plastics and articles thereof	790,601	170,229	21.53	No data
5	88	2	Aircraft, spacecraft and parts thereof	170,229	168,138	98.77	No data
			Total	76,992,951	10,082,818	13.10	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2014

Table 21 St. Lucia top imports (USD) from the UK and AHS weighted average (%) tariff for 2014

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share	Tariffs in St. Lucia
1	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.c. in item no. 4901.10 or 4901.91	2,810,337	1,522,430	54.17	16
2	842121	6	Machinery; for filtering or purifying water	1,791,893	1,329,510	74.20	4
3	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	4,849,710	925,262	19.08	16
4	870530	6	Vehicles; fire fighting vehicles	779,575	779,575	100.00	4
5	210690	6	Food preparations; n.e.c. in item no. 2106.10	4,648,532	486,148	10.46	16
6	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	9,281,271	454,435	4.90	16
7	701090	6	Glass; carboys, bottles, flasks, jars, pots, phials and other containers of glass, (not ampoules), used for the conveyance or packing of goods	3,728,003	385,707	10.35	5
8	392329	6	Plastics; sacks and bags (including cones), for the conveyance or packing of goods, of plastics other than ethylene polymers	1,637,332	369,153	22.55	16
9	848180	6	Taps, cocks, valves and similar appliances; for pipes, boiler shells, tanks, vats or the like, including thermostatically controlled valves	1,909,856	307,079	16.08	4
10	190531	6	Food preparations; sweet biscuits, whether or not containing cocoa	2,849,218	303,146	10.64	16
			Total	34,285,727	6,862,445	20.02	
1	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	42,754,319	4,159,076	9.73	4
2	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	37,734,513	2,855,805	7.57	4
3	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	28,478,907	2,354,203	8.27	23
4	49	2	Printed books, newspapers, pictures and other products of the printing industry; manuscripts, typescripts and plans	4,859,769	2,005,264	41.26	3
5	73	2	Iron or steel articles	11,229,639	1,363,692	12.14	6
			Total	125,057,147	12,738,040	10.19	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2014

Table 22 St. Vincent and the Grenadines top exports (USD) to the UK and AHS weighted average (%) tariff for 2015

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	940360	6	Furniture; wooden, other than for office, kitchen or bedroom use	202,518	33,929	16.75	0
2	220210	6	Waters; including mineral and aerated, containing added sugar or other sweetening matter or flavoured	393,150	17,301	4.40	0
3	220840	6	Rum and other spirits obtained by distilling fermented sugar-cane products	108,820	14,211	13.06	0
4	854390	6	Electrical machines and apparatus; parts of the electrical goods of heading no. 8543	7,043	6,540	92.86	0
5	850440	6	Electrical static converters	31,076	3,580	11.52	0
6	842959	6	Mechanical shovels, excavators and shovel loaders; n.e.c. in item no. 8429.50	246,990	2,477	1.00	0
7	848180	6	Taps, cocks, valves and similar appliances; for pipes, boiler shells, tanks, vats or the like, including thermostatically controlled valves	11,725	2,345	20.00	0
8	210690	6	Food preparations; n.e.c. in item no. 2106.10	26,339	2,210	8.39	0
9	220300	6	Beer; made from malt	4,831,955	1,988	0.04	0
10	621149	6	Track suits and other garments n.e.c.; women's or girls', of textile materials n.e.c. in item no. 6211.4 (not knitted or crocheted)	178,582	1,555	0.87	0
			Total	6,038,198	86,136	1.43	
1	94	2	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, n.e.c.; illuminated signs, illuminated name-plates and the like; prefabricated buildings	302,676	37,776	12.48	0
2	22	2	Beverages, spirits and vinegar	7,471,811	35,803	0.48	0
3	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	1,281,681	10,849	0.85	0
4	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	1,037,974	5,393	0.52	0
5	21	2	Miscellaneous edible preparations	64,521	2,877	4.46	0
			Total	10,158,663	92,698	0.91	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2015

Table 23 St. Vincent and the Grenadines top imports (USD) from the UK and AHS weighted average (%) tariff for 2015

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in St. Vincent
1	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.c. in item no. 4901.10 or 4901.91	1,945,453	1,022,240	52.55	14
2	842839	6	Elevators and conveyors; continuous-action, for goods or materials, n.e.c. in item no. 8428.20, 8428.31, 8428.32 or 8428.33	897,910	891,726	99.31	7
3	847480	6	Machines; for agglomerating, shaping or moulding solid mineral fuels, ceramic paste, unhardened cements, plastering materials in powder or paste form, machines for forming foundry moulds of sand	678,097	671,220	98.99	7
4	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	8,629,396	1,103,480	12.79	14
5	210690	6	Food preparations; n.e.c. in item no. 2106.10	6,634,313	643,612	9.70	14
6	940320	6	Furniture; metal, other than for office use	1,316,459	566,420	43.03	14
7	732690	6	Iron or steel; articles n.e.c. in heading no. 7326	1,866,009	505,663	27.10	14
8	940540	6	Lamps and light fittings; electric, n.e.c. in heading no. 9405	1,217,064	382,606	31.44	14
9	701090	6	Glass; carboys, bottles, flasks, jars, pots, phials and other containers of glass, (not ampoules), used for the conveyance or packing of goods	2,350,680	344,579	14.66	5
10	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	3,975,977	319,951	8.05	14
			Total	29,511,358	6,451,497	21.86	
1	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	199,597,704	3,352,380	1.68	8
2	94	2	Furniture; bedding, mattresses, mattress supports, cushions and similar stuffed furnishings; lamps and lighting fittings, n.e.c.; illuminated signs, illuminated name-plates and the like; prefabricated buildings	228,135,084	3,171,451	1.39	18
3	85	2	Electrical machinery and equipment and parts thereof; sound recorders and reproducers; television image and sound recorders and reproducers, parts and accessories of such articles	55,080,200	3,170,309	5.76	8
4	73	2	Iron or steel articles	63,488,280	2,038,569	3.21	8
5	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	21,574,020	1,241,400	5.75	17
			Total	567,875,288	12,974,109	2.28	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2015

Table 24 Suriname top exports (USD) to the UK and AHS weighted average(%) tariff for 2013

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	901590	6	Surveying equipment; parts and accessories for articles of heading no. 9015	309,179	193,166	62.48	2
2	100630	6	Cereals; rice, semi-milled or wholly milled, whether or not polished or glazed	14,007,358	110,000	0.79	8
3	220830	6	Whiskies	10,128,852	59,679	0.59	8
4	999999	6	Commodities not specified according to kind	1,857,709,590	18,500	0.00	No data
5	840999	6	Engines; parts for internal combustion piston engines (excluding spark-ignition)	98,751	16,540	16.75	2
6	340290	6	Washing and cleaning preparations; surface-active, whether or not containing soap (excluding those of heading no. 3401), including auxiliary washing preparations, not for retail sale	1,364,047	11,536	0.85	8
7	440799	6	Wood; sawn or chipped lengthwise, sliced or peeled, whether or not planed, sanded or end-jointed, thicker than 6mm, n.e.c. in heading no. 4407	3,243,234	11,006	0.34	0
8	340220	6	Washing and cleaning preparations; surface-active, whether or not containing soap (excluding those of heading no. 3401), put up for retail sale	1,333,514	10,025	0.75	8
9	440399	6	Wood; in the rough, whether or not stripped of bark or sapwood, or roughly squared, untreated, n.e.c. in heading no. 4403	12,433,550	9,963	0.08	3
10	901580	6	Surveying equipment; articles n.e.c. in heading no. 9015, including hydrographic, oceanographic, hydrological, meteorological or geophysical instruments and appliances (excluding compasses)	738,280	7,994	1.08	2
			Total	1,901,366,355	448,409	0.02	
1	90	2	Optical, photographic, cinematographic, measuring, checking, medical or surgical instruments and apparatus; parts and accessories	5,962,967	201,160	3.37	1
2	10	2	Cereals	48,987,776	1,276,091	2.60	6
3	22	2	Beverages, spirits and vinegar	1,005,067	760,450	75.66	1
4	34	2	Soap, organic surface-active agents; washing, lubricating, polishing or scouring preparations; artificial or prepared waxes, candles and similar articles, modelling pastes, dental waxes and dental preparations with a basis of plaster	1,482,627	300,309	20.26	0
5	44	2	Wood and articles of wood; wood charcoal	2,206,449	108,808	4.93	4
			Total	59,644,886	2,646,818	4.44	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2013

Table 25 Suriname imports (USD) from the UK and AHS weighted average (%) tariff for 2013

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share	Tariffs in Suriname
1	252100	6	Limestone flux; limestone and other calcareous stone, of a kind used for the manufacture of lime or cement	989,164	985,039	99.58	6
2	390690	6	Acrylic polymers; (other than polymethyl methacrylate), in primary forms	2,595,357	721,170	27.79	7
3	870421	6	Vehicles; compression-ignition internal combustion piston engine (diesel or semi-diesel), for transport of goods, (of a gvw not exceeding 5 tonnes), n.e.c. in item no 8704.1	33,431,473	603,484	1.81	6
4	841090	6	Turbines; parts of hydraulic turbines and water wheels, including regulators	488,266	488,266	100.00	6
5	220830	6	Whiskies	1,398,619	476,118	34.04	17
6	842930	6	Scrapers; self-propelled	2,004,808	366,507	18.28	6
7	840999	6	Engines; parts for internal combustion piston engines (excluding spark-ignition)	3,069,723	329,921	10.75	6
8	870324	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 3000cc	4,862,181	283,034	5.82	17
9	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	29,753,940	198,261	0.67	17
10	842959	6	Mechanical shovels, excavators and shovel loaders; n.e.c. in item no. 8429.50	2,536,023	181,615	7.16	6
			Total	81,129,554	4,633,415	5.71	
1	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	521,519,114	2,129,445	0.41	6
2	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	228,135,084	3,171,451	1.39	10
3	25	2	Salt; sulphur; earths, stone; plastering materials, lime and cement	33,990,964	990,429	2.91	8
4	39	2	Plastics and articles thereof	73,331,479	866,380	1.18	12
5	22	2	Beverages, spirits and vinegar	21,574,020	1,241,400	5.75	12
			Total	878,550,661	8,399,105	0.96	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2013

Table 26 Trinidad and Tobago top exports (USD) to the UK and AHS weighted average (%) tariff for 2013

No	Commodity Code	HS Level	Commodity description	World	UK	UK share (%)	Tariffs in UK (EU)
1	290511	6	Alcohols; saturated monohydric, methanol (methyl alcohol)	1,096,854,453	93,271,729	8.50	2
2	271111	6	Petroleum gases and other gaseous hydrocarbons; liquefied, natural gas	2,765,696,406	48,764,366	1.76	2
3	271019	6	Oils; petroleum oils and oils obtained from bituminous minerals, not crude; preparations n.e.c., containing by weight 70% or more of petroleum oils or oils obtained from bituminous minerals, (excluding waste oils), other than light oils and preparations	4,959,439,890	4,396,876	0.09	2
4	220890	6	Spirits, liqueurs and other spirituous beverages; n.e.c. in heading no. 2208	15,942,480	2,682,013	16.82	2
5	271113	6	Petroleum gases and other gaseous hydrocarbons; liquefied, butanes	227,811,353	1,677,772	0.74	2
6	220840	6	Rum and other spirits obtained by distilling fermented sugar-cane products	20,141,173	1,675,974	8.32	2
7	843143	6	Boring or sinking machinery; parts of the machinery of item no. 8430.41 or 8430.41	16,976,810	564,724	3.33	1
8	999999	6	Commodities not specified according to kind	3,663,136	508,301	13.88	No data
9	860900	6	Containers; (including containers for transport of fluids) specially designed and equipped for carriage by one or more modes of transport	414,478	351,516	84.81	1
10	730900	6	Reservoirs, tanks, vats and similar containers; for any material (excluding compressed or liquefied gas), of iron or steel, capacity exceeding 300l, whether or not lined or heat insulated	860,900	344,454	40.01	1
			Total	9,107,801,079	154,237,725	1.69	
1	29	2	Organic chemicals	1,128,802,297	93,271,729	8.26	2
2	27	2	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	10,245,203,747	54,839,515	0.54	0
3	22	2	Beverages, spirits and vinegar	130,200,574	4,775,072	3.67	1
4	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	49,725,745	600,200	1.21	1
5	99	2	Commodities not specified according to kind	3,663,136	508,301	13.88	1
			Total	11,557,595,499	153,994,817	1.33	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2013

Table 27 Trinidad and Tobago top imports (USD) from the UK and AHS weighted average (%) tariff for 2013

No	Commodity Code	HS Level	Commodity discription	World	UK	UK share (%)	Tariffs in Trinidad and Tobago
1	890190	6	Vessels; n.e.c. in heading no. 8901, for the transport of goods and other vessels for the transport of both persons and goods	229,573,953	42,618,464	18.56	6
2	271011	6	Petroleum oils and oils from bituminous minerals, not crude or waste oils; preparations n.e.c. with 70% or more (weight), of petroleum oils or oils from bituminous minerals; being the basic constituents of the preparations: light oils and preparations	404,314,936	30,339,760	7.50	16
3	870323	6	Vehicles; spark-ignition internal combustion reciprocating piston engine, cylinder capacity exceeding 1500cc but not exceeding 3000cc	176,051,284	12,613,326	7.16	16
4	220830	6	Whiskies	19,525,816	1,929,167	9.88	16
5	490199	6	Printed matter; books, brochures, leaflets and similar printed matter n.e.c. in item no. 4901.10 or 4901.91	16,603,183	6,950,937	41.87	16
6	300490	6	Medicaments; consisting of mixed or unmixed products n.e.c. in heading no. 3004, for therapeutic or prophylactic uses, packaged for retail sale	110,027,013	6,704,325	6.09	16
7	843143	6	Boring or sinking machinery; parts of the machinery of item no. 8430.41 or 8430.41	85,757,948	6,276,393	7.32	6
8	842959	6	Mechanical shovels, excavators and shovel loaders; n.e.c. in item no. 8429.50	10,996,903	5,955,471	54.16	6
9	848180	6	Taps, cocks, valves and similar appliances; for pipes, boiler shells, tanks, vats or the like, including thermostatically controlled valves	45,624,853	5,852,865	12.83	6
10	870333	6	Vehicles; compression-ignition internal combustion piston engine (diesel or semi-diesel), cylinder capacity exceeding 2500cc	23,612,523	4,501,104	19.06	16
			Total	1,122,088,412	123,741,812	11.03	
1	84	2	Nuclear reactors, boilers, machinery and mechanical appliances; parts thereof	1,068,617,633	50,847,655	4.76	6
2	89	2	Ships, boats and floating structures	294,895,443	42,764,864	14.50	18
3	87	2	Vehicles; other than railway or tramway rolling stock, and parts and accessories thereof	585,783,517	35,229,331	6.01	18
4	27	2	Mineral fuels, mineral oils and products of their distillation; bituminous substances; mineral waxes	6,347,185,058	30,580,511	0.48	5
5	38	2	Chemical products n.e.c.	150,823,587	14,296,305	9.48	7
			Total	8,447,305,238	173,718,666	2.06	

Source: Author's calculation based on data from World Integrated Trade Solution (WITS), 2013

Table 28 shows the list of countries covered in this study from 1976-2019

No	ISO3 code	Country name	No	ISO3 code	Country name	No	ISO3 code	Country name	No	ISO3 code	Country name
1	ABW	Aruba	32	BRA	Brazil	63	DMA	Dominica	94	GUF	French Guiana
2	AFG	Afghanistan	33	BRB	Barbados	64	DNK	Denmark	95	GUM	Guam
3	AGO	Angola	34	BRN	Brunei Darussalam	65	DOM	Dominican Republic	96	GUY	Guyana
4	AIA	Anguilla	35	BTN	Bhutan	66	DZA	Algeria	97	GUY	Hong Kong, SAR China
5	ALB	Albania	36	BVT	Bouvet Island	67	ECU	Ecuador	98	GUY	Heard and Mcdonald Islands
6	AND	Andorra	37	BWA	Botswana	68	EGY	Egypt	99	GUY	Honduras
7	ANT	Netherlands Antilles	38	CAF	Central African Republic	69	ERI	Eritrea	100	GUY	Croatia
8	ARE	United Arab Emirates	39	CAN	Canada	70	ESH	Western Sahara	101	GUY	Haiti
9	ARG	Argentina	40	CCK	Cocos (Keeling) Islands	71	ESP	Spain	102	GUY	Hungary
10	ARM	Armenia	41	CHE	Switzerland	72	EST	Estonia	103	GUY	Indonesia
11	ASM	American Samoa	42	CHL	Chile	73	ETH	Ethiopia	104	GUY	India
12	ATA	Antarctica	43	CHN	China	74	FIN	Finland	105	GUY	British Indian Ocean Territory
13	ATF	French Southern Territories	44	CIV	Côte d'Ivoire	75	FJI	Fiji	106	GUY	Ireland
14	ATG	Antigua and Barbuda	45	CMR	Cameroon	76	FLK	Falkland Islands (Malvinas)	107	GUY	Iran
15	AUS	Australia	46	COD	Congo, (Kinshasa)	77	FRA	France	108	GUY	Iraq
16	AUT	Austria	47	COG	Congo (Brazz aville)	78	FRO	Faroe Islands	109	GUY	Iceland

17	AZE	Azerbaijan	48	COK	Cook Islands	79	FSM	Micronesia, Federated States of	110	GUY	Israel
18	BDI	Burundi	49	COL	Colombia	80	GAB	Gabon	111	GUY	Italy
19	BEL	Belgium	50	COM	Comoros	81	GBR	United Kingdom	112	GUY	Jamaica
20	BEN	Benin	51	CPV	Cape Verde	82	GEO	Georgia	113	GUY	Jordan
21	BES	Bonaire, Sint Eustatius and Saba	52	CRI	Costa Rica	83	GHA	Ghana	114	GUY	Japan
22	BFA	Burkina Faso	53	CSK	Czechoslovakia	84	GIB	Gibraltar	115	GUY	Kazakhstan
23	BGD	Bangladesh	54	CUB	Cuba	85	GIN	Guinea	116	GUY	Kenya
24	BGR	Bulgaria	55	CUW	Curaçao	86	GLP	Guadeloupe	117	GUY	Kyrgyzstan
25	BHR	Bahrain	56	CXR	Christmas Island	87	GMB	Gambia	118	GUY	Cambodia
26	BHS	Bahamas	57	CYM	Cayman Islands	88	GNB	Guinea-Bissau	119	GUY	Kiribati
27	BIH	Bosnia and Herzegovina	58	CYP	Cyprus	89	GNQ	Equatorial Guinea	120	GUY	Saint Kitts and Nevis
28	BLR	Belarus	59	CZE	Czech Republic	90	GRC	Greece	121	GUY	Korea (South)
29	BLZ	Belize	60	DDR	German Democratic Republic	91	GRD	Grenada	122	GUY	Kuwait
30	BMU	Bermuda	61	DEU	Germany	92	GRL	Greenland	123	GUY	Lao PDR
31	BOL	Bolivia	62	DJI	Djibouti	93	GTM	Guatemala	124	GUY	Lebanon

125	LBR	Liberia	157	NAM	Namibia	189	SAU	Saudi Arabia	221	TLS	Timor-Leste
126	LBY	Libya	158	NCL	New Caledonia	190	SCG	Serbia and Montenegro	222	TON	Tonga
127	LCA	Saint Lucia	159	NER	Niger	191	SDN	Sudan	223	TTO	Trinidad and Tobago
128	LIE	Liechtenstein	160	NFK	Norfolk Island	192	SEN	Senegal	224	TUN	Tunisia
129	LKA	Sri Lanka	161	NGA	Nigeria	193	SGP	Singapore	225	TUR	Turkey
130	LSO	Lesotho	162	NIC	Nicaragua	194	SGS	South Georgia and the South Sandwich Islands	226	TUV	Tuvalu
131	LTU	Lithuania	163	NIU	Niue	195	SHN	Saint Helena	227	TWN	Taiwan, Republic of China
132	LUX	Luxembourg	164	NLD	Netherlands	196	SLB	Solomon Islands	228	TZA	Tanzania, United Republic of
133	LVA	Latvia	165	NOR	Norway	197	SLE	Sierra Leone	229	UGA	Uganda
134	MAC	Macao	166	NPL	Nepal	198	SLV	El Salvador	230	UKR	Ukraine
135	MAR	Morocco	167	NRU	Nauru	199	SMR	San Marino	231	URY	Uruguay
136	MCO	Monaco	168	NZL	New Zealand	200	SOM	Somalia	232	USA	United States of America
137	MDA	Moldova	169	OMN	Oman	201	SPM	Saint Pierre and Miquelon	233	UZB	Uzbekistan
138	MDG	Madagascar	170	PAK	Pakistan	202	SRB	Serbia	234	VAT	Holy See (Vatican City State)
139	MDV	Maldives	171	PAN	Panama	203	SSD	South Sudan	235	VCT	Saint Vincent and Grenadines
140	MEX	Mexico	172	PCN	Pitcairn	204	STP	Sao Tome and Principe	236	VDR	Democratic Republic of Viet-Nam

141	MHL	Marshall Islands	173	PER	Peru	205	SUN	Un. Sov. Soc. Rep.	237	VEN	Venezuela (Bolivarian Republic)
142	MKD	Macedonia	174	PHL	Philippines	206	SUR	Suriname	238	VGB	British Virgin Islands
143	MLI	Mali	175	PLW	Palau	207	SVK	Slovakia	239	VNM	Viet Nam
144	MLT	Malta	176	PNG	Papua New Guinea	208	SVN	Slovenia	240	VUT	Vanuatu
145	MMR	Myanmar	177	POL	Poland	209	SWE	Sweden	241	WLF	Wallis and Futuna Islands
146	MNE	Montenegro	178	PRI	Puerto Rico	210	SWZ	Swaziland	242	WSM	Samoa
147	MNG	Mongolia	179	PRK	Korea (North)	211	SXM	Sint Maarten	243	YEM	Yemen
148	MNP	Northern Mariana Islands	180	PRT	Portugal	212	SYC	Seychelles	244	YMD	The Democratic Yemen
149	MOZ	Mozambique	181	PRY	Paraguay	213	SYR	Syrian	245	YUG	Yugoslavia
150	MRT	Mauritania	182	PSE	Palestinian Territory	214	TCA	Turks and Caicos Islands	246	ZAF	South Africa
151	MSR	Montserrat	183	PYF	French Polynesia	215	TCD	Chad	247	ZMB	Zambia
152	MTQ	Martinique	184	QAT	Qatar	216	TGO	Togo	248	ZWE	Zimbabwe
153	MUS	Mauritius	185	REU	Réunion	217	THA	Thailand			
154	MWI	Malawi	186	ROU	Romania	218	TJK	Tajikistan			
155	MYS	Malaysia	187	RUS	Russia	219	TKL	Tokelau			
156	MYT	Mayotte	188	RWA	Rwanda	220	TKM	Turkmenistan			

Source: World Integrated Trade Solution (WITS), 2015

Table 31 shows countries with missing imports observations from 1976 to 2019

No	ISO3 code	No	ISO3 code	No	ISO3 code	No	ISO3 code	No	ISO3 code	No	ISO3 code
1	ABW	34	BTN	67	ETH	100	ISR	132	MLT	164	SLB
2	AFG	35	BWA	68	FIN	101	ITA	133	MMR	165	SLE
3	AGO	36	CAF	69	FJI	102	JAM	134	MNG	166	SLV
4	AIA	37	CAN	70	FRA	103	JOR	135	MOZ	167	STP
5	ALB	38	CHE	71	FRO	104	JPN	136	MRT	168	SUR
6	AND	39	CHL	72	FSM	105	KAZ	137	MSR	169	SVK
7	ANT	40	CHN	73	GAB	106	KEN	138	MTQ	170	SVN
8	ARE	41	CIV	74	GBR	107	KGZ	139	MUS	171	SWE
9	ARG	42	CMR	75	GEO	108	KHM	140	MWI	172	SWZ
10	ARM	43	COG	76	GHA	109	KIR	141	MYS	173	SYC
11	ATG	44	COK	77	GIN	110	KNA	142	NAM	174	SYR
12	AUS	45	COL	78	GLP	111	KOR	143	NCL	175	TCA
13	AUT	46	COM	79	GMB	112	KWT	144	NER	176	TCD
14	AZE	47	CPV	80	GNB	113	LAO	145	NGA	177	TGO
15	BDI	48	CRI	81	GRC	114	LBN	146	NIC	178	THA
16	BEL	49	CUB	82	GRD	115	LBY	147	NLD	179	TJK
17	BEN	50	CYM	83	GRL	116	LCA	148	NOR	180	TKM
18	BFA	51	CYP	84	GTM	117	LKA	149	NPL	181	TON
19	BGD	52	CZE	85	GUF	118	LSO	150	NZL	182	TTO
20	BGR	53	DEU	86	GUY	119	LTU	151	OMN	183	TUN
21	BHR	54	DJI	87	HKG	120	LUX	152	PAK	184	TUR
22	BHS	55	DMA	88	HND	121	LVA	153	PAN	185	TUV
23	BIH	56	DNK	89	HRV	122	MAC	154	PER	186	TZA
24	BLR	57	DOM	90	HUN	123	MAR	155	PHL	187	UGA
25	BLZ	58	DZA	91	IDN	124	MDA	156	PLW	188	UKR
26	BMU	59	ECU	92	IND	125	MDG	157	PNG	189	URY
27	BOL	60	EGY	93	IRL	126	MDV	158	POL	190	USA
28	BRA	61	ERI	94	IRN	127	MEX	159	PRT	191	VCT
29	BRB	62	ESP	95	IRQ	128	MKD	160	PRY	192	VEN
30	BRN	63	EST	96	ISL	129	MLI	161	PYF	193	VNM
31	QAT	64	VUT	97	REU	130	WLF	162	RUS	194	WSM
32	RWA	65	YEM	98	SAU	131	ZAF	163	SDN	195	ZMB
33	SEN	66	ZWE	99	SGP						

Source: World Integrated Trade Solution (WITS)

Table 32 shows the set up of the dummy variables for bilateral trade flows between 248 exporters and 248 importers over the period from 1976 to 2019. For simplicity, this table shows just a subset of countries from 1976 to 2019 instead of all countries

Exporter	**Importer**	**Exporter WB classifi-cation of June 2020**	**Expo-rter LDC**	**Trade flows from developing to developed countries**							**Trade flows from developed to developing countries**			**Intra-EU trade**	**Trade flows between devel-oped coun-tries**	**Trade flows between devel-oping coun-tries**	**Trade flows from OCT to EU**	**Trade flows from EU to OCT**
				epa_gd	fta_gd	gsp+	gsp	Intera-ction term	eba	lomé_gd	fta_dg	epa_dg	lomé_dg	eu_fta	fta_dd	fta_gg	oct_gd	oct_dg
Cariforum:																		
Antigua and Barbuda	UK	HI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Antigua and Barbuda	Belize	HI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
The Bahamas	UK	HI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
The Bahamas	Grenada	HI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Belize	UK	UMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Belize	Grenada	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Barbados	UK	HI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Barbados	Guyana	HI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Dominica	France	UMI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Dominica	Haiti	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Dominican Republic	France	UMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Dominican Republic	Saint Lucia	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Grenada	France	UMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Grenada	Dominica	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Guyana	France	UMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Guyana		UMI	N/A	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Haiti	France	LI	Yes	0	1	0	1	0	1	1	0	0	0	0	0	0	0	0
Haiti	Dominica	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Jamaica	Italy	UMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Jamaica	Suriname	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Saint Kitts and Nevis	Italy	HI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Saint Kitts and Nevis	Grenada	HI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Saint Lucia	Italy	UMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Saint Lucia	Haiti	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Suriname	Italy	UMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Suriname	Guyana	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Trinidad and Tobago	Italy	HI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Trinidad and Tobago	Jamaica	HI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Saint Vincent and the Grenadines	Italy	UMI	N/A	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Saint Vincent and the Grenadines	Suriname	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Central Africa:																		
Central African Republic	UK	LI	Yes	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Cameroon	UK	LMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Congo	UK	LMI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Equatorial Guinea	UK	UMI	N/A	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Sao Tome and Principe	France	LMI	Yes	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Chad	France	LI	Yes	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Gabon	UK	UMI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Gabon	Congo	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
EAC:																		
Burundi	France	LI	Yes	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Kenya	France	LMI	N/A	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0
Rwanda	Italy	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Tanzania	Italy	LMI	N/A	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Tanzania	Botswana	LMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Uganda	Italy	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Uganda	Kenya	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
ESA:																		
Comoros	Italy	LMI	Yes	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Djibouti	Italy	LMI	Yes	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Eritrea	UK	LI	Yes	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Ethiopia	UK	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Madagascar	UK	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Madagascar	Angola	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mauritius	UK	HI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Mauritius	Congo	HI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Malawi	UK	LI	Yes	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0
Malawi	Egypt	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Sudan	UK	LI	Yes	1	1	0	1	0	1	1	0	0	0	0	0	0	0	0
Sudan	Zambia	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Somalia	UK	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Seychelles	N/A	HI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Zambia	UK	LMI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Zambia	Kenya	LMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Zimbabwe	UK	LMI	N/A	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0
Zimbabwe	Lesotho	LMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

Pacific:																		
Cook Islands	Fiji	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Fiji	UK	UMI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Fiji	Kiribati	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Micronesia, Federated States of	Fiji	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Kiribati	UK	LMI	Yes	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Kiribati	Fiji	LMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Marshall Islands	UK	UMI	N/A	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Niue	N/A	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nauru	Tuvalu	N/A	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Palau	N/A	HI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Papua New Guinea	UK	LMI	N/A	1	1	0	1	0	0	1	0	0	0	0	0	0	0	0
Papua New Guinea	Tonga	LMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Solomon Islands	UK	LMI	Yes	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Solomon Islands	Tuvalu	LMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tonga	UK	UMI	N/A	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0
Tonga	Samoa	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Tuvalu	UK	UMI	Yes	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Tuvalu	Samoa	UMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Vanuatu	UK	LMI	Yes	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Vanuatu	Tonga	LMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Samoa	UK	UMI	N/A	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Samoa	Kiribati	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
SADC:																		
Angola	UK	LMI	Yes	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0
Botswana	UK	UMI	N/A	1	0	1	1	0	0	1	0	0	0	0	0	0	0	0
Botswana	Mauritius	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Lesotho	UK	LMI	Yes	1	0	1	1	0	1	1	0	0	0	0	0	0	0	0
Lesotho	Malawi	LMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mozambique	UK	LI	Yes	1	0	1	1	0	1	1	0	0	0	0	0	0	0	0
Mozambique	Lesotho	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Namibia	UK	UMI	N/A	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0
Namibia	Botswana	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Swaziland	UK	HI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Swaziland	Congo	HI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
South Africa	UK	UMI	N/A	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
South Africa	Angola	UMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0

West Africa:																		
Benin	UK	LMI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Benin	Ghana	LMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Burkina Faso	UK	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Burkina Faso	Benin	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Côte d'Ivoire	UK	LMI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Côte d'Ivoire	Togo	LMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Cape Verde	UK	LMI	N/A	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Ghana	UK	LMI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Ghana	Algeria	LMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Guinea	UK	LI	Yes	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Guinea	Cameroon	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Gambia	UK	LI	Yes	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Gambia	Ghana	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Guinea-Bissau	UK	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Guinea-Bissau	Benin	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Liberia	UK	LI	Yes	1	1	0	1	1	1	1	0	0	0	0	0	0	0	0
Liberia	Senegal	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mali	UK	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Mali	Gambia	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Mauritania	UK	LMI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Mauritania	Togo	LMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Niger	UK	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Niger	Mali	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Nigeria	UK	LMI	N/A	1	1	1	1	0	0	1	0	0	0	0	0	0	0	0
Nigeria	Benin	LMI	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Senegal	UK	LMI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Senegal	Guinea	LMI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Sierra Leone	UK	LI	Yes	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Sierra Leone	Nigeria	LI	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Non EPA:																		
French Polynesia-OCT	France	*HI*	N/A	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0
Chile	UK	*HI*	N/A	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Chile	Brazil	*HI*	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Algeria	UK	*LMI*	N/A	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Algeria	Morocco	*LMI*	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Colombia	Italy	*UMI*	N/A	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
Colombia	Bolivia	*UMI*	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Paraguay	Belgium	*UMI*	N/A	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Paraguay	Argentina	*UMI*	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Pakistan	Austria	*LMI*	N/A	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Pakistan	Malaysia	*LMI*	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
India	Japan	*LMI*	N/A	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
India	Spain	*LMI*	N/A	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
India	Pakistan	*LMI*	N/A	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Bangladesh	Sweden	*LMI*	Yes	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
Bangladesh	Pakistan	*LMI*	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Lao	Australia	*LMI*	Yes	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
Lao	UK	*LMI*	Yes	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Lao	Singapore	*LMI*	Yes	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Developed countries:																		
Australia	Korea	*HI*	N/A	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Australia	USA	*HI*	N/A	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Japan	Mexico	*HI*	N/A	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Japan	Australia	*HI*	N/A	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
UK	Belize	*HI*	N/A	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0
UK	Italy	*HI*	N/A	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
UK	Cayman Islands	*HI*	N/A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
USA	Israel	*HI*	N/A	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0
USA	Canada	*HI*	N/A	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0

Source: Author's calculations based on CEPII database, WB, WTO Regional Trade Agreements database, and the EU website

Notes:

For developing countries (i.e. Cariforum countries and other ACP blocs), this study focuses on policy variables that control for trade flows from developing to developed countries (i.e. columns from 5 to 11)

HI: High Income, UMI: Upper Middle Income, LMI: Lower Middle Income, LI: Lower Income.

LDC: Lest Developed Country. N/A: Not applicable.

Zambia is a beneficiary of EBA and a member of ESA EPA therefore it has an interaction term (i.e. the overlap between EBA and EPA).
Samoa acceded to the APA in December 2018 and is applying it since then. Kenya and Rwanda signed EPA in September 2016.
SADC EPA started in 2016.
Namibia has FTA with EFTA.

Table 35 shows the classification of 75 ACP countries according to World Bank June 2020

No	Exporter country code	Exporter country name	Importer Great Britain (GBR	ACP EPA bloc	WB clarification of June 2020	LDC
1	CAF	Central African Republic	GBR	CA	LI	YES
2	CMR	Cameroon	GBR	CA	LMI	N/A
3	COG	Congo	GBR	CA	LMI	N/A
4	GNQ	Equatorial Guinea	GBR	CA	UMI	N/A
5	STP	Sao Tome and Principe	GBR	CA	LMI	YES
6	TCD	Chad	GBR	CA	LI	YES
7	ATG	Antigua and Barbuda	GBR	Cariforum	HI	N/A
8	BHS	The Bahamas	GBR	Cariforum	HI	N/A
9	BLZ	Belize	GBR	Cariforum	UMI	N/A
10	BRB	Barbados	GBR	Cariforum	HI	N/A
11	DMA	Dominica	GBR	Cariforum	UMI	N/A
12	DOM	Dominican Republic	GBR	Cariforum	UMI	N/A
13	GRD	Grenada	GBR	Cariforum	UMI	N/A
14	GUY	Guyana	GBR	Cariforum	UMI	N/A
15	HTI	Haiti	GBR	Cariforum	LI	YES
16	JAM	Jamaica	GBR	Cariforum	UMI	N/A
17	KNA	Saint Kitts and Nevis	GBR	Cariforum	HI	N/A
18	LCA	Saint Lucia	GBR	Cariforum	UMI	N/A
19	SUR	Suriname	GBR	Cariforum	UMI	N/A
20	TTO	Trinidad and Tobago	GBR	Cariforum	HI	N/A
21	VCT	Saint Vincent and the Grenadines	GBR	Cariforum	UMI	N/A
22	BDI	Burundi	GBR	EAC	LI	YES
23	KEN	Kenya	GBR	EAC	LMI	N/A
24	RWA	Rwanda	GBR	EAC	LI	YES
25	TZA	Tanzania	GBR	EAC	LMI	YES
26	UGA	Uganda	GBR	EAC	LI	YES
27	COM	Comoros	GBR	ESA	LMI	YES
28	DJI	Djibouti	GBR	ESA	LMI	YES
29	ERI	Eritrea	GBR	ESA	LI	YES
30	ETH	Ethiopia	GBR	ESA	LI	YES
31	MDG	Madagascar	GBR	ESA	LI	YES
32	MUS	Mauritius	GBR	ESA	HI	N/A
33	MWI	Malawi	GBR	ESA	LI	YES
34	SDN	Sudan	GBR	ESA	LI	YES
35	SOM	Somalia	GBR	ESA	LI	YES
36	SYC	Seychelles	GBR	ESA	HI	N/A
37	ZMB	Zambia	GBR	ESA	LMI	YES
38	ZWE	Zimbabwe	GBR	ESA	LMI	N/A

39	COK	Cook Islands	GBR	Pacific	N/A	N/A
40	FJI	Fiji	GBR	Pacific	UMI	N/A
41	FSM	Micronesia, Federated States of	GBR	Pacific	N/A	N/A
42	KIR	Kiribati	GBR	Pacific	LMI	YES
43	MHL	Marshall Islands	GBR	Pacific	UMI	N/A
44	NIU	Niue	GBR	Pacific	N/A	N/A
45	NRU	Nauru	GBR	Pacific	N/A	N/A
46	PLW	Palau	GBR	Pacific	HI	N/A
47	PNG	Papua New Guinea	GBR	Pacific	LMI	N/A
48	SLB	Solomon Islands	GBR	Pacific	LMI	YES
49	TON	Tonga	GBR	Pacific	UMI	N/A
50	TUV	Tuvalu	GBR	Pacific	UMI	YES
51	VUT	Vanuatu	GBR	Pacific	LMI	YES
52	WSM	Samoa	GBR	Pacific	UMI	N/A
53	AGO	Angola	GBR	SADC	LMI	YES
54	BWA	Botswana	GBR	SADC	UMI	N/A
55	LSO	Lesotho	GBR	SADC	LMI	YES
56	MOZ	Mozambique	GBR	SADC	LI	YES
57	NAM	Namibia	GBR	SADC	UMI	N/A
58	SWZ	Swaziland	GBR	SADC	HI	N/A
59	ZAF	South Africa	GBR	SADC	UMI	N/A
60	BEN	Benin	GBR	WA	LMI	YES
61	BFA	Burkina Faso	GBR	WA	LI	YES
62	CIV	Côte d'Ivoire	GBR	WA	LMI	N/A
63	CPV	Cape Verde	GBR	WA	LMI	N/A
64	GAB	Gabon	GBR	WA	UMI	N/A
65	GHA	GHA	GBR	WA	LMI	N/A
66	GIN	Guinea	GBR	WA	LI	YES
67	GMB	Gambia	GBR	WA	LI	YES
68	GNB	Guinea-Bissau	GBR	WA	LI	YES
69	LBR	Liberia	GBR	WA	LI	YES
70	MLI	Mali	GBR	WA	LI	YES
71	MRT	Mauritania	GBR	WA	LMI	YES
72	NER	Niger	GBR	WA	LI	YES
73	NGA	Nigeria	GBR	WA	LMI	N/A
74	SEN	Senegal	GBR	WA	LMI	YES
75	SLE	Sierra Leone	GBR	WA	LI	YES

Source: European Commission and the World Bank (WB)

Notes:

HI: High Income, UMI: Upper Middle Income, LMI: Lower Middle Income, LI: Lower Income.

SECOND ESSAY

An Analysis of ACP-UK/EU-27 Trade in Global Value-added and Participation in International Network Production

ABSTRACT

This essay provides an overview of methodologies employed to measure GVCs and studies their similarities and differences and then applies the most appropriate method to analyze the ACP-UK/EU-27 trade in global value-added and participation in international network production. This work compares the most common methodologies on the decomposition of gross exports e.g; Hummels et al., (2001), approach, Koopman et al., (2014), and Borin & Mancini (2019). After a rigorous comparison, this study finds similarities and disparities between these approaches, and finds that Borin & Mancini (2019) is the most appropriate approach for this study because it refines the vertical specialization measure of Hummels et al., (2001), refines and extends Koopman et al., (2014), and addresses the limitations of other previous studies.

Therefore this study uses Borin & Mancini (2019) to analyze the ACP-UK/EU-27 trade in global value-added. To this end, given the limitation of traditional trade statistics, EORA tables combine standard trade statistics with national Input-Output (IO) tables to form production and consumption linkages among industries and countries. Thus EORA tables allow us to evaluate global networks production activities based on gross exports and value-added trade relations of goods between sectors, countries, and regions. This study's contribution to the literature is the first on an empirical investigation of ACP-UK/EU-27 trade in global value-added and participation in international networks production, using a robust methodology developed by Borin & Mancini (2019) to overcome the limitations of all previous methodologies.

Results show that the ACP blocs with the highest level of overall GVC-related trade activities in bilateral exports to the UK/EU-27 are SADC and the Caribbean (Cariforum countries). The ACP blocs GVC-related trade activities in bilateral exports to the UK are mainly driven by upstream linkages between ACP blocs and the UK except for ESA countries. Similarly, the ACP blocs GVC-related trade activities in bilateral exports to the EU-27 are mainly driven by upstream linkages between ACP blocs and the EU-27 except for ESA countries. Conversely, the EU-27/UK GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the EU-27/UK and ACP blocs.

At the country level, the share of DVA of ACP's gross exports to the UK is very high. The UK is the main destination market for some ACP countries such as Botswana, Mauritius, Guyana, Seychelles, Kenya, Jamaica, Swaziland, Belize, the Bahamas, South Africa, Ghana, Malawi, Namibia, Barbados, Gambia, and Saint Lucia. But ACP markets are not the main destination for UK exports. While the EU-27 is the main destination market for almost all ACP countries. But ACP markets are not the main destination for the EU-27 exports.

At the sector level, the share of DVA of gross exports of the UK and the EU-27 to the ACP is very high in all sectors. The UK and the EU-27 exports to ACP countries are mainly final goods and high manufactured products. ACP countries export raw materials and intermediate inputs to the UK and the EU-27. The share of DVA of ACP's gross exports to the UK and EU-27 is very high in all sectors. But ACP exports to the EU-27 and the UK are mainly dominated by agricultural products, food and beverage, mining and quarrying, and metal products. Therefore; the subsequent essay focuses on agriculture and food & beverages sectors to carry out the empirical analysis. Figures and tables are presented in the appendices section.

Keywords: global value chains, EU27, UK, ACP
JEL classification: F14, L23, O52, O54, O55.

TABLE OF CONTENTS

1. INTRODUCTION

The first essay focused on the policy analysis of Brexit's impact on ACP-UK gross trade flows to better understand the historical and institutional setting that have been governing trade relations between the two regions (ACP & UK) since the 1970s within the context of EU-ACP EPAs framework with a focus on Cariforum. This essay assesses ACP-UK trade in value-added to uncover the magnitude of trade between the two regions.

Exports are important because they generate incomes. Thus, it is important to find out which ACP sectors and countries (blocs) generate value that is contained in bilateral trade flows between EU-27 and UK and which EU-27/UK sectors create value that embodied in bilateral trade flows between ACP and EU-27/UK. Most goods are produced from other products i.e. intermediate goods. Therefore; the research questions are:
-To what extent the UK and EU-27 rely on intermediate inputs from ACP to produce exports that generate income in UK and EU-27 (i.e. how important are the UK and EU-27 markets for ACP's value-added production).
-Conversely, to what extent ACP countries rely on intermediate goods from UK and EU-27 to produce exports that generate income in ACP countries (i.e. how important are the ACP markets for UK/EU-27 exports).

To address these questions, this work needs data on the value-added of exports at bilateral and sectoral levels. Therefore, this study reviews methodologies used to measure GVCs and studies their similarities and differences, and then applies the most appropriate method to analyze the ACP-UK/EU-27 trade in global value-added and participation in international network production. This study compares the most common methodologies on the decomposition of gross exports e.g; Hummels et al., (2001), Wang et al., (2013), Koopman et al., (2014), and Borin & Mancini (2019) approach; hereafter B&M (2019).

Koopman et al.,'s (2014) methodology applies only to aggregate exports and doesn't account for the value-added content of trade at the bilateral and sectoral levels (B&M, 2019). See table G.1 appendix G. Moreover Koopman et al., (2014) approach has many limitations which will be discussed intensively in the comparison section. Wang et al., (2013) do not allow to distinguish the products that don't leave the direct importing partner because the DVA in exports of final products is measured through a sink-based decomposition and the model doesn't account for intermediate inputs consumed by the bilateral partner without additional processing stages abroad (Borin & Mancini, 2017; hereafter B&M, 2017).

Wang et al., (2013) and Koopman et al., (2014) can't identify trade flows generated within global supply networks (i.e. the GVC component calculated in table (2) which is the sum of forward-GVC and backward-GVC.The assessment of the participation of countries in GVCs requires adequate measures of the value-added consumed directly and indirectly by the importing country.

Thus; B&M (2019) develop a decomposition of gross bilateral exports to single out the total domestic value-added consumed by bilateral importers (VAXIM), and the portion that is directly consumed by the importing country, without any further processing stage abroad or at home (DAVAX). These measures cannot be obtained by the Koopman et al., (2014) framework or by the bilateral exports decomposition proposed by Wang et al., (2013) (B&M, 2019). B&M (2019) also identify separately the DVA directly consumed by the bilateral partner from the DVA consumed by the final demand in the bilateral partner only after additional processing stages abroad or at home.

After a rigorous comparison, this study finds similarities and disparities between these approaches and finds that B&M (2019) is the most appropriate approach for this study because it refines the vertical specialization measure of Hummels et al., (2001), refines and extends Koopman et al., (2014), and addresses the limitations of other previous studies.

To answer the research questions, this study analyzes the ACP-UK/EU-27 trade in global value-added by applying B&M (2019) framework to break down bilateral gross exports into the following Trade in Value-added (TiVA) measures (indicators):

1. Domestic value-added (DVA): is the value-added that originated in sectors of ACP/UK/EU-27 economy that is contained in their sectors' exports and it can be decomposed into:
    1.1. Domestic value-added embodied either in intermediate or final goods that are directly consumed by the importing country such as:
        1.1.1. DVA originated in ACP sectors that are embedded in ACP sectors' exports to the UK.
        1.1.2. DVA originated in ACP sectors that are embedded in ACP sectors' exports to the EU-27.
        1.1.3. DVA originated in UK sectors that are embedded in UK sectors' exports to ACP.
        1.1.4. DVA originated in EU-27 sectors that are embedded in EU-27 sectors' exports to ACP.
    1.2. DVA re-directed (re-exported) to the third economy: corresponds to the domestic value-added included in intermediate inputs exported to a partner country that re-exports them to a third country as contained in other goods. It is also known as forward-GVC participation such as:
        1.2.1. DVA originated in ACP sectors that are embedded in UK sectors' exports to the EU-27/Rest of the World (RoW).
        1.2.2. DVA originated in ACP sectors that are embedded in EU-27 sectors' exports to the UK/RoW.
        1.2.3. DVA originated in UK sectors that are embedded in EU-27 sectors' exports to the ACP/RoW.
        1.2.4. DVA originated in EU-27 sectors that are embedded in UK sectors' exports to the ACP/RoW.
    1.3. DVA reflected (re-imported) to the country of origin: refers to the domestic value-added of exported intermediate goods, that is sent back to the country of origin as contained in other intermediate goods to be used in the production of exports such as:
        1.3.1. DVA originated in ACP sectors that are embodied in ACP sectors' exports to the UK/EU-27 and sent back to ACP.
2. Foreign value-added (FVA) content of exports: is the value-added of imported inputs i.e. intermediate goods to produce intermediate or final goods/services to be exported. it is also known as backward GVC participation and vertical specialization (OECD TiVA database).

To compute these components, this study relies on some assumptions, the so-called proportionality assumptions. This study assumes that every sector uses a mix of imports and domestic supplies in exactly the same proportion. For instance, in multilateral input-output tables, there are no observations on the input into German cars of South African steel, but there are inputs on steel. From data, it is known what proportion of the value of German cars is made up of steel. This study also assumes that this is the same for all German-produced cars. It is also known how much of the steel is used in Germany and the sourcing country and this study assumes that the use of steel over sources exactly at the same proportion. So the results are all proximate. This is a general issue for all input-output datasets and it is unavoidable.

Given the limitation of standard trade statistics, this work uses Inter-Country Input-Output (ICIO) tables, specifically EORA26 2015 data. ICIO tables combine traditional trade statistics with national Input-Output (IO) tables to form production and consumption linkages within industries and countries. EORA26 is a complete global multi-region input-output table (MRIO), which comprises an environmental satellite account and 26-sector classification. This study uses the EORA dataset because it covers almost all countries of the world (188 countries; table 3) of which 58 ACP countries. The main sources of data used to construct EORA tables are:[8] 1) input-output (I–O) tables and main aggregates data from national statistical offices. 2) I–O compendia from Eurostat (2011), IDE-JETRO (2006), and OECD (2009). 3) the UN National Accounts Main Aggregates Database (UNSD, 2011a). 4) the UN National Accounts Official Data (UNSD, 2011b). 5) the UN Comtrade international trade database (UN, 2011). 6) the UN service trade international trade database (UN, 2009).

[8] Lenzen, M., Moran, D., Kanemoto, K., & Geschke, A. (2013). Building Eora: a Global Multi-Region Input-Output Database At High Country and Sector Resolution. Economic Systems Research, 25(1), 20–49. https://doi.org/10.1080/09535314.2013.769938

Measures based on ICIO tables suffer from two limitations (Antràs, 2020). First, they base on aggregated Input-Output data and therefore these data sources miss a notable amount of GVC related trade activities taking place among sectors. Second, global Input-Output tables are based on strong assumptions to back out specific bilateral trade flows of intermediate goods that cannot be readily read from either national Input-Output tables or customs data.

Results show that the ACP blocs with the highest level of overall GVC-related trade activities in bilateral exports to the UK/EU-27 are SADC and the Caribbean (Cariforum countries). The ACP blocs GVC-related trade activities in bilateral exports to the UK are mainly driven by upstream linkages between ACP blocs and the UK except for ESA countries. The ESA countries' GVC-related trade activities in bilateral exports to the UK are based on downstream linkage between the UK and ESA countries. Similarly, The ACP blocs GVC-related trade activities in bilateral exports to the EU-27 are mainly driven by upstream linkages between ACP blocs and the EU-27 except for ESA countries. While the UK GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the UK and ACP blocs. Also, the EU-27 GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the EU-27 and ACP blocs.

At the country level, the share of DVA of ACP's gross exports to the UK is very high. The UK is the main destination market for some ACP countries such as Botswana, Mauritius, Guyana, Seychelles, Kenya, Jamaica, Swaziland, Belize, the Bahamas, South Africa, Ghana, Malawi, Namibia, Barbados, Gambia, and Saint Lucia. But ACP markets are not the main destination for UK exports. While the EU-27 is the main destination market for almost all ACP countries. But ACP markets are not the main destination for the EU-27 exports. The ACP gross exports to the UK that are re-directed to the final destination markets in the EU-27 are very small. Also, ACP's DVA share of EU-27 exports to the UK is very small. On average, less than 1 percent of UK gross exports to the EU-27 are re-directed to the final destination markets in the ACP countries. Also on average, less than 1 percent of EU-27 gross exports to the UK are re-directed to the final destination markets in the ACP countries.

At the sector level, the share of DVA of gross exports of the UK and the EU-27 to the ACP is very high in all sectors. The UK and the EU-27 exports to ACP countries are mainly final goods and high manufactured products. ACP countries export raw materials and intermediate inputs to the UK and the EU-27. The share of DVA of ACP's gross exports to the UK and EU-27 is very high in all sectors. But ACP exports to the EU-27 and the UK are mainly dominated by agricultural products, food and beverage, mining and quarrying, and metal products. The overall share of ACP DVA in UK bilateral exports to EU-27 at the sector level is not that much, with an exception for some sectors such as metal products, mining and quarrying, petroleum, chemical, and non-metallic mineral products, fishing, and agriculture.

Also, the overall share of ACP DVA in EU-27 bilateral exports to the UK at the sector level is very low. The overall share of the UK's DVA in EU-27 bilateral exports to ACP at the industry level is very low. The overall share of the EU's-27 DVA in the UK bilateral exports to ACP at the industry level is very low. On average, less than 1 percent of ACP gross exports to UK/EU-27 returned back to be consumed in ACP final destination market. The ACP markets that received the highest good reflected back from UK/EU-27 are SADC, Caribbean, and WA. The ACP's DVA exports by industry to UK that reflected back to be consumed in ACP final destination market is very law. The ACP's DVA exports by industry to EU-27 that reflected back to be consumed in ACP final destination market also is very law.

The ACP countries use UK/EU-27 markets as a bridge to reach the final destination markets in EU-27/UK. The figures suggest that ACP first export to the UK and EU-27, and it only reaches EU-27/UK markets after some processing stages. Indirect trade relations with the UK/ EU-27 through EU-27/UK matter for some sectors of ACP countries such as metal products, mining and quarrying, petroleum, chemical, and non-metallic mineral products, fishing, food & beverage, and agriculture.

The following sections of this study are organized as follows: part two reviews the related literature. Part three presents an overview of participation in global network productions. Part four presents the comparison. Part five compares B&M (2019) with other related contributions. Part six presents highlights on ACP-UK/EU-27 GVCs trade. Part seven analyzes ACP-UK/EU-27 indirect GVC trade relations. Part eight concludes. Part nine lists the references. Part ten presents the appendices.

2. LITERATURE REVIEW

The history of the evolution of the economy's exposure to global demand dates back to the 1960s and culminated with Leontief's multiregional input-output analysis (Leontief and Strout, 1963). Leontief was the first to introduce a matrix representation of ICIO models to analyze the economic system showed not only in terms of interdependencies among several industries but also in terms of different interrelated regions. This model has been further developed to study gross and value-added trade between sectors, countries, and regions.

According to OECD-WTO (2013), the first works to apply empirical measurement using the international input-output approach to measure the value-added of trade are Daudin et al., (2011), Johnson and Noguera (2012), and Koopman et al., (2012). These studies used the GTAP database to compute trade flows in value-added. Daudin et al., (2011) compute the share of exports used as inputs to further exports and the domestic content of imports. The domestic content of imports refers to the domestic value-added that returns back to the originating country via intermediates products exported and re-imported within more processed goods. Johnson and Noguera (2012) decompose value-added exports of bilateral trade flows and compute the ratio of value-added to gross exports (a measure of the intensity of production sharing). Unlike Hummels et al., (2001), in their model, each country can export and import intermediate goods and in the VS model, the last country exports final goods only.

Koopman et al., (2014) propose a conceptual model to include all previous works of decomposition of value-added exports (OECD-WTO, 2013). This model decomposes exports into domestic value-added, domestic value-added returned back to the country of origin included in foreign inputs, and foreign value-added. Where domestic value-added again decomposes into exports absorbed directly by importing countries and indirect exports exported to third countries. Koopman et al.,'s, (2014) approach proposes a comprehensive decomposition model to break down the value-added of exports by source and final destination and the authors demonstrate that not all double-counted in gross trade statistics are the same (B&M, 2019). According to B&M (2019), this model introduces precise measures of total domestic value-added in exports, but suffers some shortcomings: 1) The decomposition by destination market is incorrect. 2) Measures of foreign double-counted components in total exports and value-added generated abroad are imprecise. 3) Neglects the bilateral and sectoral dimensions of trade flows such that it can't be used to investigate direct and indirect linkages between sectors and countries within the production networks. 4) Doesn't present an accurate measure of the share of total trade that is related to GVC participation.

Wang et al., (2013) quantify global production sharing at the bilateral and sector levels. The first study proposes a disaggregation framework to break down gross trade at the sector, bilateral, and bilateral sector levels, into the sum of value-added and double-counted components. They produce various new panel trade databases for 40 countries covering 35 industries for the period 1995-2011 and they apply their disaggregation framework to the World Input-Output Database (WIOD). Wang et al., (2013) follow in the footsteps of Koopman et al., (2014), to develop a decomposition framework of gross trade flows (for both exports and imports) at the sector, bilateral, or bilateral sector level (B&M, 2017). This indicates that the model of Wang et al., (2013) also suffers the limitations of Koopman et al., (2014); the imprecise identification of the foreign value-added term. They combine the source and sink approach to disentangle various components which leads to internal inconsistency.

Furthermore, Wang et al., (2013) and Koopman et al., (2014) can't identify trade flows generated within global supply networks (i.e. the GVC component calculated in table (2) which is the sum of forward-GVC and backward-GVC; equations (11) to (12)). Based on the definition proposed by Hummels et al., (2001), GVC requires at least two separate stages of production in two countries, before the goods are finally shipped to the final destination market. On the contrary, production and trade patterns lead to goods and services produced in a specific country and consumed by the direct importing country. Wang et al.,'s (2013) model (sink-based approach) doesn't differentiate between these two cases, while B&M's (2019) source-based decomposition methodology is designed to address these shortcomings.

Nagengast and Sterher (2016) propose a decomposition model of bilateral gross trade balances that investigates the factors underlying the extent and sign of the differences between gross and value-added concepts. This bilateral approach contributes conceptually to the literature on "double counting" in a trade where they trace the trad flow in which value-added is actually recorded for the first time in international trade statistics. They apply their methodology to the development of intra-EU27 trade balances from 1995-2011 and they find that an increasing share of intra-EU bilateral trade balances is generated by demand in countries other than the two direct trading partners.

While Los et al., (2016) provide a decomposition framework of the value of gross exports of a country based on Koopman et al., (2014) They decompose the value of gross exports of a country into four main elements (domestic value-added in exports (DVA), value-added exports (DVA(A)), domestic value-added reflected back to the home country (DVA(R)), value-added exports (DVA(A) that is related to exports of final goods (DVA(A, Fin) and value-added exports (DVA(A) that is related to exports of intermediate goods (DVA(A, Int). These four elements are combinations of the nine terms given in the Koopman et al., (2014) decomposition. They apply a mathematical technique called hypothetical extraction to compute domestic value-added embedded in exports. They use this technique to calculate value-added in a hypothetical world economy, which is similar to the input-output framework of the actual world economy but with some trade flows set to zero. Then they define DVA in exports as the variation between actual and hypothetical GDP. Wheras Los and Timmer (2018) propose a unified methodology for measuring bilateral exports of value-added. Their model combines the measures provided by Los et al., (2016) (value-added in exports) and Johnson and Noguera (2012) (value-added consumed abroad), and they refer to these as VAX-D and VAX-C respectively. They also provide a third measure called VAX-P (value-added used abroad in the final stage of production). They show that all these three measures can be derived with the mathematical technique of hypothetical extraction in a general input-output model (see appendix F). Both Los et al., (2016) and Los and Timmer (2018) follow Koopman et al., (2014) decomposition approach, therefore they suffer shortcomings and limitations of Koopman et al., (2014).

The most recent studies that applied the above decomposition methodologies to study Africa's participation in GVCs are Balié et al., (2019) and Neil Foster-McGregor et al., (2015). Neil Foster-McGregor et al., (2015) investigate the participation of Africa as a region and individual African countries in GVC. They show that continental Africa is deeply involved in GVC (such as the USA) more than many developing country regions. Their findings suggest that Africa participates in GVCs in upstream production, with African firms supplying primary inputs to firms in other countries. But at the country level, they observe great heterogeneity among African countries in terms of GVCs participation, with many African countries deeply involved in GVC participation.

Balié et al., (2019) introduce for the first time the application of Wang et al.,'s (2013) model of gross exports decomposition on EORA data to examine the GVC participation and position of SSA countries with a focus on global agro-food chains. They focus on the agriculture and food sector only. They apply the gravity model of trade on EORA Input-Output data to study whether bilateral import tariffs and changes in trade regimes associated with regional trade agreements impact the use of foreign inputs for exports (backward participation) and the use of domestic intermediates in third country exports (forward participation) of the Sub-Saharan African (SSA) countries' agriculture and food GVCs.

They conclude that, despite their low world trade shares, GVC participation in SSA economies is increasing over time, mainly upstream as suppliers of unprocessed inputs. They show that the main destination for the value-added for SSA agricultural products is the EU and emerging economies rather than from regional partners. They suggest that participation in global production networks encourages the structural transformation process and inclusive growth in SSA.

Del Prete et al., (2016) analyze the North African countries and firms' participation in GVC. They empirically assess how participation in GVC impacts the performance of North African firms. They show that North African countries are not yet fully involved in GVC activities but the importance of international production networks has been growing over time. Their findings state that firms that enjoyed access to international supply show better performance with productivity gain over time.

So most of these methodologies are either follow Wang et al.,'s (2013) breakdown framework (which follows Koopman et al., (2014) approach) or Koopman et al.,'s (2014) decomposition. Koopman et al.,'s (2014) methodology itself exhibits some limitations and shortcomings but B&M (2017, 2019) refine and extend Koopman et al., (2014) methodology to 1) Introduce precise decomposition of bilateral and sectoral trade flows. 2) Overcome limitations of Koopman et al., (2014) decomposition and previous studies based on Koopman et al., (2014) decomposition. 3) Provide accurate definitions for some terms that are imprecisely specified by Koopman et al., (2014) such as 3.1) The domestic value-added absorbed directly/indirectly by importing country.3.2) Foreign value-added in exports. 3.4) Double-counted items produced abroad. 3.5) Propose an alternative method to decompose foreign value-added and foreign double-counted.

Following the innovative work of Hummels et al., (2001), recent literature developed a conceptual framework to better understand TiVA components and measurements. As previously mentioned that the difficulty stems from how to separate domestic from foreign value-added. Because very often countries indirectly import their domestic value-added embodied in foreign inputs as domestic value-added reflected back to the country of origin. To distinguish between them, the following section provide a full decomposition of gross exports, domestic and foreign value-added based on country of origin, and destination/absorption. The literature on such decomposition presents some limitations but B&M (2019) developed a methodology of consistent decomposition of bilateral and sectoral trade flows to overcome shortcomings of previous studies.

B&M (2019) propose a comprehensive framework of value-added accounting of trade flows at the aggregate, bilateral, and sectoral levels and assessment of the share of trade related to GVCs which refines the vertical specialization measure proposed by Hummels et al., (2001). B&M (2019) show how different empirical issues need specific accounting perspectives and new tools. Moreover, this methodology was used in the World Bank (WB) world development report of 2020 which is dedicated to global value Chains: trading for development projects (WB report, 2020).

This study's contribution to the literature is the first on an empirical investigation of ACP-UK/EU-27 trade in global value-added and participation in international networks production, using a robust methodology developed by Borin & Mancini (2019) to overcome the limitations of all previous methodologies. This work compares the most common methodologies on the decomposition of gross exports e.g; Hummels et al., (2001) approach, Koopman et al., (2014), and B&M (2019). After a rigorous comparison, this study finds similarities and disparities between these approaches, and finds that B&M (2019) is the most appropriate approach for this study because it refines the vertical specialization measure of Hummels et al., (2001), refines and extends Koopman et al., (2014), and addresses the limitations of other previous studies.

Therefore this study applies B&M (2019) to analyze the ACP-UK/EU-27 trade in global value-added. To this end, given the limitation of traditional trade statistics, EORA tables combine standard trade statistics with national Input-Output (IO) tables to form production and consumption linkages among industries and countries. Thus EORA tables allow us to evaluate global networks production activities based on gross exports and value-added trade relations of goods between sectors, countries, and regions.

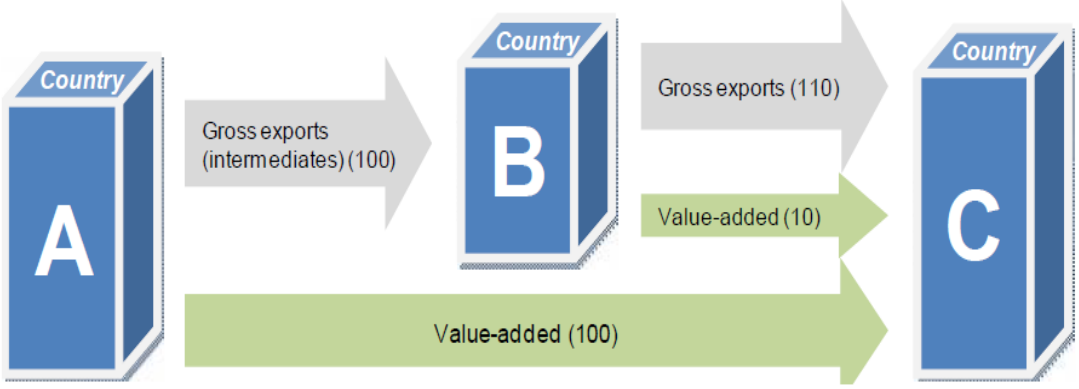
3. PARTICIPATION IN GLOBAL NETWORKS PRODUCTIONS

3.1.Trade-in value-added (TiVA)

Today, global value-added trade has dominated the global economy feature. This increasing internationalization of the production process of industrial products has questioned the capability of standard trade statistics to adequately demonstrate supply and demand linkages between sectors and countries. For instance, when stages of the production process take place in different countries, traditional trade statistics double-count the exact value-added. Given the limitation of standard trade statistics, ICIO tables combine traditional trade statistics with national Input-Output (IO) tables to form production and consumption linkages among industries and countries. Thus ICIO tables enable us to evaluate global networks production activities based on gross exports and value-added trade relations of goods between sectors, countries, and regions.

Exported and imported goods and services are comprised of inputs (intermediate goods) from different producers around the world. Trade statistics don't reflect the circulation of these goods and services within the global production networks. Trade in value-added (TiVA) takes into account the value-added by each sector/country in the production of goods and services that are consumed throughout the world. This study focuses on value-added by countries in the production of goods that are consumed globally. The trade in value-added initiative addresses the double-counting implicit in current gross flows of trade, and instead, measures flow related to the value that is added (labour compensation, taxes, and profits) by a country in the production of any goods or services that are exported (OECD-WTO database on TiVA, 2013).

Figure 1 depicts the difference between gross exports and value-added trade



Source: OECD-WTO TiVA database, 2013

Figure (1) explains the difference between gross exports and value-added trade. Country A exports $100 of goods, produced entirely within A, to country B that further processes them before exporting them to C where they are consumed. B adds the value of $10 to the goods and so exports $110 to C. Conventional measures of trade show total global exports and imports of $210 but only $110 of value-added has been generated in their production (OECD-WTO TiVA database, 2013). After clarifying the difference between gross exports and value-added trade, this study will focus on the breakdown of gross exports into value-added components in the following section.

3.2.Decomposition of gross exports

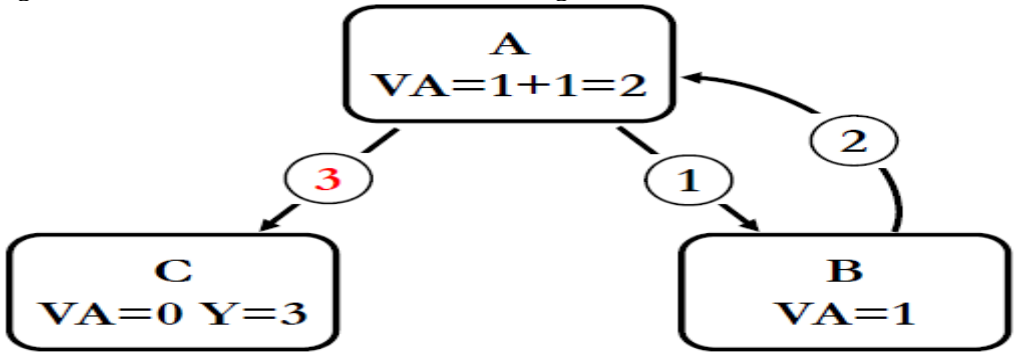
This section is dedicated to bilateral trade flows at the country level to trace value-added exports in production networks and also provides a conceptual decomposition framework for bilateral gross exports. There are two ways to measure the value-added flows between sectors and economies: 1) Trade in value-added (TiVA) which accounts for the value-added that originated in a specific sector/country and directly or indirectly contained in the final demand of another economy. In other words, TiVA is a

statistical computation that allows us to investigate the levels of sectors' and countries' participation in global network production. 2) Value added in trade measures the value-added contained in aggregate trade flows between sectors and countries.

The double-counting item: This conceptual matter arises when considering single bilateral trade flows. For instance, consider the stylized international production network depicted in Figure 2. Where the $1 of value-added originated in country A. A is the first country that exported this value-added to country B as intermediate inputs. B processed and exported it back to A and used it to produce final products for re-export to country C. In this situation, the value-added first produced in A is counted twice (first in gross bilateral exports from A to B and second in gross bilateral exports from A to C. The issue is that in which case value-added can be considered as domestic value-added and in which case as a double-counted item? Nagengast and Stehrer (2016) suggest that the solution to this issue is a matter of definition and therefore to some extent arbitrary and they propose two alternative approaches: 1) The source-based approach which takes the perspective of the country where the value-added originated. 2) The sink-based approach takes the perspective of the country that ultimately consumed it in its final demand. They prefer the source-based approach because it contains an intuitive definition of double-counted value-added based on the number of border crossings. In this approach, the value-added export is assigned to the gross trade flow, in which it leaves the originating economy for the very first time and here it will be considered as double-counted when it has crossed international borders previously.

Similarly, B&M (2019) propose two approaches. First, the source-based approach where the $1 produced in country A (see figure 2) would be accounted as domestic value-added in the gross exports to country B and double-counted in the shipments to C. Second the sink-based approach where it would be accounted as domestic value-added in the exports to C and double-counted in the shipments to B. The source-based approach accounts for the value-added for the very first time it leaves the country of origin, where the sink-based method considers it when the last time it crosses the national borders.

Figure 2 shows value-added and double counting in bilateral trade flows



Source: Borin & Mancini (2017)

The choice between these two methods depends on answering the specific empirical question. For example, if you would like to trace the final destination of the value-added in global production networks, the sink-based decomposition is more suitable. On the other hand, the source-based approach traces the very first destination market of the value-added from the country of origin. Table (1) explains the full value-added accounting of exports of country A according to the source and sink frameworks. Based on the source-based decomposition, the original $1 of production of country A would be recorded as Domestic Value-added (DVA) in bilateral exports flows from A to B and double-counted in A's exports to C. While according to the sink-based approach it would be accounted as DVA in A's exports to C and double-counted in A's exports to B).

B&M (2019) develop their two decompositions (source and sink) of bilateral trade flows starting from the Koopman et al., (2014) breakdown presented in figure A1. Where the gross exports flow from country *s* to country *r* ($\mathbf{E}_{sr}$) are broken down based on the country of origin into 1) The domestic content $\mathbf{DC}_{sr}$: decomposes into domestic value-added $\mathbf{DVA}_{sr}$ and the domestic double-counted item $\mathbf{DDC}_{sr}$.

Where $\mathbf{DVA}_{sr}$ further decomposed into value-added exports (**VAX**) and value-added returned back (reflection). 2) The foreign content $\mathbf{FC}_{sr}$: decomposes into foreign value-added $\mathbf{FVA}_{sr}$ and the foreign double-counted items $\mathbf{FDC}_{sr}$. 3) Then additional details are added to account for the final market dimension by tracking the direct importing country, if the value-added is not consumed by the direct importers then to consider the further destinations of re-export from the direct importers. The goal of B&M (2019) breakdown framework is to decompose gross bilateral trade flows from country *s* to country *r* ($\mathbf{E}_{sr}$) to identify the following: 1) The country of origin of value-added. 2) The direct importers. 3) The (eventual) second destination of re-export. 4) The country of completion of final products. 5) The final destination market.

Table 1 shows source and sink accounting of country A's exports in Figure 2

Trade flow →	A→ B				A→ C				
	DVA	DDC	FVA	FDC	DVA	DDC	FVA	FDC	Gross exports
Source	1	0	0	0	1	1	1	0	4
Sink	0	1	0	0	2	0	1	0	4

Source: B&M (2019)

To sum up, gross exports can be decomposed into DVA, DDC, FVA, and FDC based on source/sink-based methods. The choice between these two approaches depends on the specific empirical question that the study wants to address. Therefore, the following section makes a comparison between the most common decomposition methods used in the literature e.g. Hummels et al., (2001), Koopman et al., (2014), and B&M (2019) to find out their similarities and differences.

4. COMPARISON

This section aims at comparing B&M (2019) methodology of gross exports decomposition with the vertical specialization measure proposed by Hummels et al., (2001) and the aggregate exports breakdown methodology developed by Koopman et al., (2014). B&M (2019) approach refines the vertical specialization measure of Hummels et al., (2001), extends Koopman et al., (2014), and addresses the limitations of other previous studies. Here this study only compares the differences and similarities among these studies (the full analytical derivations of methodologies are presented in the appendices section). Many trade literature developed methodologies of value-added decomposition of gross exports applying the ICIO framework to disentangle double-counting terms. Double-counting terms are defined as the items (domestic or foreign value-added) that cross the same national border multiple times; at least twice (B&M, 2017). The domestic value-added (DVA) can be accounted for as a double-counted term (DDC) in the domestic content (DC) of exports from the exporting country's point of view. DVA itself can be counted as foreign value-added (FVA) in exports of another country and double-counted (FDC). While the foreign double-counting (FDC) term is more complex to calculate and to define. At this stage, to decompose a country's gross exports, Koopman et al., (2014) refer to pure-double counting as the difference between aggregate exports and the sum of (DVA + FVA). Whereas B&M (2017, 2019) propose an adequate definition for double-counted (DDC and FDC) terms from the exporting country perspective as the value-added that crosses the country's national border several times (i.e. more than once). Therefore; to clarify the issue of double-counting terms, the following section compares the most common methods of gross exports decomposition to trace the origin and destination of the value-added.

4.1. B&M (2019) versus Hummels et al., (2001)

Let's start with the contribution of Hummels et al., (2001) as following:

1. Is the first to propose vertical specialization (**VS**) to measure the import content of export and can be calculated for bilateral exports.

2. **VS** aims at dividing gross exports into items produced at home and imported intermediates contained in exports (account for direct and indirect production networks within the domestic market).
3. The **VS** measure is a good indicator of a country's participation in downstream stages of global production networks.
4. Hummels et al., (2001) apply an input-output framework to distinguish the domestic content from the import content of exports (Johnson, 2018).
5. Hummels et al., (2001) use data for one country at a time, instead of a complete global input-output framework, they say nothing about the exact relationship between the domestic and foreign content of exports and the origin of value-added content embodied in exports.
6. The **VS** measure considers imported intermediate inputs in exports as a single category, without distinguishing between the part that was generated abroad and the part that was domestically produced by the exporting country (*s*) itself and then re-imported (B&M, 2019).
7. **VS** index measures the import content of exports as in equation (1) to account for a partial measure of participation in GVC because it only computes the backward linkages.
8. For forward-GVC participation, Hummels et al., (2001) develop an index to account for the exports of intermediate inputs that are further processed and re-exported (VS1).

Whereas B&M (2019) propose a bilateral source-based approach to account for a precise indicator of the share of exports related to forward supply linkages (forward-GVC or **VS1** indicator) and the backward-GVC measure corresponding to the **VS** index (see appendix D). The forward-GVC measure is the first correct implementation of the **VS1** measure of Hummels et al., (2001). B&M (2019) forward-GVC indicators will be discussed in detail in the section on GVC indicators.

Accounting of TiVA indicators are based on ICIO framework with *G* countries and *N* sectors where $\mathbf{X}_s$ is the *N×1* vector of gross output produced in-country *s*, **A** is the *GN×GN* global input coefficients matrix, **B** is the global Leontief inverse matrix, $\mathbf{V}_s$ is the *1×N* vector of the value-added shares embedded in each gross output unit produced in country *s* and $\mathbf{E}_{sr}$ is the *N×1* vector of exports of country *s* to country *r*, (for more details see appendix B). Based on B&M (2019), the vertical specialization index $\mathbf{VS}_{sr}$ for bilateral exports between *s* and *r* in ICIO framework can be expressed as:

$$\mathbf{VS}_{sr} = \mathbf{u}_N \sum_{t \neq s}^{G} \mathbf{A}_{ts} \left(\mathrm{I} - \mathbf{A}_{ss}\right)^{-1} \mathbf{E}_{sr} / \mathbf{u}_N \mathbf{E}_{sr} \tag{1}$$

Where $\mathbf{u}_N$ is the *1×N* unit row vector and $(\mathrm{I} - \mathbf{A}_{ss})^{-1}$ account for the domestic inverse Leontief matrix.

At this point, there are also some contributions from other works to further disentangle the Hummels et al., (2001) VS measure to decompose gross exports of each country into a country of origin and destination of each component by using the ICIO framework. Among those, Koopman et al., (2012) apply the global Leontief inverse matrix to trace back the total gross output produced by each country *j* to deliver one unit of the country *s* exports ($\mathbf{B}_{js}$), and the related value-added shares ($\mathbf{V}_j$) (B&M, 2019). Where the component produced in country *s* is referred to as the domestic content of exports ($\mathbf{DC}_{sr}$) and the remaining part is referred to as foreign content of exports ($\mathbf{FC}_{sr}$):

$$\mathbf{u}_N \mathbf{E}_{sr} = \mathbf{V}_s \mathbf{B}_{ss} \mathbf{E}_{sr} + \sum_{t \neq s}^{G} \mathbf{V}_t \mathbf{B}_{ts} \mathbf{E}_{sr} \tag{2}$$

Where $\mathbf{V}_s \mathbf{B}_{ss} \mathbf{E}_{sr}$ accounts for $\mathbf{DC}_{sr}$ and $\sum_{t \neq s}^{G} \mathbf{V}_t \mathbf{B}_{ts} \mathbf{E}_{sr}$ records $\mathbf{FC}_{sr}$. Equation (2) decomposes gross exports according to the country of origin. In the same way, we can break down gross exports according to the final destination market as follows:

$$\mathbf{E}_{sr} = \mathbf{Y}_{sr} + \mathbf{A}_{sr} \mathbf{X}_r \tag{3}$$

where $\mathbf{Y}_{sr}$ is *N×1* vector records final goods produced in *s* and consumed in *r*'s final demand and $\mathbf{A}_{sr}$ is the intermediate inputs produced in country *s* used in the production of gross output in country *r* ($\mathbf{X}_r$). Based on the input-output accounting relationship (equation B.2 Appendix B), all the remaining production stages are recorded by the Leontief inverse matrix **B** (B&M, 2019):

$$\mathbf{E}_{sr} = \mathbf{Y}_{sr} + \mathbf{A}_{sr} \sum_{k}^{G} \sum_{l}^{G} \mathbf{B}_{sk} \mathbf{Y}_{kl} \quad (4)$$

Where *k* and *l* can be any exporting country including *s*.

So far, these measures of gross exports decompositions (4) contain double-counted items that cross *s*'s borders many times during production stages. Therefore it is important to identify the double-counted items to account for pure value-added contained in exports. Johnson and Noguera (2012) approach addresses this issue by proposing an indicator of the share of *s*'s production (GDP) that is absorbed abroad termed as ($\mathbf{VAX}_s$) value-added export (B&M, 2019):

$$\mathbf{VAX}_s = \mathbf{V}_s \sum_{k}^{G} . \sum_{l \neq s}^{G} . \mathbf{B}_{sk} \mathbf{Y}_{kl} \quad (5)$$

Although $\mathbf{VAX}_s$ is a good measure to provide information about the link between production and a certain final destination market, it doesn't allow to identify the trade linkages through which the value-added originated in country *s* reaches the final destination market and it doesn't account for the part that is later re-imported and consumed by final demand in country *s* (B&M, 2019).

Koopman et al.,'s (2014) approach decomposes gross exports of the country *s* into domestic value-added, foreign value-added, and value-added exports (**VAX**). Where the intermediate inputs cross exporting country borders several times during production stages are called purely double-counted items. The full breakdown proposed by Koopman et al., (2014) is presented in appendix A and figure A1 depicts their breakdown of gross exports. So Koopman et al., (2014) integrate measures of the content of exports proposed by Koopman et al., (2012) with value-added exports measures (**VAX**) of Johnson and Noguera (2012).

Koopman et al.,'s (2014) methodology applies only to aggregate exports and doesn't account for the value-added content of trade at the bilateral and sectoral levels (B&M, 2019). Moreover, the Koopman et al., (2014) approach suffers many limitations which will be discussed intensively in the following section. B&M (2019) propose value-added decompositions of exports and imports at the aggregate, bilateral, and sectoral levels. There are also some works developed to address similar issues such as Wang et al., (2013), Los et al., (2016), Nagengast and Stehrer (2016); Johnson (2018), and Los and Timmer (2018) and will analyze these studies in the end. The existence of various concurring methodologies addressing similar aspects has raised the question of the suitable approach to measure value-added in disaggregated trade flows. There is no particular methodology to account for value-added in disaggregated trade flows, and we have to consider different measures to tackle different empirical questions (B&M, 2019). Therefore in the following section, this study makes a comparison between Koopman et al., (2014) and B&M (2017, 2019) to find out which decomposition is the most appropriate for different types of trade analysis.

4.2. B&M (2019) gross exports decomposition versus Koopman et al., (2014) aggregate exports breakdown

Koopman et al., (2014) propose a methodology to decompose gross exports into DVA, FVA, and value-added exports (**VAX**). Where the intermediate goods cross exporting country borders multiple times during production stages are called purely double-counted items (see appendix A). The pure double-counting terms consist of DDC (term6) and FDC (term9) components so that the gross exports finally broke down into four main terms (i.e. DVA, DDC, FVA, and FDC). There are nine terms in the Koopman et al., (2014) decomposition framework but the other five terms further break down DVA and FVA terms. So Koopman et al., (2014) integrate measures of the content of exports proposed by Koopman et al., (2012) with value-added exports indicators (**VAX**) of Johnson and Noguera (2012).

Koopman et al.,'s (2014) methodology applies only to aggregate exports and doesn't account for the value-added content of trade at the bilateral and sectoral levels (B&M, 2019). See table G.1 appendix

G. Moreover Koopman et al., (2014) approach has many limitations which will be discussed intensively in the following paragraphs.

At this point, B&M (2019) propose a bilateral source-based breakdown of gross exports (based on B&M, 2017) to refine **VAX** measures of Koopman et al., (2014) and Johnson and Noguera (2012) (see equation (H.14, Appendix H)). This measure separates the domestic value-added finally consumed by final demand in the country of origin (reflection; Koopman et al., (2014) terminology) from domestic value-added consumed in a foreign market (value-added exports **VAX** measure proposed by Johnson and Noguera, 2012).

B&M (2019) decomposition framework is conceptually consistent with Koopman et al.,'s (2014) approach. For instance, B&M (2019) express their sink-based breakdown of bilateral exports in equation (E.2) so that the components match directly those proposed in Koopman et al., (2014) (see equation (E.1) in appendix E) (B&M, 2019)). Even their sink-based world-level perspective of equations (53) and (54) was also consistent with Koopman et al., (2014).

Despite the algebraical consistency between the two accounting relationships in equation (E.1) and equation (E.2), there are noticeable differences, because of two main limitations of the Koopman et al., (2014) decomposition framework (B&M, 2019). These two limitations are:

1. Koopman et al., (2014) decomposition doesn't allocate the domestic value-added embedded in exports between the share going to direct importers and the share absorbed in third countries.
2. Koopman et al., (2014) decomposition considers a portion of the foreign content of export as double-counted whereas it should be allocated to the foreign value-added.

Koopman et al., (2014) framework accounts for the domestic value-added in intermediate exports consumed by direct importers as $\mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rr}$ and the domestic value-added in intermediate inputs re-exported to third countries as $\mathbf{V}_s \sum_{r\neq s}^{G} \sum_{t\neq s,r}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rt}$. These two components refer to the domestic value-added consumed in any foreign market. The difference between them is that, in the first component, the final products are completed and consumed in the same country while in the second component, products are completed in a specific foreign country and consumed in another foreign country as well, and the issue is that the global inverse Leontief matrix $\mathbf{B}_{sr}$ used by Koopman et al., (2014) doesn't trace a bilateral exporter-importer linkage (B&M, 2019).

Koopman et al., (2014) decomposition allocates $\mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rr}$ to the bilateral importers' final demand. While only sub-items $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr}$, $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr}]$ of equation (E.2) can be defined as such, and the sub-component $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{kr}]$ of equation (E.2) should also be considered as direct importer's final consumption instead of third countries (B&M, 2019).

The assessment of the participation of countries in GVCs requires adequate measures of the value-added consumed directly and indirectly by the importing country. Therefore; B&M (2019) propose the decomposition of gross bilateral exports to single out the total domestic value-added consumed by bilateral importers (**VAXIM**), and the portion that is directly consumed by the importing country, without any further processing stage abroad or at home (**DAVAX**). These measures cannot be obtained by the Koopman et al., (2014) framework or by the bilateral exports decomposition proposed by Wang et al., (2013) (B&M, 2019).

Koopman et al., (2014) decomposition is incorrectly classified as the part of the foreign value-added in exports; some items can be classified as **FDC** (term9) even if they are never recorded as foreign value-added (B&M, 2019). They classify the whole foreign content of exports of country *s* that the importing country *r* re-exports abroad as foreign double counted ($\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{E}_{r*}$). Their framework doesn't account for the foreign value-added originated in the importing country *r*, that *r* itself re-exports to the market of final destination. Their sink-based world-level perspective used to

record the foreign content of exports shows that a particular component is accounted for as foreign value-added the last time it is exported by a country other than the country of origin.

Computational examples illustrating similarities and differences between Koopman et al., (2014) and B&M (2017, 2019):

The source-based decomposition accounts for the value generated in a country as value-added the first time it crosses the national borders of the exporting country. The sink-based approach considers the value-added the last time it leaves national borders, and in the case of multiple crossing, it is accounted as double-counted in prior shipments.

Further, to understand the similarities and differences between these two frameworks, this work provides computational examples based on the world-level decomposition of gross exports according to Koopman et al., (2014) and B&M (2017, 2019). Because Koopman et al., (2014) can be computed at the world level only. This study uses the WIOD table for the year 2014 to decompose aggregate exports into nine terms according to equation (E.1, appendix E) proposed by Koopman et al., (2014) decomposition methodology and their counterparts in equation (E.2) in B&M (2017, 2019) as illustrated in the table (2). Table (2) contrasts B&M (2017, 2019) with Koopman et al.,'s (2014) decomposition methodology for UK's gross exports to all countries in the world.

In table (2), for B&M (2017, 2019) decomposition methodology, this study applied a sink-based and source-based approach for all components (DC, DVA, DDC, FC, FVA, FDC) except for GVC this study used a source-based approach only. At the world level, B&M (2017, 2019) source-based and sink-based approaches will lead to the same results. For instance, based on B&M (2017, 2019), the FVA and FDC are equal to 18.88% and 0.08% of the UK's gross exports respectively in both sink-based and source-based approaches (table 2). Whereas Koopman et al., (2014) decomposition methodology is based on a sink-based world-level approach and the FVA and FDC are equal to 13.69 % and 5.27 % of the UK's gross exports respectively which are different from the results obtained by B&M (2017, 2019).

Table (2) shows that B&M (2017, 2019) sink-based and source-based decomposition of the UK gross exports are consistent with Koopman et al., (2014) sink-based approach for all components (DC, DVA, DDC, and FC) except for FVA, FDC, and GVC-related trade activities (i.e. which are the variables of interest to understand a country's involvement in global networks production). Koopman et al., (2014) decomposition incorrectly estimates the part of FVA in exports; some items can be accounted as FDC (term9: Koopman et al., (2014)) even if they are never recorded as foreign value-added (B&M, 2019). Therefore it will lead to overestimation of the FDC term (table 2) which is amounted to 5.27 percent of exports ($39.5 billion) compared with only 0.08 percent of exports ($583.5 million) according to both B&M (2017, 2019) sink and source-based approaches, led to an overestimation of GVC-related trade activities which amounted to over 30 percent of exports compared to only 20.93 percent of exports according to the source-based approach of B&M (2017, 2019).

These results clearly explain the limitations of Koopman et al.,'s (2014) decomposition framework. This framework doesn't provide adequate measures for FVA, FDC, and the participation of a country in GVCs. B&M (2019) value-added accounting methodology focus on the selection of perspectives that the analysis should consider to tackle a certain issue. This perspective identifies the perimeter based on the classification of value-added or double-counted items. The boundaries are defined at the exporting/importing country level, or specific bilateral relation, or exporting sector within a bilateral flow. The following paragraphs discuss these aspects in detail.

Table (2) compares Koopman et al., (2014) with B&M (2017, 2019) decomposition methodology for UK's gross exports to all countries in the world based on WIOD data for the year 2014

Sink-based decomposition of 9 terms of KWW (2014)			**Sink-based decomposition of 9 terms of BM (2017,2019)**			**Source-based decomposition of 9 terms of BM (2017,2019)**		
Terms	('000$')	% of export	Terms	('000$)	% of export	Terms	('000$)	% of export
KWW1	217,358,336.70	28.92	BM1	217,358,336.70	28.92	BM1a	216,560,327.57	28.82
						BM1b	798,009.13	0.11
						BM1c	0.00	0.00
KWW2	307,789,480.40	40.96	BM2a	378,969,057.23	50.43	BM2a	377,617,245.56	50.25
			BM2b	0.00	0.00	BM2b	1,351,811.67	0.18
			BM2c	0.00	0.00	BM2c	0.00	0.00
KWW3	71,179,576.83	9.47	BM3a	0.00	0.00	BM3a	0.00	0.00
			BM3b	0.00	0.00	BM3b	0.00	0.00
			BM3c	0.00	0.00	BM3c	0.00	0.00
			BM3d	0.00	0.00	BM3d	0.00	0.00
KWW4	5,924,673.89	0.79	BM4a	5,924,673.89	0.79	BM4a	5,900,940.69	0.79
			BM4b	0.00	0.00	BM4b	23,733.21	0.00
			BM4c	0.00	0.00	BM4c	0.00	0.00
KWW5	4,579,266.61	0.61	BM5	4,579,266.61	0.61	BM5	4,579,266.61	0.61
KWW6	2,198,882.17	0.29	BM6	2,198,882.17	0.29	BM6	2,198,882.17	0.29
KWW7	51,173,569.54	6.81	BM7	51,173,569.54	6.81	BM7	50,963,357.20	6.78
KWW8	51,678,061.84	6.88	BM8	88,136,247.54	11.73	BM8	87,776,065.22	11.68
KWW9	39,591,455.37	5.27	BM9a	1,484,225.47	0.20	BM9a	1,477,848.68	0.20
			BM9b	1,065,579.61	0.14	BM9b	1,642,351.06	0.22
			BM9c	0.00	0.00	BM9c	0.00	0.00
			BM9d	583,464.59	0.08	BM9d	583,464.59	0.08
Aggregate exports decomposition (KWW 2014), sink-based approach			Aggregate exports decomposition (BM 2017, 2019), sink-based approach			Aggregate exports decomposition (BM 2017, 2019), source-based approach		
Terms	('000$')	% of export	Terms	('000$)	% of export	Terms	('000$)	% of export
DC	609,030,216.60	81.04	DC	609,030,216.60	81.04	DC	609,030,216.60	81.04
DVA	606,831,334.43	80.75	DVA	606,831,334.43	80.75	DVA	606,831,334.43	80.75
DDC	2,198,882.17	0.29	DDC	2,198,882.17	0.29	DDC	2,198,882.17	0.29
FC	142,443,086.75	18.96	FC	142,443,086.75	18.96	FC	142,443,086.75	18.96
FVA	102,851,631.39	13.69	FVA	141,859,622.16	18.88	FVA	141,859,622.16	18.88
FDC	39,591,455.37	5.27	FDC	583,464.59	0.08	FDC	583,464.59	0.08
GVC	226,325,486.25	30.12	GVC	N/A	N/A	GVC	157,295,730.22	20.93

Source: Author's computation based on WIOD data for the year 2014

Notes: KWW denotes Koopman et al., (2014). UK gross exports for 2014 is amounted to $751,473,303,350.00. BM denotes (B&M, 2017/2019). N/A means not applicable.

DC = the sum of the terms from KWW1 to KWW6 = the sum of the terms from BM1a to BM6.

DVA = the sum of the terms from KWW1 to KWW5 = the sum of the terms from BM1a to BM5.

DDC = KWW6 = BM6.

FC = the sum of the terms from KWW7 to KWW9 = the sum of the terms from BM7 to BM9d.

FVA = the sum of the terms KWW7 and KWW8 Koopman et al., (2014).

FVA = the sum of the terms from BM7 to BM9b (BM, 2017 & 2019).

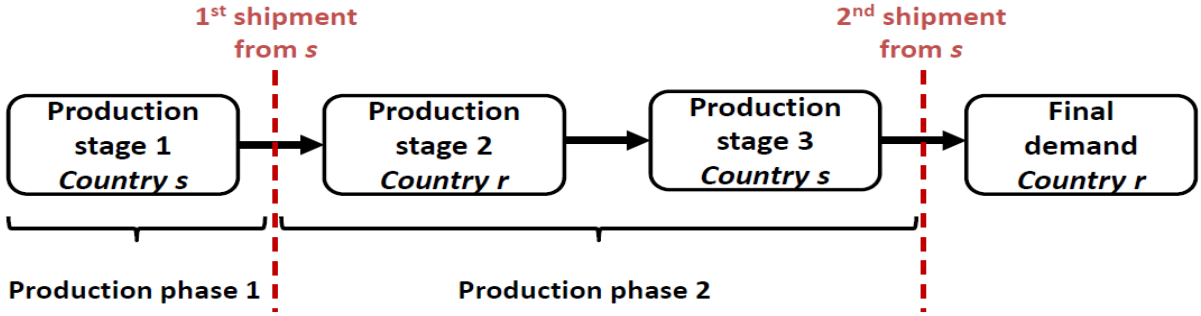
FDC = KWW9 (KWW, 2014).

FDC = the sum of terms BM9c plus BM9d (BM, 2017 & 2019).

GVC = the sum of the terms from KWW3 to KWW9 (Koopman et al., (2014)).
GVC = the sum of the terms BM1b plus BM2b to BM9d (BM, 2017 & 2019).

B&M (2019) source-based approach of bilateral exports considers the value generated in a country as value-added the first time it crosses the national borders of the exporting country. In figure (3) the value generated in phase (1) is recorded as a value-added component in the first shipment from country *s* to country *r*, while in the last shipment it is recorded as a double-counted component (B&M, 2019). To distinguish a value-added item from the double-counted component, B&M (2019) divide the production chain into phases where each phase is delimited by an exports flow of country *s* and what is produced within that specific production phase is considered as value-added in exports, which comes from further upstream production stages is counted as the double-counted item.

Figure 3 depicts the decomposition of production stages



Source: B&M (2019)

In Koopman et al., (2014) the Leontief inverse matrix **B** considers all the backward production networks that precede particular export flow, creates the double-counting issue (B&M, 2019). Whereas B&M (2019) develop a methodology to separate the value-added items by amending the matrix **B** where they consider the representation of the global Leontief inverse as a sum of infinite series of the gross output produced in all the upstream stages of the production process (appendix H, equation H.1). B&M (2019) refine the bilateral decomposition in equation (2) to separate the value-added and double-counted terms within each component (H.5).

B&M (2019) source-based framework accounts for the DVA in exports by separating all the domestic production stages required to produce the exported products without accounting for the domestic content of imported inputs (H.6). This indicator (H.6) of domestic value-added in exports is the complement to the import content of exports proposed by Hummels et al., (2001) and also corresponds to the indicator of domestic value-added proposed by Johnson (2018) in the two-country world framework (B&M, 2019).

Up to now, the decomposition of bilateral value-added stems from the country of origin, and the literature has also considered the final destination market (Koopman et al., (2014)). While B&M (2019) consider the direct importer, the second destination of re-export, the country of completion of final goods, and the final destination market. Therefore B&M (2019) divide the bilateral exports $\mathbf{E}_{sr}$ into final products ($\mathbf{Y}_{sr}$) and intermediate goods for gross output production of country *r* ($\mathbf{X}_{r}$) (H.7). Where country importing country *r* processes these intermediate inputs imported from *s* to generate final products for domestic consumption or re-export (both intermediate and final goods) At this stage, they link the intermediate inputs imported by country *j* with the country of final completion and final destination market while other remaining (and potentially infinite) production stages are accounted for by the Leontief inverse matrix **B** (see equation B.2 in appendix B) to derive the comprehensive source-based decomposition of DVA and FVA of bilateral exports flows (H.11 & H.12).

4.3.Global Value Chain (GVC) indicators

To better understand the bilateral trade flows between country *s* and *r*, it is necessary to uncover the portion of the export flows between them that is related to GVC activities. GVC-related trade is goods and services that cross more than one national border and must involve two or more production stages located in different countries before the final goods or services reach the final destination market (Hummels et al., (2001)). A GVC breaks up the production process across countries where firms specialize in a particular task and don't produce the whole product (World development report of World Bank, 2020)[9].

The directly consumed value-added in exports $\mathbf{DAVAX}_{sr}$ accounts for products produced domestically in country *s* and consumed by final demand in country *r* ($\mathbf{V}_s(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{Y}_{sr}$), and of the intermediate goods that are generated in *s* and used by *r* to generate final products for the domestic market ($\mathbf{V}_s(\mathrm{I} - \mathbf{A}_{SS})^{-1}\ \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rr}$), without any further re-export to other countries. This form of trade is not related to the global sharing of production (GVC-related trade) because it doesn't involve any further re-export. At this point, B&M (2019) propose a measure of GVC in a bilateral trade flow, by excluding from the country *s*'s gross exports the domestic value-added consumed directly by its importer ($\mathbf{DAVAX}_{sr}$):

$$\mathbf{GVCX}_{sr} = \mathbf{u}_N\mathbf{E}_{sr} - \mathbf{DAVAX}_{sr} \tag{6}$$

Thus, the GVC share in bilateral exports is given by the following accounting relationship:

$$\mathbf{GVC}_{sr} = \frac{\mathbf{GVCX}_{sr}}{\mathbf{u}_N\mathbf{E}_{sr}} \tag{7}$$

Which can be accounted for the exporting country *s* as a whole:

$$\mathbf{GVC}_{s} = \frac{\sum_{r\neq s}^{G}\mathbf{GVCX}_{sr}}{\mathbf{u}_N\mathbf{E}_{sr}} \tag{8}$$

And at the world level:

$$\mathbf{GVC}_{world} = \frac{\sum_{s}^{G}\sum_{r\neq s}^{G}\mathbf{GVCX}_{sr}}{\sum_{s}^{G}(\mathbf{u}_N\mathbf{E}_{s*})} \tag{9}$$

These GVC-related trade measures are not the first indicators based on the ICIO framework to assess the participation of countries in global network production. Hummels et al., (2001) propose a vertical specialization (**VS**) index (measures the import content of exports as in equation (1)) to account for a partial measure of participation in global production networks because it only computes the backward linkages. For forward linkages, Hummels et al., (2001) propose a crude index to account for the exports of intermediate inputs that are further processed and re-exported (**VS1)**.

Based on the bilateral source-based framework, B&M (2019) propose a precise indicator of the share of exports related to forward supply linkages ($\mathbf{GVC}forward$ or **VS1**) and the $\mathbf{GVC}backward$ indicator corresponding to the **VS** Index (see appendix D). The $\mathbf{GVC}forward$ indicator is the first correct implementation of the **VS1** measure of Hummels et al., (2001):

$$\mathbf{GVC}_{sr} = \mathbf{GVC}backward_{sr} + \mathbf{GVC}forward_{sr} \tag{10}$$

$$\text{Where } \mathbf{GVC}backward_{sr}\ (\mathbf{VS}_{sr}) = \frac{\mathbf{V}_s(\mathrm{I}-\mathbf{A}_{ss})^{-1}\sum_{j\neq s}^{G}\mathbf{A}_{sj}\mathbf{B}_{js}\mathbf{E}_{sr} + \sum_{t\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{E}_{sr}}{\mathbf{u}_N\mathbf{E}_{sr}} \tag{11}$$

$$\mathbf{GVC}forward_{sr}\ (\mathbf{VS1}_{sr}) = \frac{\mathbf{V}_s(\mathrm{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left(\sum_{j\neq r}^{G}\mathbf{Y}_{rj} + \sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k}^{G}\sum_{l\neq s}^{G}\mathbf{B}_{jk}\mathbf{Y}_{kl}\right)}{\mathbf{u}_N\mathbf{E}_{sr}} \tag{12}$$

[9] See World development report of World Bank (2020). "Trading for Development in the Age of Global Value Chains"

There are also other indicators developed to measure a forward GVC participation by considering the export that is later re-exported by the direct importer as proposed by B&M (2019) such as Cappariello and Felettigh (2014), $\mathbf{VS1}_s$ of Koopman et al., (2014) and Altomonte et al (2018). But these studies are based on gross exports breakdown of Koopman et al., (2014) or Wang et al., (2013) where these methodologies do not properly allocate countries' exports between the share that is directly consumed by importers and the one that is re-exported abroad and indicators of GVC participation are also imprecise (B&M, 2019).

4.4.An amendment (I) of Wang et al., (2013) by B&M (2019)

Wang et al., (2013) do not allow to distinguish the products that never leave the direct importing partner (B&M 2017). Because 1) the DVA in exports of final products is measured through a sink-based decomposition. 2) The model doesn't account for intermediate inputs consumed by the bilateral partner without additional processing stages abroad. Whereas B&M (2019) identify separately the DVA directly consumed by the bilateral partner from the DVA consumed by the final demand in the bilateral partner only after additional processing stages abroad or at home. B&M (2019) bilateral sink-based approach considers the value-added the last time it leaves national borders, and in the case of multiple crossing, it is accounted as double-counted in prior shipments. Therefore; this decomposition methodology is suitable for answering questions on how to link the total value-added generated in a particular economy to the final destination market. While source-based decomposition is more appropriate for assessing production networks.

To identify the value-added items in a sink-based framework, B&M (2019) propose a decomposition to separate the portion of ultimate shipments within a specific bilateral trade flow. Where these ultimate exports ($\mathbf{E}_{sr}^{(\overset{\$}{\rightarrow}\mathbf{Y}_*)}$) are consist of final products ($\mathbf{Y}_{sr}$) and intermediate inputs that do not re-enter the country *s*'s exports, before reaching the final destination market ($\mathbf{A}_{sr}\mathbf{X}_j^{(\overset{\$}{\rightarrow}\mathbf{Y}_*)}$). They account for the overall value-added by pre-multiplying the vector of ultimate exports by the **VB** matrix i.e. when the part of ultimate exports is identified, the value-added in exports can be calculated in the same way as to how the **VBY** matrix is applied to account for the total value-added in final demand (see appendix B) and the global Leontief inverse matrix **B** considers all the upstream production phases. They assume that they can divide the bilateral exports into ultimate shipments ($\mathbf{E}_{sr}^{(\overset{\$}{\rightarrow}\mathbf{Y}_*)}$) and exports of intermediate goods that will be re-exported again by country *s* ($\mathbf{E}_{sr}^{(\rightarrow\mathbf{E}_{s*})}$), the value-added decomposition of bilateral exports in a sink-based approach is given by the following accounting relationship:

$$\begin{aligned}\mathbf{u}_N\mathbf{E}_{sr} &= \mathbf{V}_s\mathbf{B}_{ss}\mathbf{E}_{sr}^{(\overset{\$}{\rightarrow}\mathbf{Y}_*)} + \mathbf{V}_s\mathbf{B}_{ss}\mathbf{E}_{sr}^{(\rightarrow\mathbf{E}_{s*})} + \textstyle\sum_{t\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{E}_{sr}^{(\overset{\$}{\rightarrow}\mathbf{Y}_*)} \\ &\quad + \textstyle\sum_{t\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{E}_{sr}^{(\rightarrow\mathbf{E}_{s*})}\end{aligned} \tag{13}$$

Where the first term in the RHS of equation (13) is domestic value-added ($\mathbf{DVA}sink_{sr}$), the second term in the RHS is domestic double counted ($\mathbf{DDC}sink_{sr}$) and the sum of these two terms account for the domestic content ($\mathbf{DC}_{sr}$). The third term in the RHS is foreign value-added ($\mathbf{FVA}sink_{sr}$), the fourth term in the RHS is foreign double counted ($\mathbf{FDC}sink_{sr}$) and the sum of these two terms account for the foreign content ($\mathbf{FC}_{sr}$) To identify the ultimate shipment, B&M (2019) proceed by disentangling the bilateral trade flow $\mathbf{E}_{sr}$, as they did for the source-based decomposition to identify the downstream linkages with final demand. They exploit the accounting relationships in equations (H.7)–(H.9) to express the bilateral exports:

$$\begin{aligned}\mathbf{E}_{sr} = \mathbf{Y}_{sr} &+ \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} + \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{Y}_{rj} \\ &+ \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{X}_j\end{aligned} \tag{14}$$

Where the first three components in the RHS of equation (14) account for part of the ultimate shipment of country *s* and the value-added reaches the final destination market without any further re-export from

country *s*. Then they identify the part of country *j*'s output that passes through country *s*'s export borders ($\mathbf{X}_j^{(\rightarrow \mathbf{E}_{s*})}$) and the part that reaches the final demand without any further re-export from *s* ($\mathbf{X}_j^{(\overset{\$}{\rightarrow} \mathbf{Y}_{*})}$). To address this issue, they modify the version of the Leontief inverse matrix that excludes the intermediate export linkages from country *s* ($\mathbf{B}^{\$}$) to account for all possible patterns through which the production of country *j* reaches the final destination market, with the exception of the part that contains re-export from *s* without considering final goods exports of country *s*. To split the output of country *j*, they re-express the production accounting relationship and trade in their global I-O framework (see B.1 in appendix B) by isolating the export flows from country *s* as:

$$\mathbf{X} = \mathbf{A}^{s}\mathbf{X} + \mathbf{A}^{s}\mathbf{X} \; + \mathbf{Y}^{s} + \mathbf{Y}^{s} \tag{15}$$

Where $\mathbf{A}^{s} = (\mathbf{A} - \mathbf{A}^{\$})$, $\mathbf{Y}^{\$}$ is the final demand matrix $\mathbf{Y}$ with the block matrix corresponding to exports of final products from *s* equal to zero (including domestic final demand $\mathbf{Y}_{ss}$), and $\mathbf{Y}^{s} = (\mathbf{Y} - \mathbf{Y}^{\$})$. Since the sum of $\mathbf{A}^{s}\mathbf{X}$ and $\mathbf{Y}^{s}$ is a *GN*×*N* matrix with gross exports from country *s* in the corresponding block submatrix and zeros elsewhere ($\mathbf{E}^{s}$), they re-express equation (15) as:

$$\mathbf{X} = \mathbf{B}^{\$}\mathbf{Y}^{\$} + \mathbf{B}^{\$}\mathbf{E}^{s} \tag{16}$$

Where $\mathbf{B}^{\$} \equiv (\mathbf{I} - \mathbf{A}^{\$})^{-1}$ is the Leontief inverse matrix obtained from the new input coefficient matrix $\mathbf{A}^{\$}$ without the input requirement of other countries from country *s*. By using the new accounting relationship in (16), they break down the gross production of country *j* as follows:

$$\mathbf{X}_j \; = \sum_{k\neq s}^{G} \sum_{l}^{G} \mathbf{B}_{jk}^{\$}\mathbf{Y}_{kl} + \; \mathbf{B}_{js}^{\$}\mathbf{Y}_{ss} + \mathbf{B}_{js}^{\$}\mathbf{E}_{s*} \tag{17}$$

Where the sum of the first and second components of the RHS of equation (17) account for $\mathbf{X}_j^{(\overset{\$}{\rightarrow} \mathbf{Y}_{*})}$, and the last component represents $\mathbf{X}_j^{(\rightarrow \mathbf{E}_{s*})}$. Equation (17) allows to single out the part of the output of country *j* that is not involved in country *s*'s exports before reaching the ultimate destination market ($\mathbf{X}_j^{(\overset{\$}{\rightarrow} \mathbf{Y}_{*})}$), while the remaining item accounts for the double-counted components ($\mathbf{X}_j^{(\rightarrow \mathbf{E}_{s*})}$). Then they integrate equations (13), (14), and (17) to obtain the main terms of the sink-based decomposition of bilateral exports (the domestic value-added, $\mathbf{DVA}_{sr}$, the foreign value-added, $\mathbf{FVA}_{sr}$, the domestic double-counted, $\mathbf{DDC}_{sr}$, and the foreign double-counted, $\mathbf{FDC}_{sr}$) as following:

$$\begin{aligned}\mathbf{DVA}sink_{sr} = \mathbf{V}_s\mathbf{B}_{ss}[\mathbf{Y}_{sr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{Y}_{rj} \\ + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{A}_{rj}\,(\sum_{k\neq s}^{G}\sum_{l}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kl} + \mathbf{B}_{js}^{\$}\mathbf{Y}_{ss})]\end{aligned} \tag{18}$$

$$\begin{aligned}\mathbf{FVA}sink_{sr} = \textstyle\sum_{t\neq s}^{G}\mathbf{V}_t\,\mathbf{B}_{ss}[\mathbf{Y}_{sr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{Y}_{rj} \\ + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{A}_{rj}\,(\sum_{k\neq s}^{G}\sum_{l}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kl} + \mathbf{B}_{js}^{\$}\mathbf{Y}_{ss})]\end{aligned} \tag{19}$$

$$\mathbf{DDC}sink_{sr} = \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{A}_{rj}\,\mathbf{B}_{js}^{\$}\mathbf{E}_{s*} \tag{20}$$

$$\mathbf{FDC}sink_{sr} = \textstyle\sum_{t\neq s}^{G}\mathbf{V}_t\,\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{A}_{rj}\,\mathbf{B}_{js}^{\$}\mathbf{E}_{s*} \tag{21}$$

Equations (18) and (19) allow us to separate the value-added in exports for one or more economies (the exporter, the importer, the origin of the value-added, the market of re-export, the country of final completion, and final destination market). At this point, B&M (2019) also isolate the domestic value-added that is eventually consumed by domestic final demand ($\mathbf{REF}_{sr}$) from the one that consumed abroad ($\mathbf{VAX}_{sr}$) as follows:

$$\begin{aligned}\mathbf{REF}sink_{sr} = \mathbf{V}_s\mathbf{B}_{ss}[\mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\mathbf{Y}_{rs} \\ + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\textstyle\sum_{j\neq r}^{G}\mathbf{A}_{rj}\,(\sum_{k\neq s}^{G}\sum_{l}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{ks} + \mathbf{B}_{js}^{\$}\mathbf{Y}_{ss})]\end{aligned} \tag{22}$$

$$\mathbf{VAX}sink_{sr} = \mathbf{V}_s\mathbf{B}_{ss}[\mathbf{Y}_{sr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\sum_{j\neq r,s}^{G}\mathbf{Y}_{rj} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s}^{G}\sum_{l\neq s}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kl}] \quad (23)$$

While the subcomponent of the term $\mathbf{VAX}sink_{sr}$ is the domestic value-added that is consumed by final demand in the importing country *r*:

$$\mathbf{VAXIM}_{sr} = \mathbf{V}_s\mathbf{B}_{ss}[\mathbf{Y}_{sr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kr}] \quad (24)$$

Where $\mathbf{VAXIM}_{sr}$ contains the value-added generated in country *s* and consumed in country *r*. The $\mathbf{DAVAX}_{sr}$ the measure of the source-based approach is a subcomponent of the $\mathbf{VAXIM}_{sr}$ as it accounts for the value-added produced in *s* and directly consumed in *r*, without any further re-export or re-import by country *r*. The $\mathbf{DAVAX}_{sr}$ can be calculated only in a source-based framework and differs from the sum of the first two components of the Koopman et al., (2014) breakdown where they call this term exports absorbed by the direct importer (B&M, 2019). These indicators cannot be obtained by Koopman et al., (2014) or by the bilateral exports decomposition developed by Wang et al., (2013) (B&M, 2019).

The source-based approach and sink-based framework can be used to tackle various empirical issues. At the bilateral level decomposition of gross exports, the domestic and foreign contents are the same in the two approaches. While the value-added and double-counted components of the two Breakdowns are the same when summing across the destinations of a specific exporter vary only at the bilateral level (B&M, 2019).

4.5.An amendment (II) of Wang et al., (2013)

This section shows how B&M (2019) bilateral sectoral decomposition framework amends Wang et al., (2013) sectoral framework. B&M (2019) both source and sink breakdowns of gross exports at the country level can be extended to consider the sectoral decomposition dimension. They maintain the same perimeter to identify double-counting, which is defined by the borders of the exporting country. Based on the choice between the source and the sink decomposition approach, a component first exported by a particular sector and then re-exported by another industry is recorded as value-added on one occasion and as double-counted on another. By maintaining this country-level perspective, the sum across all sectors and all bilateral partners is equal to the total production (GDP) contained in a country's exports (the additivity of value-added components).

B&M (2019) take into account three sectoral decompositions, 1) by sector of origin, 2) by sector of export (the only item considered by Wang et al., (2013), and 3) by sector of final consumption. Whereas Wang et al., (2013) sectoral decomposition consider the only sector of export. To obtain industries breakdown by sectors of origin, B&M (2019) substitute in all the indicators of source and sink breakdowns the *1*×*N* vector $\mathbf{V}_j$ (*j* = *s*, *t*) with its diagonalized form $\widehat{\mathbf{V}}_j$ (the *N*×*N* diagonal matrix with the direct value-added coefficients along the principal diagonal and zeros elsewhere):

$$\widehat{\mathbf{V}}_j = \begin{bmatrix} v_{j,1} & 0 & \cdots & 0 \\ 0 & v_{j,2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & v_{j,N} \end{bmatrix}$$

Similarly, the breakdown by export industries is derived by replacing vectors $\mathbf{V}_j\mathbf{B}_{js}$ and $\mathbf{V}_j\mathbf{B}_{js}^{\$}$ in the **DVA** and **FVA** terms of equations (13) (and the following ones) with their *N*×*N* diagonalized forms $\widehat{\mathbf{V}_j\mathbf{B}_{js}}$ and $\widehat{\mathbf{V}_j\mathbf{B}_{js}^{\$}}$:

$$\widehat{\mathbf{V}_j\mathbf{B}_{js}} \equiv \begin{bmatrix} \sum_n^N v_{j,n}\, b_{js,n1} & 0 & \cdots & 0 \\ 0 & \sum_n^N v_{j,n}\, b_{js,n2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sum_n^N v_{j,n}\, b_{js,nN} \end{bmatrix}$$

While the Breakdown by sectors of final consumption is derived by replacing the vector of final demand with its diagonalized form, for example, for products completed in country *k* and consumed by final demand in country l, the *N*×*N* diagonal matrix of final demand is:

$$\widehat{\mathbf{Y}}_{kl} \equiv \begin{bmatrix} ykl,1 & 0 & \cdots & 0 \\ 0 & ykl,2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & ykl,N \end{bmatrix}$$

The choice of appropriate bilateral sectoral decomposition depends on the empirical issue you want to address, for example, if you are interested in the origin of output then the choice is to extend the source-based breakdown with decomposition by sector of origin. You can also combine different sectoral decompositions, for instance, to account for the value-added in a bilateral trade flow in a particular sector of origin intended for a specific sector of consumption, use $\widehat{\mathbf{V}}_j$ and $\widehat{\mathbf{Y}}_{kl}$ simultaneously. In the particular empirical analysis, there might be an interest in measuring the value-added of country *s* that enters in the exports between country *s* and country *r* in a specific industry. From this point, B&M (2019) propose a decomposition based on a pure sectoral-bilateral perspective which means that a specific component is recorded as double-counted only when it is exported several times to the same partner within the same industry. B&M (2019) proceed in the same way as the other breakdowns to define a modified version of the input requirement matrix in which all the coefficients corresponding to the intermediate exports from *s* to *r* in (exporting) sector *n* is set to zero:

$$\mathbf{A}^{sr,n} = \begin{bmatrix} \mathrm{a}_{11,11} & \cdots & \mathrm{a}_{1r,11} & \cdots & \mathrm{a}_{1r,1n} & \cdots & \mathrm{a}_{1r,1N} & \cdots & \mathrm{a}_{1G,1N} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \mathrm{a}_{s1,11} & \cdots & \mathrm{a}_{sr,11} & \cdots & \mathrm{a}_{sr,1n} & \cdots & \mathrm{a}_{sr,1N} & \cdots & \mathrm{a}_{sG,1N} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \mathrm{a}_{s1,n1} & \cdots & 0 & \cdots & 0 & \cdots & 0 & \cdots & \mathrm{a}_{sG,nN} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \mathrm{a}_{G1,N1} & \cdots & \mathrm{a}_{Gr,N1} & \cdots & \mathrm{a}_{Gr,Nn} & \cdots & \mathrm{a}_{Gr,NN} & \cdots & \mathrm{a}_{GG,NN} \end{bmatrix} \quad (25)$$

The corresponding inverse Leontief matrix is:

$$\mathbf{B}^{sr,n} = (\mathrm{I} - \mathbf{A}^{sr,n})^{-1} \quad (26)$$

As in previous cases, B&M (2019) derive exports decomposition from a sectoral-bilateral perspective:

$$\begin{aligned} \mathrm{e}_{sr,n} = {} & \mathbf{V}_s\mathbf{B}_{ss}^{sr,n}\mathbf{E}_{sr,n} + \mathbf{V}_s\mathbf{B}_{ss}^{sr,n}\mathbf{A}_{sr}\mathbf{B}_{rs}\mathbf{E}_{sr,n} + \sum_{t\neq s}^{G} \mathbf{V}_t\mathbf{B}_{ts}^{sr,n}\mathbf{E}_{sr,n} \\ & + \sum_{t\neq s}^{G} \mathbf{V}_t\mathbf{B}_{ts}^{sr,n}\mathbf{A}_{sr}\mathbf{B}_{rs}\mathbf{E}_{sr,n} \end{aligned} \quad (27)$$

Where $\mathbf{E}_{sr,n}$ is an *N*×*1* vector with the scalar corresponding to the gross exports from *s* to *r* in position *n* (i.e. $\mathrm{e}_{sr,n}$) and zeros elsewhere. The first term in the RHS of equation (27) is a sectoral-bilateral perspective $\mathbf{DVA}_{sr}^{\S}$, the second term in the RHS is a sectoral-bilateral perspective $\mathbf{DDC}_{sr}^{\S}$ and the sum of these two terms account for the domestic content ($\mathbf{DC}_{sr}$). The third term in the RHS is the sectoral-bilateral perspective $\mathbf{FVA}_{sr}^{\S}$, the fourth term in the RHS is a sectoral-bilateral perspective $\mathbf{FDC}_{sr}^{\S}$) and the sum of these two terms account for the foreign content ($\mathbf{FC}_{sr}$).

When the focus is on all the exports of a country in a specific sector without taking into account any particular bilateral importer, B&M (2019) derive a decomposition of a country's aggregate sectoral

exports based on a sectoral-level perspective. Where the domestic and foreign value-added embedded in total exports of country *s* and industry *n* ($\sum_{r\neq s} \mathrm{e}_{sr,n}$) considered in a similar way to the sectoral bilateral breakdown (see equation (27)). In this case, they amend the matrix of technical coefficients **A** where $\mathrm{a}_{sj,n}$ is set to zero $\forall\ j \neq s$; thus the inverse Leontief matrix is calculated accordingly. In some cases, there might be the need to uncover the output (GDP) of country *j* that enters, directly or indirectly in the total imports of country *r*. From this point, B&M (2019) adopt a procedure similar to that applied to derive the exporting country-level perspective where the total gross imports of country *r* can be decomposed as follows:

$$\mathbf{u}_n\mathbf{E}_{*r} = \sum_j^G \mathbf{V}_j \sum_{s\neq r} \tilde{\mathrm{B}}_{js}^{\prime} \mathbf{E}_{sr} + \sum_j^G \mathbf{V}_j \sum_{t\neq r} \tilde{\mathrm{B}}_{jt}^{\prime} \sum_{s\neq r} \mathbf{A}_{tr}\mathbf{B}_{rs}\mathbf{E}_{sr} \quad (28)$$

Where $\tilde{\mathrm{B}}_{js}^{\prime}$is the Leontief inverse block matrix computed from a technical coefficient matrix **A** where the sub-blocks $\mathbf{A}_{tr}$ are set to zero $\forall\ t \neq r$. The first term in the RHS of equation (28) records importer perspective value-added and the second term accounts for importer perspective double-counted. Here they don't use the distinction between domestic and foreign value-added since this distinction applies to the exporting country (the domestic items). At this point, B&M (2019) modify the decomposition in (28) to distinguish the value-added produced in country *j* that is embedded in the total import of country *r* in a given sector *n*. This can be derived by replacing the matrix $\tilde{\mathrm{B}}_{js}^{\prime}$ with a Leontief inverse $\tilde{\mathrm{B}}_{js}^{r,n}$ based on a technical coefficient matrix where only the elements $\mathrm{a}_{tr,n}$ are set to zero $\forall\ t \neq r$.

4.6.Decomposition of foreign content of exports: the distinction between FVA and FDC

Based on the country-level perspective proposed by B&M (2019), the foreign double counted (**FDC**) items include only components that cross the same exporter's border more than once. Other studies (i.e. Koopman et al., (2014), Wang et al., (2013), Nagengast and Sterher (2016), Miroudot and Ye (2018)), which also use a country-level perspective for the domestic component, apply the different approach for the foreign content of exports; a particular component is recorded as value-added only the first or the last time it crosses a foreign border, whereas all the other times it crosses any foreign border it is considered as double counted B&M (2019).

This approach is termed the world-level perspective because it takes into account all trade flow not only the exports of one country to identify the components that are exported multiple times. Therefore at the country-level perspective, a specific component is considered as **FVA** only once in the total exports of a country, whereas at the world-level perspective is classified as **FVA** only once in total world exports (B&M, 2019). To better understand the distinction between the two frameworks, it is necessary to present the decompositions of the foreign content of export from a world-level perspective. At this point, B&M (2019) propose a source-based decomposition where a specific component is considered as foreign value-added the first time it is re-exported by a country other than the country of origin and they also consider the country of final completion and the final destination market (Miroudot and Ye (2018) follow similar approach) as follows:

$$\begin{aligned}\mathbf{FVA}source_{sr}^{WP} = {} & \sum_{t\neq s}^G \mathbf{V}_t(\mathrm{I}-\mathbf{A}_{tt})^{-1}\mathbf{A}_{ts}\,(\mathrm{I}-\mathbf{A}_{ss})^{-1}\,[\mathbf{Y}_{sr} + \mathbf{A}_{sr}\,(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} \\ & + \mathbf{A}_{sr}\,(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^G \mathbf{Y}_{rj} + \mathbf{A}_{sr}\,(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^G \mathbf{A}_{rj}\sum_k^G\sum_l^G \mathbf{B}_{jk}\mathbf{Y}_{kl}] \quad (29)\end{aligned}$$

$$\mathbf{FDC}source_{sr}^{WP} = \sum_{t\neq s}^G \mathbf{V}_t(\mathrm{I}-\mathbf{A}_{tt})^{-1}[\sum_{j\neq t,s}^G \mathbf{A}_{tj}\mathbf{B}_{js}\mathbf{E}_{sr} + \mathbf{A}_{ts}(\mathrm{I}-\mathbf{A}_{ss})\sum_{t\neq s}^G \mathbf{A}_{st}\mathbf{B}_{ts}\mathbf{E}_{sr} \quad (30)$$

While in the sink-based approach, B&M (2019) propose a framework where a given item is considered foreign value-added the last time it is exported by a country that is not the country of origin (Koopman et al., (2014)) adopt the same approach but this part in their methodology faces some limitations (see the following section)) as follows:

$$\mathbf{FVA}sink_{sr}^{WP} = \sum_{t\neq s}^G \mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} + \sum_{t\neq s}^G \mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}\,(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr}$$

$$+ \mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}\ (\mathrm{I} - \mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{Y}_{rj} + \sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I} - \mathbf{A}_{jj})^{-1}\mathbf{Y}_{jj}\right] \quad (31)$$

$$\mathbf{FDC}sink_{sr}^{WP} = \sum_{t\neq s,r}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\mathbf{E}_{r*} + \mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}\ (\mathrm{I} - \mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I} - \mathbf{A}_{jj})^{-1}\mathbf{E}_{j*} \quad (32)$$

The distinction between the **FVA** and the **FDC** from a world perspective will be useful when the aim is the decomposition of world aggregate trade but not in the decomposition of gross exports of a particular country (i.e. country-level). Consider the following example: Kenya imports intermediate inputs directly from Ghana and indirectly from the UK; according to a source-based approach the Ghanian value-added is accounted as **FVA** in Kenyan exports while the British value-added is considered as **FDC**, even if the two components contribute in very a similar way to the value embedded in Kenyan exports. From this point of view of the exporting country (Kenya), B&M (2019) allow us to measure the share of exports that can be traced back to the domestic and foreign GDP, independently from the number of upstream or downstream production stages that separate the exporting country from the country of origin and/or the final destination market. They exclude from the **FVA** only the components that cross the same (domestic) border more than once.

The foreign value-added measures at a country-level perspective are useful for considering the share of a country's exports that can be traced back to another country's GDP i.e. the part of a country's GDP that is embedded into the exports of another particular country or a bilateral trade flow. Whereas the **FVA** indicators at the world-level perspective can be used to uncover the portion of a country *s*'s GDP embedded in other countries' exports.

5. B&M (2019) VERSUS OTHER CONTRIBUTIONS

Here this study discusses the main limitations of the other contributions in the literature and how B&M (2019) address these issues to decide which model is appropriate for this study. B&M (2019) develop a comprehensive decomposition framework of trade flows at the aggregate, bilateral, and sectoral levels and assessment of the share of trade-related to GVCs which refines the vertical specialization (**VS**) measure proposed by Hummels et al., (2001). They also refine and extend Koopman et al., (2014) decomposition framework.

First, the focus will be on the contribution of Hummels et al., (2001) which is the first to propose the **VS** indicator to account for the import content of export and can be calculated for bilateral exports (see equation 1). This indicator decomposes aggregate exports into items produced domestically and imported intermediates contained in exports (account for direct and indirect production networks within the domestic market). **VS** measure is a good indicator of a country's participation in downstream stages of GVCs. But it accounts for imported intermediate inputs in exports as a single category, without separating between the part generated abroad and the part that was produced at home and then re-imported again by the country of origin (B&M, 2019). Some recent studies by Johnson & Noguera (2012), Koopman et al., (2014), and Los et al., (2016) have addressed these issues without proposing a full answer (Johnson, 2018). B&M (2019) propose a precise indicator (based on the bilateral source-based approach) of the share of exports related to forward supply linkages (**GVC**$forward$ or **VS1**) and the **GVC**$backward$ indicator corresponding to the **VS** Index. The **GVC**$forward$ indicator is the first correct implementation of the **VS1** measure of Hummels et al., (2001) (See equations (11) and (12)).

Second, the measures of gross exports decompositions contain double-counted items that cross *s*'s national borders many times during production stages. Thus it is necessary to identify the double-counted items to account for pure value-added contained in exports. To address this issue, Johnson and Noguera (2012) propose an indicator of the share of *s*'s production (GDP) that is consumed abroad (the (**VAX**) value-added export) see equation (5). Although **VAX** is a good indicator to evaluate the connection between production and a given final destination market, it doesn't identify the trade linkages through which the value-added originated in a given country *s* reaches the final destination

market and it doesn't consider the part that is later re-imported and consumed domestically in *s* (B&M, 2019).

Third, to estimate a country's integration into international production networks, this work needs precise indicators of the value-added consumed directly and indirectly by the final demand of the importing country. At this point, B&M (2019) framework decomposes the gross bilateral exports to disentangle the total domestic value-added consumed by bilateral importers (**VAXIM**), and the part that is directly consumed by the importing country, without any further processing stage abroad or at home (**DAVAX**). These measures cannot be obtained by the bilateral exports decomposition framework proposed by Wang et al., (2013) (B&M, 2019). Some literature that based their decomposition of foreign content of exports on Koopman et al., (2014) approach incorrectly classifies the part of the foreign value-added in exports; some items can be classified as **FDC** even if they are never recorded as foreign value-added (B&M, 2019). Specifically, this limitation is evident in the bilateral exports breakdown proposed by Wang et al., (2013). Moreover, this methodology is also a mix between sink and source approaches at the same time to distinguish various items, then it suffers from internal inconsistency (B&M, 2019). Besides Wang et al., (2013), there are also other decomposition methodologies that adopt Koopman et al., (2014) decomposition framework and suffer their limitations.

Fourth, Although Nagengast and Sterher (2016) propose the source-based and sink-based approaches to consider the value-added items that are generated and consumed at the bilateral level, they don't adopt a particular strategy to distinguish value-added from double-counted components. Based on B&M (2019), the decomposition methodology of Nagengast and Sterher (2016) suffers the following limitations: 1) They don't separate value-added from double-counted components. Instead, they differentiate between components that are considered as domestic content of exports and components that are part of the foreign content of exports. 2)Their definitions of the domestic value-added finally consumed at home and in third countries generate an overestimation of the domestic value-added in exports because it contains double-counted items.

Since Nagengast and Sterher (2016) focus on the role of final demand in generating bilateral trade balances, B&M (2019) propose a sink-based approach to overcome the limitations of Nagengast and Sterher (2016). The appropriate indicator of this component is given by the **VAXIM** of equation (24) which differs from Nagengast and Sterher's (2016) indicator. They consider values embedded in products that don't leave the country again as domestic value-added consumed by direct importers and the remainder accounted for as the double-counted items. At this point, Nagengast and Sterher (2016) don't consider $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr}$, $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr}]$ and $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{kr}]$ components in equation (E.2) which underestimate the domestic value-added consumed by direct importers (B&M, 2019).

To sum up, in general, the sectoral and bilateral exporter-importer trade flows are overlooked by some methodologies. At this point, some particular methodological problems occur when accounting for trade flows at a more disaggregated level instead of an aggregate level. To address these methodological issues, B&M (2019) propose a comprehensive value-added breakdown framework of exports and imports at the aggregate, bilateral and sectoral levels by applying ICIO tables to evaluate countries and sectors' integration into GVCs. Therefore; based on the limitations of previous contributions to the literature and the refinements of these limitations by B&M (2019), this study considers this framework decomposition, is the most appropriate model to address the research questions. Besides the fact that this model allows us to account for the value-added at aggregate, bilateral and sectoral perspectives (see table G.1 appendix G), it also provides a precise measure of trade flows related to global sharing of production (GVC-related trade activities) which is the topic of the following section.

6. HIGHLIGHTS ON ACP-UK/EU-27 GVCs TRADE

6.1. ACP-UK/EU-27 direct trade relations from gross to value-added exports: bloc level

To investigate the involvement of ACP, UK, and EU-27 in international demand network activities, this work uses EORA26; the Inter-Country Input-Output (ICIO) table for the year 2015. This study uses the simplified model of EORA26 where all countries have been aggregated to a common 26-sector classification and the supply-use tables for 188 countries (table 3). Table 4 presents the Final Demand (FD), Value-added (VA), and industry classification for EORA26 in 2015. Where FD, VA, and industry in each country, decomposed into 6 sectors, 6 sectors and 26 sectors respectively, however for simplicity in table (5) this study shows just 2 countries instead of 188 countries, two sectors, two FD and VA for two countries only.

The EORA data is divided into transactions matrix (intermediate good flows between sectors) T or Z, primary inputs or value-added (VA), and final demand block (FD). Table (5) shows the structure of the EORA26 Input-Output (IO) table (i.e. representation of supply and demand interactions among sectors/countries). Yellow shading indicates flows between domestic sources (row) and domestic destinations. FD (or Y) bloc presents trade flows to final consumers. Final good consumption columns show the value of a rows' output consumed as final goods but not used in the production process. Where import by final consumers is calculated as the sum of imports by FD (household final consumption, government final consumption, etc). In IO table gross input is equal to gross output (xin = xout). Whereas VA is computed as the difference between the total input and the sum of transactions (T). While total exports are computed as the sum of exports to companies and exports to direct foreign final consumers. Where export to companies is calculated as the sum of cross-border transactions (T) the blue shading cells (table 5). Export to direct foreign final consumers is computed as the sum of final demand except for the green shading cells.

The matrix of technical coefficients A (table 5) conveys how many different types of goods and services are required to produce one unit of output. It shows all direct impacts on output in one industry needed by an output unit from another industry. The Leontief inverse (L = (I-A)^-1) can be obtained by subtracting the technical coefficient matrix from the identity matrix I (with one on the main diagonal and zeros elsewhere) and then invert the I-A matrix. The matrix L shows the network impacts created by the change in the final output. Matrix L coefficient represents direct and indirect output required from sector j to supply a single unit of final demand for sector k.

This study starts with ACP-UK/EU-27 bilateral trade relations comparing gross and net export shares. Export shares are calculated as value-added that originates in a specific country which is the exporter of the value-added and absorbed by another country (foreign market) which is the importer. ACP's total gross exports in 2015 amounted to $259.3 billion of which only 4.73 percent ($12.3 billion) went to the UK (table 6). While the EU-27 received about 27 percent ($69 billion) of total ACP's exports in the same year (table 6).

At the value-added (VA) level, the total ACP's VA directly consumed by the UK's final demand is reached $7.4 billion which amounted to 60 percent of total ACP's exports to the UK in 2015 (table 7). The total ACP's VA directly consumed by the final demand in the EU-27 is about $42 billion which amounted to about 61 percent of total ACP's exports to the EU-27 in 2015 (table 9). But at the bloc level, the picture is very different. There is heterogeneity among ACP regions. For instance, the UK received only 5 percent ($11 billion) of total exports of African EPA blocs to the world (table 6) and absorbed about $7 billion total value-added of African EPA blocs which is 60 percent of total exports of African EPA blocs to the UK (table 7). But the UK received only around 2 percent ($905 million) of total gross exports of Caribbean+Pacific EPA blocs to the world (table 6) and consumed $568 million total value-added of Caribbean+Pacific EPA blocs which is about 63 percent of total exports of Caribbean+Pacific EPA blocs to the UK (table 7).

Whereas 29 percent ($66 billion) of total gross exports of African EPA blocs in 2015 went to the EU-27 (table 6), and the EU-27 absorbed $40 billion of total value-added of African EPA blocs which is about 61 percent of total exports of African EPA blocs to the EU-27 (table 8). The EU-27 received about 10 percent ($3.6 billion) of total gross exports of Caribbean+Pacific blocs (table 6) and consumed $2 billion total value-added of Caribbean+Pacific EPA blocs which is about 59 percent of total exports

of Caribbean+Pacific EPA blocs to the EU-27 (table 8). The overall exposure of ACP to the UK is lower than exposure to the EU-27, on average around 5 parent and 27 percent respectively (table 6). So the UK and the EU-27 received a higher level of gross exports and value-added from African EPA blocs than from Caribbean+Pacific blocs; proximity matters in international trade.

Table 5 shows the structure of the EORA26 Input-Output (IO) table for 2015

No								FD (or Y) block:							
1															
2			Country 1	Country 1	Country 2	Country 2		Country 1 Final Demand	Country 1 Final Demand	Country 2 Final Demand	Country 2 Final Demand	Gross output	Exports		
3		T (or Z)	Sector 1	Sector 2	Sector 1	Sector 2		Households	Change in Inventory	Households	Change in Inventory	xout	Total	To companies	To direct foreign final consumers
4	Country 1	Sector 1													
5	Country 1	Sector 2													
6	Country 2	Sector 1													
7	Country 2	Sector 2													
8	VA (or PI, Primary Inputs) block:														
9	Country 1	Value Added													
10	Country 2	Value Added													
11	**Total input**	xin													
12	Country 1														
13	Country 1														
14	Country 2	**A**													
15	Country 2														
16															
17	Country 1		1	0	0	0									
18	Country 1	I	0	1	0	0									
19	Country 2		0	0	1	0									
20	Country 2		0	0	0	1									
21															
22	Country 1														
23	Country 1	(I-A)													
24	Country 2														
25	Country 2														
26															
27	Country 1	**Leontief inverse:**													
28	Country 1														
29	Country 2	$L = (I-A)^{\wedge -1}$													
30	Country 2														

Source: EORA input-output table for 2015

Table 7 shows the decomposition of bilateral exports of ACP blocs to the UK for the year 2015

Bloc	ACP exports to the world in $ millions	ACP gross exports (GEXP) to UK in $ millions	Share (%) of gross exports (GEXP) to the UK											
			Domestic content (DC)	Domestic Value-Added (DVA)	VAX ->DVA absorbed abroad	VA directly absorbed by the UK (DAVAX)	Reflection	Domestic double counting (DDC)	Foreign content (FC)	Foreign Value-Added (FVA)	Foreign double counting (FDC)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
SADC	130,721.93	8,252.00	85.28	85.22	84.85	57.53	0.38	0.06	14.72	14.71	0.01	42.47	14.78	27.69
West Africa	52,978.18	1,206.18	92.34	92.32	92.08	70.80	0.25	0.01	7.66	7.66	0.00	29.20	7.68	21.52
Central Africa	16,545.48	150.70	90.83	90.82	90.80	67.22	0.02	0.01	9.17	9.17	0.00	32.78	9.18	23.60
ESA	14,601.90	1,113.11	75.39	75.37	75.35	62.48	0.02	0.01	24.61	24.61	0.00	37.52	24.63	12.89
EAC	7,563.80	646.43	87.82	87.81	87.74	69.96	0.08	0.00	12.18	12.18	0.00	30.04	12.19	17.85
Caribbean	29,902.13	663.25	79.28	79.26	78.95	61.03	0.31	0.02	20.72	20.72	0.00	38.97	20.74	18.23
Pacific	6,999.51	242.48	86.63	86.62	86.62	67.49	0.00	0.01	13.37	13.37	0.00	32.51	13.38	19.13
ACP average	37,044.70	1,753.45	85.37	85.35	85.20	65.22	0.15	0.02	14.63	14.63	0.00	34.78	14.65	20.13
African EPA blocs	222,411.29	11,368.42	85.28	85.23	84.93	60.26	0.31	0.05	14.72	14.71	0.01	39.74	14.77	24.97
Caribbean+Pacific	36,901.64	905.73	81.25	81.23	81.00	62.76	0.23	0.02	18.75	18.75	0.00	37.24	18.77	18.47
Total ACP exports to the world	259,312.93	12,274.15	84.98	84.94	84.64	60.45	0.30	0.04	15.02	15.01	0.01	39.55	15.06	24.49
Source: Author's calculation based on EORA input-output table for 2015														
Total DAVAX is $7.4 billions														

Table 8 decomposition of bilateral exports of ACP blocs to the EU-27 for the year 2015

Bloc	ACP exports to the world in $ millions	ACP gross exports (GEXP) to EU-27 in $ millions	Share (%) of gross exports (GEXP) to the EU-27											
			Domestic content (DC)	Domestic Value-Added (DVA)	VAX ->DVA absorbed abroad	VA directly absorbed by the EU-27 (DAVAX)	Reflection	Domestic double counting (DDC)	Foreign content (FC)	Foreign Value-Added (FVA)	Foreign double counting (FDC)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
SADC	130,721.93	30,491.49	84.99	84.94	84.54	55.68	0.40	0.06	15.01	14.99	0.01	44.32	15.06	29.26
West Africa	52,978.18	22,650.56	93.58	93.57	93.29	66.77	0.28	0.01	6.42	6.42	0.00	33.23	6.43	26.80
Central Africa	16,545.48	5,625.35	92.41	92.40	92.25	62.05	0.15	0.01	7.59	7.59	0.00	37.95	7.60	30.35
ESA	14,601.90	4,426.05	79.71	79.70	79.67	60.78	0.04	0.01	20.29	20.28	0.00	39.22	20.30	18.93
EAC	7,563.80	2,383.21	86.55	86.54	86.48	61.27	0.07	0.00	13.45	13.45	0.00	38.73	13.46	25.27
Caribbean	29,902.13	2,704.05	81.52	81.50	81.29	57.28	0.21	0.02	18.48	18.48	0.00	42.72	18.50	24.22
Pacific	6,999.51	870.33	89.21	89.20	89.20	64.27	0.00	0.01	10.79	10.79	0.00	35.73	10.80	24.93
Average	37,044.70	9,878.72	86.85	86.84	86.67	61.16	0.16	0.02	13.15	13.14	0.00	38.84	13.16	25.68
African EPA blocs	222,411.29	65,576.66	88.30	88.26	87.97	60.60	0.30	0.03	11.70	11.70	0.01	39.40	11.74	27.66
Caribbean+Pacific	36,901.64	3,574.38	83.39	83.38	83.21	58.99	0.16	0.02	16.61	16.61	0.00	41.01	16.62	24.39
Total ACP exports to the world	259,312.93	69,151.04	88.04	88.01	87.72	60.52	0.29	0.03	11.96	11.95	0.01	39.48	11.99	27.49
Source: Author's calculation based on EORA input-output table for 2015														
Total DAVAX is about $42 billions														

UK market is an export destination for EAC, ESA, and SADC, with a gross share of about 9 percent, 8 percent, and 6 percent respectively (table 6). The share of overall ACP's value-added consumed by the UK final demand amounted to on average 65 percent of gross exports of ACP to the UK (figure 4). While the EU market is an extremely significant export destination for WA, CA, EAC, ESA, and SADC, with 43 percent, 34 percent, 31 percent, 30 percent, and 23 percent respectively (table 6). The share of overall ACP's value-added consumed by the EU-27 final demand amounted to on average 61 percent of gross exports of ACP to EU-27 (figure 5). The UK's total gross exports in 2015 were amounted to about $811 billion of which about 4 percent ($32 billion) went to the ACP (table 9).

Table 9 decomposition of bilateral exports of UK to the ACP blocs for the year 2015

Bloc	UK gross exports (GEXP) to ACP in $ millions	Share (%) of exports											
		Domestic content (DC)	Domestic Value-Added (DVA)	VAX ->DVA absorbed abroad	VA directly absorbed by the ACP (DAVAX	Reflection	Domestic double counting (DDC)	Foreign content (FC)	Foreign Value-Added (FVA)	Foreign double counting (FDC)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
SADC	10,498.81	71.17	70.41	69.75	59.71	0.66	0.75	28.83	28.59	0.25	40.29	29.59	10.70
West Africa	7,716.56	70.86	70.10	69.98	67.08	0.12	0.76	29.14	28.89	0.25	32.92	29.90	3.02
Central Africa	417.06	73.29	72.59	72.45	66.70	0.14	0.70	26.71	26.48	0.23	33.30	27.41	5.89
ESA	1,090.17	71.88	71.15	70.51	64.23	0.63	0.73	28.12	27.88	0.24	35.77	28.85	6.92
EAC	2,834.40	72.25	71.53	71.31	68.74	0.22	0.72	27.75	27.52	0.23	31.26	28.47	2.79
Caribbean	8,958.79	64.72	63.93	63.88	62.95	0.05	0.79	35.28	35.01	0.26	37.05	36.07	0.98
Pacific	64.09	75.15	74.49	74.10	62.89	0.39	0.66	24.85	24.64	0.21	37.11	25.51	11.60
Average	4,511.41	71.33	70.60	70.28	64.61	0.32	0.73	28.67	28.43	0.24	35.39	29.40	5.99
African EPA blocs	22,556.99	71.27	70.52	70.11	63.71	0.41	0.75	28.73	28.48	0.25	36.29	29.48	6.81
Caribbean+Pacific	9,022.88	64.80	64.00	63.95	62.95	0.05	0.79	35.20	34.94	0.26	37.05	36.00	1.06
Total	31,579.86	69.42	68.66	68.35	63.49	0.31	0.76	30.58	30.33	0.25	36.51	31.34	5.16
Source: Author's calculation based on EORA input-output table for 2015													

Notes: The UK's total exports to the world are $ 810,908.04 million. The total share of UK exports to African EPA blocs is only 2.78 percent. The total share of UK exports to Caribbean+Pacific is only 1 percent

African EPA blocs received $23 billion (about 3 percent of the UK's exports) and Caribbean+Pacific blocs received $9 billion (1 percent of the UK's exports). At the value-added level, the share of the UK's value-added consumed by final demand in ACP is amounted to on average about 65 percent (about $21 billion) of the UK's gross exports to ACP (figure 6). While the total gross exports of the EU-27 in 2015 was amounted to about $3.6 trillion of which about 3.5 percent ($126 billion) went to the ACP (table 10). African EPA blocs received $110 billion (about 3 percent of EU-27 exports) and Caribbean+Pacific blocs received about $16 billion (0.43 percent of EU-27 exports). At the value-added level, the share of EU-27 value-added consumed by final demand in ACP is amounted to on average about 73 percent (about $92 billion) of EU-27 gross exports to ACP (figure 7).

Table 10 decomposition of bilateral exports of EU-27 to the ACP blocs for the year 2015

Bloc	EU-27 gross exports (GEXP) to ACP in $ millions	Share (%) of exports											
		Domestic content (DC)	Domestic Value-Added (DVA)	VAX ->DVA absorbed abroad	VA directly absorbed by the ACP (DAVAX	Reflection	Domestic double counting (DDC)	Foreign content (FC)	Foreign Value-Added (FVA)	Foreign double counting (FDC)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
SADC	52,359.95	81.02	79.79	77.54	68.40	2.24	1.23	18.98	18.65	0.33	31.60	20.21	11.39
West Africa	35,045.00	81.42	80.25	79.05	76.71	1.20	1.18	18.58	18.26	0.31	23.29	19.75	3.54
Central Africa	11,286.51	81.85	80.68	79.54	76.53	1.14	1.17	18.15	17.84	0.31	23.47	19.32	4.16
ESA	5,446.38	83.23	82.15	79.14	72.89	3.00	1.08	16.77	16.48	0.29	27.11	17.85	9.26
EAC	6,096.05	79.85	78.65	77.93	75.37	0.72	1.21	20.15	19.82	0.32	24.63	21.35	3.27
Caribbean	15,350.00	74.34	72.89	72.58	69.69	0.31	1.45	25.66	25.27	0.39	30.31	27.11	3.21
Pacific	231.89	83.11	82.06	80.65	68.33	1.41	1.06	16.89	16.61	0.28	31.67	17.94	13.72
Average	17,973.68	80.69	79.49	78.06	72.56	1.43	1.20	19.31	18.99	0.32	27.44	20.51	6.93
African EPA blocs	110,233.90	81.28	80.08	78.33	72.48	1.75	1.20	18.72	18.40	0.32	27.52	19.92	7.60
Caribbean+Pacific	15,581.88	74.47	73.03	72.70	69.67	0.33	1.44	25.53	25.14	0.39	30.33	26.97	3.36
Total	126,047.67	80.44	79.21	77.63	72.12	1.58	1.23	19.56	19.23	0.33	27.88	20.79	7.09

Source: Author's calculation based on EORA input-output table for 2015

Notes:

EU-27 total exports to the world are $ 3,631,194.95 million. The total share of EU-27 exports to African EPA blocs is only 3 percent. The total share of EU-27 exports to Caribbean+Pacific is less than 1 percent (i.e. 0.43 %)

6.2.ACP countries trade with UK/EU-27: country level

Table (12) shows the 58 ACP countries' trade (shares %) with the UK and the EU-27: gross and value-added exports by country in 2015. At the country level, the UK and EU markets represent the main destinations for many ACP countries as follows:

SADC states:

UK market is the main export destination for Botswana, Swaziland, and South Africa. Botswana's total exports in 2015 were over $1 billion of which about 30 percent ($314 million) went to the UK (table 11). The total value-added of Botswana directly consumed by the UK is amounted to about $221 million (table 12) which is 70 percent of the gross exports of Botswana to the UK (table 11). Swaziland's total exports are over $1 billion of which about 9 percent ($97 million) went to the UK (table 11).

The total value-added of Swaziland directly consumed by the UK is amounted to about $56 million (table 12) which is 57 percent of the gross exports of Swaziland to the UK (table 11). South Africa's total exports are over $118 billion of which about 7 percent ($8 billion) went to the UK (table 11). The total value-added of South Africa directly consumed by the UK is amounted to over $4 billion (table 12) which is 56 percent of the gross exports of South Africa to the UK (table 11). These figures suggest that the value-added of SADC's countries exported to the UK might often be re-exported to other foreign markets.

Table 12 demonstrates that value-added shares of all SADC countries in the UK final demand are higher than the share of gross exports; meaning that the UK market stimulates ACP production more than traditional trade statistics might explain. While the EU-27 market represents an important export destination for Namibia, Mozambique, South Africa, and Swaziland. Namibia's total exports are over $2 billion of which 31 percent ($671 million) went to the EU-27 (table 11). The total value-added of Namibia directly consumed by the EU-27 amounts to $408 million (table 12) which is 61 percent of the gross exports of Namibia to the EU-27 (table 11). Mozambique's total exports are over $900 million of which 25 percent ($227 million) went to the EU-27 (table 11).

Table 11 shows ACP (58 countries) trade to the UK, EU-27, and the RoW (shares %): gross and value-added exports by country in 2015

Bloc/country	ACP Total exports to the world in $ millions	UK		EU-27	
		Share (%) of ACP gross exports to UK	ACP's Value-added directly consumed by UK; share (%) of gross exports	Share (%) of ACP gross exports to EU-27	ACP's Value-added directly consumed by EU-27; share (%) of gross exports
SADC:					
AGO	26,108.09	0.05	67.09	11.13	61.77
BWA	1,058.64	29.63	70.32	6.22	54.69
LSO	303.80	1.46	39.43	9.89	39.11
MOZ	900.71	1.16	57.33	25.21	69.53
NAM	2,148.26	4.92	68.44	31.21	60.89
SWZ	1,128.96	8.60	57.27	12.99	52.43
ZAF	118,444.51	6.51	55.84	22.33	54.12
WA:					
BEN	590.68	0.49	54.75	10.94	71.02
BFA	297.17	0.82	46.26	34.36	68.87
CIV	7,150.76	2.66	75.77	54.31	71.88
CPV	260.29	1.56	56.29	10.63	60.94
GHA	5,344.45	6.43	77.13	48.27	64.62
GIN	1,485.72	0.27	59.28	61.16	54.42
GMB	117.39	4.46	66.92	15.17	60.92
LBR	948.33	1.27	64.86	37.27	63.89
MLI	731.47	1.89	70.96	19.70	74.16
MRT	1,795.08	0.60	59.39	47.50	65.03
NER	566.62	0.59	52.31	35.27	63.12
NGA	32,763.40	1.66	66.22	35.56	65.17
SEN	2,623.95	2.05	66.87	60.75	73.85
SLE	362.90	2.47	56.64	34.25	68.86
TGO	973.27	0.71	60.27	15.14	70.54
CA:					
CAF	250.34	0.84	54.70	39.45	61.94
CMR	4,084.95	2.65	69.58	62.94	66.81
COD	2,669.65	0.44	66.48	60.55	50.86
COG	4,473.64	0.22	61.15	7.09	63.55
GAB	4,415.08	0.16	60.24	16.98	63.73
STP	152.06	1.55	42.64	12.97	55.71
TCD	869.05	1.11	60.42	29.06	77.06
ESA:					
DJI	258.76	1.40	54.70	8.87	65.51
ERI	290.83	1.73	59.35	11.47	69.48
ETH	2,293.83	2.83	62.21	33.57	54.34
MDG	2,348.70	2.28	75.36	50.95	70.72
MUS	3,506.55	21.34	57.90	38.67	53.44
MWI	1,102.29	5.90	70.65	25.65	65.87
SUD	134.20	3.08	59.50	6.65	74.86
SYC	770.42	13.03	78.70	36.10	67.30
ZMB	4,273.12	1.60	67.76	11.17	56.80
EAC:					
BDI	244.26	1.90	59.72	22.32	64.20
KEN	6,178.80	9.40	70.74	27.16	61.17
RWA	226.83	1.59	54.29	16.48	59.66
SDS	514.79	1.33	63.27	5.20	78.05
TZA	1,530.72	1.92	54.79	23.12	54.49
UGA	1,028.15	2.08	69.14	22.63	65.11
Caribbean:					
ATG	246.17	1.45	50.85	25.68	51.21
BHS	1,037.51	7.47	64.80	42.19	58.26
BLZ	638.33	7.72	69.41	9.17	64.10
BRB	1,087.26	4.89	47.79	4.04	58.30
DOM	8,259.09	0.65	68.01	7.94	63.52
GUY	1,133.79	14.14	57.26	24.81	52.52
HTI	835.43	0.47	62.33	7.65	64.51
JAM	2,028.97	9.12	55.74	15.19	44.25
SUR	1,009.29	2.17	72.13	37.63	51.93
TTO	25,082.43	0.22	67.36	1.64	60.25
Pacific:					
FJI	1,236.73	9.07	67.04	3.54	62.87
PNG	5,194.14	2.40	68.60	15.13	64.49
VUT	335.00	0.85	49.15	7.55	60.72
WSM	253.59	1.02	51.31	6.02	61.05
Source: Author's calculation based on EORA input-output table for 2015					

The total value-added of Mozambique directly consumed by the EU-27 amounts to $158 million (table 12) which is 70 percent of the gross exports of Mozambique to the EU-27 (table 11). South Africa's total exports are over $118 Billion of which 22 percent ($26 billion) went to the EU-27 (table 11). The total value-added of South Africa directly consumed by the EU-27 amounts to $14 billion (table 12) which is 54 percent of the gross exports of South Africa to the EU-27 (table 11). Swaziland's total exports are over $1 Billion of which 13 percent ($147 million) went to the EU-27 (table 11). The total value-added of Swaziland directly consumed by the EU-27 amounts to $77 million (table 12) which is 52 percent of the gross exports of Swaziland to the EU-27 (table 11).

West Africa (WA) countries:

EU-27 market is extremely important for exports from Senegal, Guinea, Côte d'Ivoire, Ghana, Mauritania, Liberia, Nigeria, Niger, Burkina Faso, and Sierra Leone. Senegal's total exports are over $2.6 Billion of which 61 percent ($1.6 billion) went to the EU-27 (table 11). The total value-added of Senegal directly consumed by the EU-27 amounts to $1.2 billion (table 12) which is 74 percent of the gross exports of Senegal to the EU-27 (table 11). Guinea's total exports are over $1.5 Billion of which 61 percent ($907 million) went to the EU-27 (table 11). The total value-added of Guinea directly consumed by the EU-27 amounts to $494 million (table 12) which is 54 percent of the gross exports of Guinea to the EU-27 (table 11).

Côte d'Ivoire's total exports are over $7 Billion of which 54 percent ($3.9 billion) went to the EU-27 (table 11). The total value-added of Côte d'Ivoire directly consumed by the EU-27 amounts to $2.8 billion (table 12) which is 71 percent of the gross exports of Côte d'Ivoire to the EU-27 (table 11). Ghana's total exports are over $5.3 Billion of which 48 percent ($2.6 billion) went to the EU-27 (table 11). The total value-added of Ghana directly consumed by the EU-27 amounts to $1.7 billion (table 12) which is 65 percent of the gross exports of Ghana to the EU-27 (table 11). Mauritania's total exports are about $1.8 Billion of which 48 percent ($853 million) went to the EU-27 (table 11). The total value-added of Mauritania directly consumed by the EU-27 amounts to $554 million (table 12) which is 65 percent of the gross exports of Mauritania to the EU-27 (table 11).

Liberia's total exports are about $948 million of which 37 percent ($353 million) went to the EU-27 (table 11). The total value-added of Liberia directly consumed by the EU-27 amounts to $226 million (table 12) which is 64 percent of the gross exports of Liberia to the EU-27 (table 11). Nigeria's total exports are about $33 Billion of which 36 percent ($13 billion) went to the EU-27 (table 11). The total value-added of Nigeria directly consumed by the EU-27 is amounted to about $8 billion (table 12) which is 65 percent of the gross exports of Nigeria to the EU-27 (table 11). Niger's total exports are about $567 million of which 35 percent ($200 million) went to the EU-27 (table 11).

The total value-added of Niger directly consumed by the EU-27 amounts to $126 million (table 12) which is 63 percent of the gross exports of Niger to the EU-27 (table 11). Burkina Faso's total exports are about $297 million of which 34 percent ($102 million) went to the EU-27 (table 11). The total value-added of Burkina Faso directly consumed by the EU-27 amounts to $69 million (table 12) which is 70 percent of gross exports of Burkina Faso to the EU-27 (table 11). Sierra Leone's total exports are about $363 million of which 34 percent ($124 million) went to the EU-27 (table 11). The total value-added of Sierra Leone directly consumed by the EU-27 amounts to $86 million (table 12) which is 69 percent of gross exports of Sierra Leone to the EU-27 (table 11).

While the UK is an important destination market for Ghana and Gambia only. Ghana's total exports are over $5.3 billion of which 6 percent ($343 million) went to the UK (table 11). The total value-added of Ghana directly consumed by the UK amounts to $265 million (table 12) which is 77 percent of the gross exports of Ghana to the UK (table 11). Gambia's total exports are about $117 million of which 4.5 percent ($5 million) went to the UK (table 11). The total value-added of Gambia directly consumed by the UK is amounted to about $4 million (table 12) which is 67 percent of the gross exports of Gambia to the UK (table 11).

Table 12 shows ACP trade to the UK, EU-27, and the RoW in $ millions: gross and value-added exports by country in 2015

Bloc/country	ACP Total exports to the world	Total ACP's DVA absorbed abroad	UK		EU-27	
			ACP gross exports to UK	ACP's Value-added directly consumed by UK	ACP gross exports to EU-27	ACP's Value-added directly consumed by EU-27
SADC:						
AGO	26,108.09	24,750.66	13.22	8.87	2,906.90	1,795.55
BWA	1,058.64	767.24	313.72	220.62	65.88	36.04
LSO	303.80	168.54	4.43	1.75	30.04	11.75
MOZ	900.71	822.46	10.44	5.99	227.06	157.87
NAM	2,148.26	1,547.96	105.73	72.37	670.56	408.27
SWZ	1,128.96	707.41	97.10	55.61	146.63	76.87
ZAF	118,444.51	98,021.16	7,707.36	4,303.67	26,444.41	14,311.70
WA:						
BEN	590.68	523.10	2.88	1.58	64.63	45.90
BFA	297.17	236.71	2.43	1.12	102.10	70.31
CIV	7,150.76	6,639.77	190.52	144.35	3,883.91	2,791.71
CPV	260.29	196.97	4.06	2.28	27.68	16.87
GHA	5,344.45	4,927.81	343.46	264.93	2,579.56	1,667.03
GIN	1,485.72	1,358.41	4.00	2.37	908.67	494.45
GMB	117.39	97.22	5.23	3.50	17.81	10.85
LBR	948.33	873.81	12.00	7.78	353.41	225.81
MLI	731.47	661.07	13.81	9.80	144.09	106.86
MRT	1,795.08	1,524.04	10.81	6.42	852.58	554.39
NER	566.62	471.05	3.35	1.75	199.87	126.16
NGA	32,763.40	30,746.28	543.95	360.19	11,650.62	7,592.27
SEN	2,623.95	2,360.49	53.81	35.98	1,594.01	1,177.16
SLE	362.90	290.33	8.98	5.09	124.28	85.58
TGO	973.27	845.83	6.88	4.15	147.35	103.94
CA:						
CAF	250.34	220.27	2.11	1.15	98.75	61.17
CMR	4,084.95	3,798.79	108.13	75.23	2,571.25	1,717.78
COD	2,669.65	2,357.40	11.62	7.72	1,616.50	822.16
COG	4,473.64	4,119.30	9.90	6.05	317.04	201.48
GAB	4,415.08	4,182.87	6.95	4.18	749.59	477.68
STP	152.06	108.37	2.36	1.01	19.72	10.99
TCD	869.05	824.85	9.64	5.83	252.50	194.57
ESA:						
DJI	258.76	215.95	3.62	1.98	22.96	15.04
ERI	290.83	263.62	5.02	2.98	33.36	23.18
ETH	2,293.83	1,761.44	64.87	40.35	770.04	418.41
MDG	2,348.70	2,076.23	53.50	40.32	1,196.68	846.31
MUS	3,506.55	2,245.90	748.31	433.26	1,355.96	724.65
MWI	1,102.29	2,245.90	65.04	45.95	282.75	186.26
SUD	134.20	130.70	4.13	2.46	8.92	6.68
SYC	770.42	664.70	100.39	79.01	278.13	187.18
ZMB	4,273.12	664.70	68.25	46.24	477.25	271.07
EAC:						
BDI	244.26	203.89	4.65	2.78	54.52	35.00
KEN	6,178.80	5,146.26	580.59	410.70	1,678.01	1,026.45
RWA	226.83	170.73	3.61	1.96	37.38	22.30
SDS	514.79	170.73	6.84	4.32	26.78	20.90
TZA	1,530.72	1,032.97	29.42	16.12	353.85	192.82
UGA	1,028.15	911.55	21.33	14.75	232.68	151.49
Caribbean:						
ATG	246.17	184.55	3.56	1.81	63.23	32.38
BHS	1,037.51	738.16	77.54	50.25	437.74	255.01
BLZ	638.33	518.61	49.27	34.19	58.55	37.54
BRB	1,087.26	876.02	53.16	25.41	43.93	25.61
DOM	8,259.09	6,893.67	53.79	36.58	655.48	416.38
GUY	1,133.79	808.20	160.36	91.83	281.33	147.75
HTI	835.43	744.03	3.92	2.44	63.94	41.25
JAM	2,028.97	1,593.63	184.95	103.09	308.18	136.38
SUR	1,009.29	819.27	21.93	15.82	379.83	197.25
TTO	25,082.43	23,291.36	54.77	36.89	411.84	248.11
Pacific:						
FJI	1,236.73	1,036.95	112.15	75.19	43.75	27.51
PNG	5,194.14	4,722.43	124.90	85.68	786.00	506.92
VUT	335.00	275.74	2.85	1.40	25.31	15.37
WSM	253.59	208.30	2.58	1.32	15.27	9.32

Source: Author's calculation based on EORA input-output table for 2015

Central Africa (CA):

EU-27 market represents the main export destination for CA countries such as Cameroon, the Democratic Republic of Congo (COD), Central African Republic (CAF), and Chad. Cameroon's total exports are over $4 billion of which 63 percent ($2.6 billion) went to the EU-27 (table 11). The total value-added of Cameroon directly consumed by the EU-27 amounts to $1.7 billion (table 12) which is 69 percent of the gross exports of Cameroon to the EU-27 (table 11). COD total exports are over $2.7 billion of which 61 percent ($1.6 billion) went to the EU-27 (table 11).

The total value-added of COD directly consumed by the EU-27 amounts to $822 million (table 12) which is 51 percent of gross exports of COD to the EU-27 (table 11). CAF total exports are over $250 million of which about 40 percent ($99 million) went to the EU-27 (table 11). The total value-added of CAF directly consumed by the EU-27 amounts to $61 million (table 12) which is 61 percent of the gross exports of CAF to the EU-27 (table 11). Chad's total exports are over $869 million of which about 29 percent ($253 million) went to the EU-27 (table 11). The total value-added of Chad directly consumed by the EU-27 amounts to $195 million (table 12) which is 77 percent of the gross exports of Chad to the EU-27 (table 11).

These figures show that the value-added of CA exported to the EU-27 might often be re-exported to other countries outside the EU-27. The UK is an important destination market for Cameroon only. Cameroon's total exports are over $4 billion of which 3 percent ($108 million) went to the UK (table 11). The total value-added of Cameroon directly consumed by the UK has amounted to $75 million (table 12) which is 70 percent of the gross exports of Cameroon to the UK (table 11).

East and Southern Africa (ESA) countries:

UK market represents the main export destination for Mauritius and Seychelles. Mauritius's total exports are over $3.5 billion of which 21 percent ($748 million) went to the UK (table 11). The total value-added of Mauritius directly consumed by the UK has amounted to $433 million (table 12) which is 58 percent of the gross exports of Mauritius to the UK (table 11). Seychelles' total exports are over $770 million of which 13 percent ($100 million) went to the UK (table 11). The total value-added of Seychelles directly consumed by the UK has amounted to $79 million (table 12) which is 79 percent of gross exports of Seychelles to the UK (table 11).

Whereas the EU-27 market is the major export destination for Madagascar, Mauritius, Seychelles, Ethiopia, and Malawi. Madagascar's total exports are over $2.3 billion of which 51 percent ($1.2 billion) went to the EU-27 (table 11). The total value-added of Madagascar directly consumed by the EU-27 has amounted to $846 million (table 12) which is 71 percent of gross exports of Madagascar to the EU-27 (table 11) Mauritius total exports is over $3.5 billion of which 39 percent ($1.4 billion) went to the EU-27 (table 11). The total value-added of Mauritius directly consumed by the EU-27 has amounted to $725 million (table 12) which is 53 percent of the gross exports of Mauritius to the EU-27 (table 11).

Seychelles' total exports are over $770 million of which 36 percent ($278 million) went to the EU-27 (table 11). The total value-added of Seychelles directly consumed by the EU-27 has amounted to $187 million (table 12) which is 67 percent of gross exports of Seychelles to the EU-27 (table 11). Ethiopia's total exports are over $2.3 billion of which 34 percent ($770 million) went to the EU-27 (table 11). The total value-added of Ethiopia directly consumed by the EU-27 has amounted to $418 million (table 12) which is 54 percent of the gross exports of Ethiopia to the EU-27 (table 11). Malawi's total exports are over $1.1 billion of which 26 percent ($283 million) went to the EU-27 (table 11). The total value-added of Malawi directly consumed by the EU-27 has amounted to $186 million (table 12) which is 66 percent of the gross exports of Malawi to the EU-27 (table 11).

East African Community (EAC):

UK market is an important export destination for Kenya only. Kenya's total exports are over $6.2 billion of which 9 percent ($581 million) went to the UK (table 11). The total value-added of Kenya directly consumed by the UK has amounted to $411 million (table 12) which is 71 percent of the gross exports of Kenya to the UK (table 11). The EU-27 market represents the main export destination for all EAC countries (except South Sudan). Kenya's total exports are over $6.2 billion of which 27 percent ($1.8 billion) went to the EU-27 (table 11). The total value-added of Kenya directly consumed by the EU-27 is amounted to over $1 billion (table 12) which is 61 percent of the gross exports of Kenya to the EU-27 (table 11).

Tanzania's total exports are over $1.5 billion of which 23 percent ($354 million) went to the EU-27 (table 11). The total value-added of Tanzania directly consumed by the EU-27 has amounted to $193 million (table 12) which is 54 percent of the gross exports of Tanzania to the EU-27 (table 11). Uganda's total exports are over $1 billion of which 23 percent ($233 million) went to the EU-27 (table 11). The total value-added of Uganda directly consumed by the EU-27 has amounted to $151 million (table 12) which is 65 percent of the gross exports of Uganda to the EU-27 (table 11). Burundi's total exports are over $244 million of which 22 percent ($55 million) went to the EU-27 (table 11).

The total value-added of Burundi directly consumed by the EU-27 has amounted to $35 million (table 12) which is 64 percent of the gross exports of Burundi to the EU-27 (table 11). Rwanda's total exports are over $227 million of which 16 percent ($37 million) went to the EU-27 (table 11). The total value-added of Rwanda directly consumed by the EU-27 has amounted to $22 million (table 12) which is 60 percent of gross exports of Rwanda to the EU-27 (table 11).

Caribbean countries:

UK market is an important export destination for Guyana, Jamaica, Belize, and the Bahamas. Guyana's total exports are over $1.1 billion of which 14 percent ($160 million) went to the UK (table 11). The total value-added of Guyana directly consumed by the UK has amounted to $92 million (table 12) which is 57 percent of the gross exports of Guyana to the UK (table 11). Jamaica's total exports are over $2 billion of which 9 percent ($185 million) went to the UK (table 11). The total value-added of Jamaica directly consumed by the UK has amounted to $103 million (table 12) which is 56 percent of the gross exports of Jamaica to the UK (table 11).

Belize's total exports are over $638 million of which 8 percent ($49 million) went to the UK (table 11). The total value-added of Belize directly consumed by the UK has amounted to $34 million (table 12) which is 69 percent of the gross exports of Belize to the UK (table 11). Bahamas total exports are over $1 billion of which 7 percent ($78 million) went to the UK (table 11). The total value-added of Bahamas directly consumed by the UK has amounted to $50 million (table 12) which is 65 percent of the gross exports of Bahamas to the UK (table 11).

The EU-27 is the important export destination for almost all Caribbean EPA bloc. Bahamas total exports are over $1 billion of which 42 percent ($438 million) went to the EU-27 (table 11). The total value-added of Bahamas directly consumed by the EU-27 has amounted to $255 million (table 12) which is 58 percent of the gross exports of Bahamas to the EU-27 (table 11). Suriname's total exports are over $1 billion of which 38 percent ($380 million) went to the EU-27 (table 11). The total value-added of Suriname directly consumed by the EU-27 has amounted to $197 million (table 12) which is 52 percent of the gross exports of Suriname to the EU-27 (table 11).

Antigua and Barbuda's total exports are over $246 million of which 26 percent ($63 million) went to the EU-27 (table 11). The total value-added of Antigua and Barbuda directly consumed by the EU-27 has amounted to $32 million (table 12) which is 51 percent of the gross exports of Antigua and Barbuda to the EU-27 (table 11). Guyana's total exports are over $1.1 billion of which 25 percent ($281 million) went to the EU-27 (table 11). The total value-added of Guyana directly consumed by the EU-27 has amounted to $148 million (table 12) which is 53 percent of the gross exports of Guyana to the EU-27

(table 11). Jamaica's total exports are over $2 billion of which 15 percent ($308 million) went to the EU-27 (table 11). The total value-added of Jamaica directly consumed by the EU-27 has amounted to $136 million (table 12) which is 44 percent of the gross exports of Jamaica to the EU-27 (table 11).

Pacific countries:

The UK market is an important destination for Fiji and Papua New Guinea. Fiji's total exports are over $1.2 billion of which 9 percent ($112 million) went to the UK (table 11). The total value-added of Fiji directly consumed by the UK has amounted to $75 million (table 12) which is 67 percent of the gross exports of Fiji to the UK (table 11). Papua New Guinea's total exports are over $5 billion of which 2.4 percent ($125 million) went to the UK (table 11). The total value-added of Papua New Guinea directly consumed by the UK has amounted to $86 million (table 12) which is 69 percent of the gross exports of Papua New Guinea to the UK (table 11). While the EU-27 represents the main export destination for Papua New Guinea only. Papua New Guinea's total exports are over $5 billion of which 15 percent ($786 million) went to the EU-27 (table 11). The total value-added of Papua New Guinea directly consumed by the EU-27 has amounted to $507 million (table 12) which is 64 percent of gross exports of Papua New Guinea to the EU-27 (table 11).

6.3.ACP-UK/EU direct sectoral GVC trade

Based on the value-added decomposition methodology, this study can decompose bilateral export flows between ACP and UK/EU-27 into their value-added components and trace their country of origin and final destination market at the region, country, and industry level. On average, about 57 percent of ACP value-added (VA) is delivered directly to the UK (figure 8). Figure (8) presents the VA of ACP manufacturing exports share to the UK. The industries with the highest VA of ACP manufacturing exports share to the UK are other manufacturing, food & beverages, and agriculture, with 76 percent, 72 percent, and 70 percent respectively (Figure 8). While in terms of values, the industries with the highest ACP manufacturing exports are metal products and food & beverages, agriculture, and mining and quarrying sector, with about $1.85 billion, $1.28 billion, $0.84 billion, and $0.83 billion respectively (table 13).

Table 13 decomposition of sectoral-bilateral exports of ACP countries to the UK for the year 2015

Sector	Gross exports (GEXP) in $ millins	Share (%) of exports											
		Domestic content (DC)	Domestic Value-Added (DVA)	VAX ->DVA absorbed abroad	VA directly absorbed by the UK	Reflection	Domestic double counting (DDC)	Foreign content (FC)	Foreign Value-Added (FVA)	Foreign double counting (FDC)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
Agriculture	842.36	94.35	94.34	94.13	70	0.20	0.01	5.65	5.65	0.00	29.94	5.66	24.28
Fishing	18.73	84.59	84.54	84.32	59	0.22	0.04	15.41	15.41	0.01	40.62	15.46	25.16
Mining and Quarryi	827.51	81.82	81.77	81.39	51	0.39	0.05	18.18	18.17	0.01	49.23	18.23	31.00
Food & Beverages	1,277.24	84.70	84.67	84.55	72	0.12	0.03	15.30	15.30	0.00	27.87	15.33	12.54
Textiles and Wearing Apparel	485.74	64.00	63.97	63.89	55	0.07	0.03	36.00	35.99	0.01	44.86	36.03	8.83
Wood and Paper	420.30	84.80	84.76	84.47	58	0.29	0.04	15.20	15.19	0.01	42.01	15.24	26.77
Petroleum, Chemical and Non-Metallic Mineral	871.87	78.42	78.34	77.92	46	0.42	0.07	21.58	21.57	0.01	53.88	21.66	32.23
Metal Products	1,845.37	82.98	82.90	82.19	30	0.71	0.09	17.02	17.00	0.02	69.82	17.10	52.72
Electrical and Mach	745.55	80.84	80.77	80.47	59	0.30	0.07	19.16	19.15	0.01	40.58	19.23	21.35
Transport Equipme	225.77	65.43	65.30	65.09	53	0.21	0.13	34.57	34.55	0.03	47.15	34.70	12.45
Other Manufacturir	276.26	81.36	81.28	81.22	76	0.07	0.08	18.64	18.63	0.01	24.29	18.72	5.57
Average	712.43	80.30	80.24	79.97	57	0.27	0.06	19.70	19.69	0.01	42.75	19.76	22.99

Source: Author's calculation based on EORA input-output table for 2015

On average, about 60 percent of ACP value-added is delivered directly to EU-27 (figure 9). Figure 9 shows the direct sectoral GVC-related bilateral trade flows between ACP and EU-27. The industries with the highest VA of ACP manufacturing exports share to EU-27 are food & beverages, agriculture, fishing, and other manufacturing, with 72 percent, 67 percent, 67 percent, and 66 percent respectively (figure 9). But in terms of values, the industries with the highest ACP manufacturing exports are the mining and quarrying sector, agriculture, food & beverages, and metal products, with $20.81 billion, $9.34 billion, $6.69 billion, and $4.94 billion respectively (table 14).

Table 14 decomposition of sectoral-bilateral exports of ACP countries to the EU-27 for the year 2015

Sector	Gross exports (GEXP) in $ millins	Share (%) of exports											
		Domestic content (DC)	Domestic Value-Added (DVA)	VAX ->DVA absorbed abroad	VA directly absorbed by the UK	Reflection	Domestic double counting (DDC)	Foreign content (FC)	Foreign Value-Added (FVA)	Foreign double counting (FDC)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
Agriculture	9,432.41	92.39	92.37	92.18	67	0.20	0.02	7.61	7.61	0.00	33.06	7.63	25.43
Fishing	436.68	86.23	86.18	85.95	67	0.22	0.05	13.77	13.76	0.01	33.31	13.82	19.49
Mining and Quarry	20,812.60	90.77	90.75	90.40	58	0.35	0.02	9.23	9.22	0.00	42.50	9.25	33.25
Food & Beverages	6,693.50	86.55	86.52	86.39	72	0.14	0.02	13.45	13.45	0.00	27.79	13.48	14.31
Textiles and Wearing Apparel	1,897.17	72.20	72.17	72.09	59	0.08	0.03	27.80	27.79	0.01	41.34	27.83	13.51
Wood and Paper	2,866.87	88.33	88.31	88.09	64	0.23	0.02	11.67	11.66	0.00	36.30	11.69	24.61
Petroleum, Chemical and Non-Metallic Mineral	3,636.84	79.52	79.46	79.08	50	0.37	0.07	20.48	20.47	0.01	49.94	20.54	29.40
Metal Products	4,943.00	82.87	82.79	82.32	44	0.47	0.08	17.13	17.12	0.01	55.80	17.21	38.59
Electrical and Mach	1,511.58	80.68	80.62	80.33	58	0.29	0.06	19.32	19.31	0.01	42.36	19.38	22.98
Transport Equipme	1,455.66	67.94	67.82	67.50	51	0.32	0.11	32.06	32.04	0.02	48.83	32.18	16.65
Other Manufacturir	365.76	75.49	75.44	75.34	66	0.10	0.05	24.51	24.50	0.01	33.81	24.56	9.25
Average	4,913.82	82.09	82.04	81.79	60	0.25	0.05	17.91	17.90	0.01	40.46	17.96	22.50
Source: Author's calculation based on EORA input-output table for 2015													

On average, about 67 percent of the UK value-added is delivered directly to ACP (figure 10). Figure (10) presents VA of UK manufacturing exports share to ACP. The sectors with the highest VA of UK manufacturing exports share to ACP are fishing, other manufacturing, food & beverages, and agriculture, with 78 percent, 74 percent, 72 percent, and 72 percent respectively (Figure 8). While in terms of values, the industries with the highest UK manufacturing exports are electrical and machinery, transport equipment, metal products, and food & beverages, agriculture, with about $7.48 billion, $2.25 billion, $1 billion, and $1 billion respectively (table 15).

Table 15 decomposition of sectoral-bilateral exports of UK to the ACP countries for the year 2015

Sector	Gross exports (GEXP) in $ millions	Share (%) of exports											
		Domestic content (DC)	Domestic Value-Added (DVA)	VAX ->DVA absorbed abroad	VA directly absorbed by ACP (DAVAX)	Reflection	Domestic double counting (DDC)	Foreign content (FC)	Foreign Value-Added (FVA)	Foreign double counting (FDC)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
Agriculture	161.57	82.60	82.06	81.24	72	0.82	0.54	17.40	17.24	0.16	27.95	17.94	10.01
Fishing	9.23	88.81	88.52	87.81	78	0.71	0.29	11.19	11.09	0.09	22.00	11.48	10.52
Mining and Quarrying	217.38	90.32	90.11	88.46	58	1.65	0.21	9.68	9.62	0.07	41.94	9.89	32.05
Food & Beverages	972.95	76.36	75.58	75.29	72	0.30	0.78	23.64	23.40	0.23	27.66	24.42	3.24
Textiles and Wearing Appa	458.84	72.91	72.28	71.65	66	0.63	0.63	27.09	26.89	0.20	34.14	27.72	6.42
Wood and Paper	896.96	75.14	74.46	73.85	65	0.61	0.68	24.86	24.66	0.20	34.56	25.54	9.02
Petroleum, Chemical and Non-Metallic Mineral Products	3,716.75	75.92	75.16	74.53	64	0.63	0.76	24.08	23.86	0.22	36.17	24.84	11.34
Metal Products	995.87	75.60	75.06	74.15	58	0.91	0.54	24.40	24.23	0.18	41.64	24.94	16.70
Electrical and Machinery	7,481.44	72.35	71.58	71.38	68	0.20	0.77	27.65	27.38	0.27	31.99	28.42	3.57
Transport Equipment	2,251.24	63.84	62.83	62.66	60	0.17	1.01	36.16	35.81	0.35	39.88	37.17	2.70
Other Manufacturing	384.35	77.07	76.46	76.26	74	0.20	0.61	22.93	22.75	0.18	26.08	23.54	2.54
Average	1,595.14	77.36	76.74	76.12	67	0.62	0.62	22.64	22.45	0.20	33.09	23.26	9.83
Source: Author's calculation based on EORA input-output table for 2015													

On average, about 75 percent of EU-27 value-added is delivered directly to ACP (figure 11). Figure 11 shows the direct sectoral GVC-related bilateral trade flows between EU-27 and ACP. The industries with the highest VA of EU-27 manufacturing exports share to ACP are other manufacturing, food & beverages, agriculture, and electrical and machinery, with 84 percent, 83 percent, 80 percent, and 79 percent respectively (figure 11). But in terms of values, the industries with the highest EU-27 manufacturing exports are electrical and machinery, transport equipment, petroleum & Chemical, and non-metallic mineral products, and food & beverages, with $31.86 billion, $17.18 billion, $15.49 billion, and $5.66 billion respectively (table 16).

Table 16 decomposition of sectoral-bilateral exports of EU-27 to the ACP countries for the year 2015

Sector	Gross exports (GEXP) in $ millions	Share (%) of exports											
		Domestic content (DC)	Domestic Value-Added (DVA)	VAX ->DVA absorbed abroad	VA directly absorbed by ACP (DAVAX)	Reflection	Domestic double counting (DDC)	Foreign content (FC)	Foreign Value-Added (FVA)	Foreign double counting (FDC)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
Agriculture	993.61	91.80	91.33	87.55	80	3.78	0.47	8.20	8.07	0.13	20.32	8.67	11.65
Fishing	65.17	89.68	89.07	86.29	78	2.79	0.61	10.32	10.16	0.16	22.18	10.93	11.25
Mining and Quarrying	1,293.91	92.66	92.24	88.44	70	3.80	0.42	7.34	7.23	0.11	29.69	7.76	21.93
Food & Beverages	5,655.18	87.88	87.21	85.79	83	1.41	0.67	12.12	11.94	0.18	16.97	12.79	4.18
Textiles and Wearing Appa	3,393.86	85.07	84.10	81.80	77	2.30	0.97	14.93	14.67	0.26	23.42	15.90	7.51
Wood and Paper	2,925.58	88.54	87.76	83.95	73	3.81	0.78	11.46	11.27	0.20	27.13	12.24	14.89
Petroleum, Chemical and Non-Metallic Mineral Products	15,491.17	76.85	75.64	73.23	64	2.40	1.21	23.15	22.82	0.33	35.65	24.36	11.29
Metal Products	4,457.51	85.07	84.00	80.47	66	3.53	1.06	14.93	14.66	0.27	33.79	16.00	17.80
Electrical and Machinery	31,859.82	84.91	83.78	82.86	79	0.92	1.13	15.09	14.80	0.30	20.71	16.22	4.49
Transport Equipment	17,175.12	83.70	82.37	81.07	77	1.30	1.33	16.30	15.95	0.35	23.26	17.63	5.64
Other Manufacturing	2,677.41	86.28	85.40	85.04	84	0.36	0.88	13.72	13.49	0.23	16.41	14.60	1.81
Average	7,817.12	86.58	85.72	83.32	75	2.40	0.87	13.42	13.19	0.23	24.50	14.28	10.22
Source: Author's calculation based on EORA input-output table for 2015													

To sum up, at the bloc level, the African EPA blocs are more dependent on the UK market than the Caribbean and Pacific EPA blocs. While all ACP EPA blocs are depending on the EU-27 markets. At the country level, the UK represents the main destination market for some ACP countries such as Botswana, Mauritius, Guyana, Seychelles, Kenya, Jamaica, Swaziland, Belize, the Bahamas, South Africa, Ghana, Malawi, Namibia, Barbados, Gambia, and Saint Lucia. But ACP markets are not the main destination for UK exports. The EU-27 is the main destination market for almost all ACP countries and the ACP markets but ACP markets are not the main destination for the EU-27 exports.

7. ACP-UK/EU-27 INDIRECT GVC TRADE RELATIONS

7.1.The upstream and downstream linkage between ACP and the UK/EU-27

Downstream linkages (forward-GVC participation) can be assessed by tracking the destination (where the DVA is absorbed) of the DVA, whether it is absorbed by the exporting country (reflected back) or re-exported and absorbed by other countries. Whereas the upstream linkages (backward-GVC participation) can be evaluated by considering FC from other countries embedded in the bilateral trade flows between ACP and the UK/EU-27 or between UK and EU-27.

Based on the decomposition of bilateral trade, this study can trace the country of origin of FC, the destination market of FC, and the country where the final good is finally absorbed. By looking at the upstream linkage, this study can trace the countries of origin of FC contained in bilateral trade flows between the UK and EU-27 to evaluate the sourcing strategies of the two regions. In other words, by looking at the upstream structure, this study can identify the FC originated in ACP that is embedded in bilateral trade flows between the UK and EU-27.

So, the FC share in EU-27 exports to the UK that originated in ACP is, on average, only 0.09 percent, and also just 0.07 percent of the UK gross exports to EU-27 embed intermediate goods that are produced in ACP (table 17). Most of ACP FC shares embedded in EU-27 gross exports to the UK came from SADC with 0.28 percent of EU-27 gross export to the UK which amounted to over $1.6 billion and WA with 0.18 percent of EU-27 gross export to the UK which amounted to over USD 1 billion (table 17). Similar situation for the UK, most of ACP FC shares embedded in UK gross exports to EU-27 came from SADC with 0.34 percent of UK gross export to EU-27 which amounted to over USD 1.4 billion (table 17).

Table 17 shows foreign content embedded in bilateral exports between the UK and the EU-27 originally from ACP for the year 2015

Bloc	UK		EU-27	
	Total FC in $ millions	Total FC share (%) of gross exports of	Total FC in $ millions	Total FC share (%) of gross exports of
SADC	1,437	0.34	1,671	0.28
West Africa	296	0.07	1,071	0.18
Central Africa	68	0.02	295	0.05
ESA	98	0.02	170	0.03
EAC	77	0.02	151	0.03
Caribbean	105	0.02	173	0.03
Pacific	32	0.01	45	0.01
Average	301.93	0.07	511.00	0.09

Source: Author's calculation based on EORA input-output table for 2015

Whereas at the sector level, on average, only 0.5 percent of UK gross exports to EU-27 consist of FC originated in ACP which amounted to on average around $138 million (table 18). The EU-27 industries are also not depending on intermediate inputs from ACP. On average, only 0.5 percent of EU-27 gross exports to the UK embed FC originated in ACP which amounted to on average over $203 million (table 19). The UK sectors with the highest overall share of FC originated in ACP are electrical and machinery, petroleum, chemical and non-metallic mineral products, metal products, and transport equipment, with only between on average 0.07 percent and 0.14 percent of UK gross exports (i.e. in these sectors) to EU-27 (table 18). The EU-27 sectors with the highest overall share of FC originated in ACP are petroleum, chemical and non-metallic mineral products, food and beverages, electrical and machinery, transport equipment, and metal products with only on average between 0.06 percent and 0.11 percent of EU-27 gross exports (i.e. in these sectors) to UK (table 19).

Table 18 presents ACP's VA embedded in the UK exports to EU-27 by industries for the year 2015

Sector	SADC		West Africa		Central Africa		ESA		EAC		Caribbean		Pacific		Average	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
Agriculture	5.58	0.15	4.74	0.13	0.50	0.01	1.10	0.03	2.67	0.07	0.84	0.02	0.60	0.02	2.29	0.06
Fishing	1.21	0.12	0.43	0.04	0.11	0.01	0.22	0.02	0.15	0.01	0.14	0.01	0.07	0.01	0.33	0.03
Mining and Quarrying	29.24	0.16	4.73	0.03	1.16	0.01	2.01	0.01	0.98	0.01	1.39	0.01	0.40	0.00	5.70	0.03
Food & Beverages	43.37	0.23	36.85	0.19	2.84	0.01	13.87	0.07	19.93	0.10	11.28	0.06	8.35	0.04	19.50	0.10
Textiles and Wearing Apparel	28.39	0.23	7.59	0.06	2.00	0.02	4.05	0.03	2.66	0.02	1.83	0.01	0.59	0.00	6.73	0.05
Wood and Paper	34.20	0.21	12.70	0.08	6.26	0.04	3.02	0.02	1.57	0.01	3.14	0.02	0.75	0.00	8.81	0.05
Petroleum, Chemical and Non-Metallic Mineral Products	207.65	0.29	68.46	0.10	12.11	0.02	12.11	0.02	9.03	0.01	17.35	0.02	4.09	0.01	47.26	0.07
Metal Products	227.06	0.88	12.87	0.05	4.30	0.02	4.92	0.02	2.43	0.01	7.95	0.03	1.07	0.00	37.23	0.14
Electrical and Machinery	272.80	0.31	37.70	0.04	11.77	0.01	12.46	0.01	7.73	0.01	19.81	0.02	3.11	0.00	52.20	0.06
Transport Equipment	165.98	0.44	24.11	0.06	7.73	0.02	6.70	0.02	3.96	0.01	9.20	0.02	1.64	0.00	31.33	0.08
Other Manufacturing	26.62	0.38	5.45	0.08	2.47	0.03	1.25	0.02	0.79	0.01	1.77	0.02	0.29	0.00	5.52	0.08

Source: Author's calculation based on EORA input-output table for 2015

Table 19 presents ACP's VA embedded in the EU-27 exports to the UK by industries for the year 2015

Sector	SADC		West Africa		Central Africa		ESA		EAC		Caribbean		Pacific		Average	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
Agriculture	17.76	0.15	17.49	0.15	3.13	0.03	2.96	0.03	4.83	0.04	2.96	0.03	0.52	0.00	7.09	0.06
Fishing	0.30	0.09	0.23	0.07	0.06	0.02	0.06	0.02	0.03	0.01	0.05	0.01	0.01	0.00	0.11	0.03
Mining and Quarrying	4.65	0.16	3.13	0.10	0.89	0.03	0.47	0.02	0.23	0.01	0.36	0.01	0.10	0.00	1.40	0.05
Food & Beverages	149.23	0.26	161.07	0.28	22.20	0.04	33.18	0.06	51.81	0.09	27.56	0.05	11.03	0.02	65.15	0.11
Textiles and Wearing Apparel	53.29	0.18	36.83	0.12	9.69	0.03	15.20	0.05	4.73	0.02	4.96	0.02	1.94	0.01	18.09	0.06
Wood and Paper	34.19	0.16	27.94	0.13	17.84	0.08	3.59	0.02	1.85	0.01	3.06	0.01	0.77	0.00	12.75	0.06
Petroleum, Chemical and Non-Metallic Mineral Products	226.58	0.30	269.01	0.35	46.22	0.06	11.66	0.02	7.31	0.01	21.05	0.03	2.59	0.00	83.49	0.11
Metal Products	117.00	0.50	30.43	0.13	15.07	0.06	4.96	0.02	1.58	0.01	6.55	0.03	2.19	0.01	25.39	0.11
Electrical and Machinery	216.03	0.20	75.58	0.07	27.18	0.03	14.87	0.01	7.19	0.01	18.33	0.02	3.87	0.00	51.86	0.05
Transport Equipment	183.83	0.25	78.36	0.11	23.45	0.03	11.54	0.02	5.13	0.01	14.47	0.02	2.93	0.00	45.67	0.06
Other Manufacturing	23.71	0.23	19.67	0.19	12.18	0.12	2.59	0.02	0.88	0.01	1.47	0.01	0.43	0.00	8.71	0.08

Source: Author's calculation based on EORA input-output table for 2015

Tracing the value-added also allows us to evaluate downstream linkage (i.e. forward-GVC participation) of ACP and UK/EU-27 economies by identifying the final destination market of bilateral trade flows. It turns out that on average, about 8 percent of ACP gross exports to the UK are re-directed to the final destination markets in the EU-27 which is estimated to be around $161 million (table 20). On average, about 4 percent of ACP gross exports to the EU-27 are re-exported to the UK which amounted to about $356 million (table 20). On average, about 0.1 percent of UK gross exports to the EU-27 are re-directed to the final destination markets in the ACP which is estimated to be around $457 million (table 20). On average, about 0.1 percent of EU-27 gross exports to the UK are re-directed to the final destination markets in the ACP which is estimated to be around $0.655 million (table 20).

Table 20 shows DVA of ACP/UK/EU-27 exports to UK/EU-27/ACP that redirected to EU-27/ACP

Bloc	ACP's DVA of UK exports to EU-27		ACP's DVA of EU-27 exports to UK		UK's DVA of EU-27 exports to ACP		EU's-27 DVA of UK exports to ACP	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
SADC	845	10	1,113	3.65	1,198	0.28	1,307	0.22
WA	103	9	796	3.52	844	0.20	1,077	0.18
CA	14	9	214	3.80	279	0.07	62	0.01
ESA	56	5	125	2.81	125	0.03	156	0.03
EAC	47	7	118	4.95	182	0.04	392	0.07
Caribbean	46	7	99	3.67	562	0.13	1,576	0.27
Pacific	19	8	31	3.56	10	0.00	13	0.00
Sum	1,130		2,495		3,199		4,583	
Average	161	8	356	3.71	457	0.11	655	0.11
Source: Author's calculation based on EORA input-output table for 2015								

While on average, only 0.15 percent of ACP gross exports to the UK reflected back to be consumed in ACP final destination market (table 21). On average, only 0.16 percent of ACP gross exports to EU-27 came back to be consumed in ACP final destination market (table 20). The ACP markets that received the highest good reflected back from the UK are SADC, Caribbean, and WA, with 0.38 percent and 0.31 percent and 0.25 percent respectively which amounted to around $31 million, $2 million, and $3 million respectively (table 21). Similarly, the ACP markets that received the highest good came back from EU-27 are SADC, WA, and the Caribbean, with 0.40 percent, 0.28 percent, and 0.21 respectively which amounted to around $121 million, $63 million, and $6 million respectively (table 21).

Table 21 shows ACP's DVA exported to the UK and EU-27 and reflected back to ACP

Bloc	DVA exported to UK and reflected back		DVA exported to EU-27 and reflected back	
	Millions of $	% of export	Millions of $	% of export
SADC	31.14	0.38	121.08	0.40
WA	2.97	0.25	63.30	0.28
CA	0.04	0.02	8.37	0.15
ESA	0.24	0.02	1.56	0.04
EAC	0.49	0.08	1.57	0.07
Caribbean	2.08	0.31	5.76	0.21
Pacific	0.01	0.00	0.03	0.00
Average	5.28	0.15	28.81	0.16
Source: Author's calculation based on EORA input-output table for 2015				

At the sector level, table (22) presents the DVA of ACP in UK bilateral exports to EU-27 by industries. The overall share of ACP DVA in UK bilateral exports to EU-27 at the sector level is not that much, with an exception for some sectors such as metal products, mining and quarrying, petroleum, chemical, and non-metallic mineral products, fishing, and agriculture with on average, about 15 percent, 13 percent, 11 percent, 11 percent, and 11 percent respectively. Table (23) shows ACP DVA embedded in EU-27 bilateral exports to the UK by sectors. The overall share of ACP DVA in EU-27 bilateral exports

to the UK at the sector level is very low. For instance, on average, between the lowest 1 percent for other manufacturing and the highest about only 5 percent for agriculture.

Table 22 presents ACP's DVA of UK exports to EU-27 by industries (2015)

Sector	SADC		West Africa		Central Africa		ESA		EAC		Caribbean		Pacific		Average	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
Agriculture	5.52	9.61	40.11	10.67	1.95	14.57	4.90	10.47	29.13	9.83	2.11	9.55	3.22	10.63	12.42	10.76
Fishing	0.80	9.56	0.51	12.03	0.04	9.65	0.32	10.25	0.12	11.61	0.07	10.81	0.10	11.48	0.28	10.77
Mining and Quarrying	82.72	10.88	9.86	17.09	0.07	12.55	0.52	13.25	0.09	13.07	0.53	13.28	0.03	12.09	13.40	13.17
Food & Beverages	16.92	3.58	9.90	4.17	0.06	12.21	14.10	7.33	2.79	3.12	12.08	6.77	10.46	9.81	9.47	6.71
Textiles and Wearing Apparel	11.43	7.59	1.44	7.24	0.08	11.41	3.29	1.11	1.77	14.90	0.19	3.39	0.03	3.62	2.61	7.04
Wood and Paper	27.01	10.47	8.53	11.17	6.30	11.15	0.13	9.85	0.26	9.50	2.23	9.64	0.22	10.57	6.38	10.33
Petroleum, Chemical and Non-Metallic Mineral Products	90.80	11.79	11.18	17.96	0.06	11.68	0.20	8.96	0.48	6.40	2.30	8.03	0.04	10.83	15.01	10.81
Metal Products	338.25	19.17	1.54	16.40	0.44	18.04	1.15	16.65	0.51	7.96	9.47	17.08	0.02	10.04	50.20	15.05
Electrical and Machinery	45.17	7.43	4.46	8.05	0.50	8.69	0.60	7.25	1.29	6.45	5.69	11.98	0.05	8.50	8.25	8.34
Transport Equipment	11.29	5.25	0.10	9.75	0.05	10.59	0.07	8.61	0.19	6.00	0.26	5.07	0.02	9.10	1.71	7.77
Other Manufacturing	4.78	1.99	0.39	3.56	0.05	8.15	0.15	2.61	0.23	1.78	0.23	3.93	0.02	9.42	0.84	4.49

Source: Author's calculation based on EORA input-output table for 2015

Table 23 presents ACP's DVA of EU-27 exports to the UK by industries in 2015

Sector	SADC		West Africa		Central Africa		ESA		EAC		Caribbean		Pacific		Average	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
Agriculture	106.61	4.63	167.98	4.92	30.92	3.77	40.88	4.09	73.06	6.59	28.91	6.00	13.37	4.42	65.96	4.92
Fishing	14.44	4.48	1.65	1.80	0.04	2.09	0.15	2.12	0.20	2.66	0.09	2.20	0.05	2.35	2.38	2.53
Mining and Quarrying	276.68	3.36	351.00	3.40	74.20	3.68	1.10	3.70	0.78	3.26	3.41	3.85	4.28	4.48	101.64	3.67
Food & Beverages	40.29	2.91	79.67	2.67	3.38	3.13	16.15	2.59	20.43	3.46	18.05	2.45	6.85	2.54	26.40	2.82
Textiles and Wearing Apparel	12.54	2.66	6.17	2.26	0.12	2.05	14.81	1.40	1.51	2.68	0.55	1.97	0.05	1.75	5.11	2.11
Wood and Paper	18.52	3.54	42.57	3.04	28.43	3.39	1.37	2.37	0.41	2.41	0.49	2.78	0.33	3.26	13.16	2.97
Petroleum, Chemical and Non-Metallic Mineral Products	116.11	4.09	11.41	2.79	1.26	4.26	1.69	2.53	0.88	2.52	8.56	3.36	0.05	2.31	20.00	3.12
Metal Products	159.78	3.83	2.18	4.20	4.10	3.70	7.29	3.65	0.36	2.62	16.06	4.05	0.04	2.24	27.11	3.47
Electrical and Machinery	30.30	2.75	4.37	3.47	0.99	3.13	1.99	1.86	0.37	1.90	3.00	2.63	0.51	4.37	5.93	2.87
Transport Equipment	28.22	2.30	5.66	3.38	0.16	2.54	0.14	1.23	0.10	2.15	0.66	1.94	0.09	3.06	5.00	2.37
Other Manufacturing	2.67	1.56	0.79	1.50	0.13	2.07	0.76	0.84	0.30	0.93	0.15	1.57	0.05	1.57	0.69	1.43

Source: Author's calculation based on EORA input-output table for 2015

Table 24 shows the UK's DVA embedded in EU-27 bilateral exports to ACP by sectors. The overall share of the UK's DVA in EU-27 bilateral exports to ACP at the industry level is very low. For instance, on average, between the lowest 0.04 percent for other manufacturing and the highest about only 0.23 percent for mining and quarrying. Table 25 shows the EU's-27 DVA embedded in the UK bilateral exports to ACP by sectors. The overall share of the EU's-27 DVA in the UK bilateral exports to ACP at the industry level is very low. For example, on average, between the lowest 0.03 percent for other manufacturing and the highest about only 0.24 percent for metal products.

Table 24 presents the UK's DVA of EU-27 exports to ACP by industries in 2015

Sector	SADC		West Africa		Central Africa		ESA		EAC		Caribbean		Pacific		Average	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
Agriculture	8.23	0.22	6.60	0.18	1.75	0.05	1.13	0.03	1.56	0.04	6.34	0.17	0.07	0.00	3.67	0.10
Fishing	1.62	0.17	1.52	0.16	0.50	0.05	0.30	0.03	0.32	0.03	1.09	0.11	0.02	0.00	0.77	0.08
Mining and Quarrying	100.14	0.54	79.70	0.43	26.72	0.14	10.50	0.06	20.13	0.11	56.86	0.31	0.91	0.00	42.14	0.23
Food & Beverages	23.03	0.12	19.25	0.10	5.68	0.03	3.19	0.02	4.65	0.02	16.94	0.09	0.22	0.00	10.42	0.05
Textiles and Wearing Apparel	14.38	0.12	11.45	0.09	4.47	0.04	2.13	0.02	2.00	0.02	6.12	0.05	0.17	0.00	5.82	0.05
Wood and Paper	39.18	0.24	30.70	0.19	9.80	0.06	4.58	0.03	6.70	0.04	22.72	0.14	0.38	0.00	16.29	0.10
Petroleum, Chemical and Non-Metallic Mineral Products	238.14	0.33	174.49	0.24	56.86	0.08	26.40	0.04	39.08	0.05	110.91	0.15	2.03	0.00	92.56	0.13
Metal Products	107.91	0.42	77.72	0.30	25.20	0.10	11.60	0.04	14.35	0.06	41.26	0.16	0.92	0.00	39.85	0.15
Electrical and Machinery	238.43	0.27	161.58	0.18	53.84	0.06	24.41	0.03	28.32	0.03	82.62	0.09	1.76	0.00	84.42	0.10
Transport Equipment	72.78	0.19	51.34	0.14	18.86	0.05	6.37	0.02	6.87	0.02	26.34	0.07	0.36	0.00	26.13	0.07
Other Manufacturing	8.05	0.11	5.60	0.08	2.19	0.03	0.88	0.01	1.23	0.02	3.40	0.05	0.07	0.00	3.06	0.04

Source: Author's calculation based on EORA input-output table for 2015

Table 25 presents EU's-27 DVA of UK exports to ACP by industries in 2015

Sector	SADC		West Africa		Central Africa		ESA		EAC		Caribbean		Pacific		Average	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
Agriculture	25.64	0.22	27.94	0.24	1.49	0.01	3.84	0.03	10.36	0.09	49.63	0.42	0.29	0.00	17.03	0.15
Fishing	0.91	0.27	0.98	0.29	0.05	0.02	0.14	0.04	0.37	0.11	1.85	0.54	0.01	0.00	0.62	0.18
Mining and Quarrying	11.54	0.39	9.35	0.31	0.60	0.02	1.27	0.04	3.46	0.12	15.30	0.51	0.12	0.00	5.95	0.20
Food & Beverages	48.47	0.08	50.52	0.09	2.66	0.00	7.06	0.01	18.49	0.03	106.31	0.18	0.53	0.00	33.43	0.06
Textiles and Wearing Apparel	28.76	0.09	23.52	0.08	1.69	0.01	4.63	0.02	10.48	0.03	45.81	0.15	0.38	0.00	16.47	0.05
Wood and Paper	77.08	0.35	63.29	0.29	3.79	0.02	9.24	0.04	33.27	0.15	106.53	0.49	0.81	0.00	42.00	0.19
Petroleum, Chemical and Non-Metallic Mineral Products	227.37	0.30	185.81	0.24	11.12	0.01	26.14	0.03	70.19	0.09	289.55	0.38	2.26	0.00	116.06	0.15
Metal Products	122.90	0.52	100.50	0.43	6.04	0.03	14.45	0.06	34.91	0.15	111.70	0.47	1.41	0.01	55.99	0.24
Electrical and Machinery	308.37	0.28	279.86	0.26	15.02	0.01	37.36	0.03	85.38	0.08	287.34	0.27	2.96	0.00	145.18	0.13
Transport Equipment	166.92	0.23	96.73	0.13	5.50	0.01	17.54	0.02	33.48	0.05	165.30	0.22	0.98	0.00	69.49	0.09
Other Manufacturing	5.09	0.05	4.37	0.04	0.29	0.00	0.70	0.01	1.88	0.02	8.76	0.08	0.07	0.00	3.02	0.03

Source: Author's calculation based on EORA input-output table for 2015

Similarly, the ACP's DVA exports by industry to UK that reflected back to be consumed in ACP final destination market is very law. For example, on average, between the lowest 0.03 percent for other manufacturing and the highest about only 0.23 percent for mining and quarrying (table 26). The ACP's DVA exports by industry to EU-27 that reflected back to be consumed in ACP final destination market is very law. For example, on average, between the lowest 0.03 percent for textiles and wearing apparel and the highest about only 0.21 percent for metal products (table 27).

Table 26 presents ACP's DVA exported to the UK and reflected back to ACP by industries in 2015

Sector	SADC		West Africa		Central Africa		ESA		EAC		Caribbean		Pacific		Average	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
Agriculture	0.16	0.28	1.13	0.30	0.00	0.04	0.02	0.04	0.29	0.10	0.10	0.44	0.00	0.00	0.24	0.17
Fishing	0.02	0.28	0.01	0.34	0.00	0.03	0.00	0.04	0.00	0.12	0.00	0.26	0.00	0.00	0.01	0.15
Mining and Quarrying	2.89	0.38	0.27	0.48	0.00	0.04	0.00	0.05	0.00	0.13	0.02	0.52	0.00	0.00	0.46	0.23
Food & Beverages	0.52	0.11	0.30	0.13	0.00	0.03	0.06	0.03	0.03	0.03	0.63	0.35	0.00	0.00	0.22	0.10
Textiles and Wearing Apparel	0.27	0.18	0.03	0.17	0.00	0.03	0.01	0.00	0.01	0.12	0.01	0.13	0.00	0.00	0.05	0.09
Wood and Paper	0.88	0.34	0.23	0.30	0.02	0.03	0.00	0.04	0.00	0.11	0.09	0.39	0.00	0.00	0.17	0.17
Petroleum, Chemical and Non-Metallic Mineral Products	3.26	0.42	0.31	0.51	0.00	0.03	0.00	0.04	0.01	0.07	0.10	0.34	0.00	0.00	0.53	0.20
Metal Products	12.79	0.72	0.05	0.49	0.00	0.05	0.01	0.07	0.01	0.09	0.28	0.50	0.00	0.00	1.88	0.28
Electrical and Machinery	1.85	0.30	0.16	0.29	0.00	0.02	0.00	0.03	0.01	0.07	0.19	0.40	0.00	0.00	0.32	0.16
Transport Equipment	0.46	0.21	0.00	0.26	0.00	0.03	0.00	0.03	0.00	0.06	0.01	0.19	0.00	0.00	0.07	0.11
Other Manufacturing	0.16	0.07	0.01	0.10	0.00	0.02	0.00	0.01	0.00	0.02	0.01	0.13	0.00	0.00	0.03	0.05

Source: Author's calculation based on EORA input-output table for 2015

Table 27 presents ACP's DVA exported to the EU-27 and reflected back to ACP by industries in 2015

Sector	SADC		West Africa		Central Africa		ESA		EAC		Caribbean		Pacific		Average	
	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export	Millions of $	% of export
Agriculture	6.26	0.27	8.65	0.25	0.73	0.09	0.40	0.04	0.82	0.07	1.71	0.35	0.01	0.00	2.65	0.15
Fishing	0.84	0.26	0.13	0.14	0.00	0.06	0.00	0.04	0.00	0.05	0.00	0.11	0.00	0.01	0.14	0.10
Mining and Quarrying	36.34	0.44	33.53	0.32	3.08	0.15	0.02	0.05	0.02	0.07	0.16	0.18	0.01	0.01	10.45	0.18
Food & Beverages	2.60	0.19	4.90	0.16	0.10	0.09	0.17	0.03	0.27	0.05	1.00	0.14	0.00	0.00	1.29	0.09
Textiles and Wearing Apparel	0.93	0.20	0.27	0.10	0.00	0.08	0.21	0.02	0.01	0.02	0.02	0.07	0.00	0.01	0.21	0.07
Wood and Paper	1.79	0.34	3.75	0.27	0.92	0.11	0.03	0.05	0.01	0.05	0.03	0.17	0.00	0.01	0.93	0.14
Petroleum, Chemical and Non-Metallic Mineral Products	11.88	0.42	1.23	0.30	0.04	0.14	0.04	0.06	0.02	0.05	0.38	0.15	0.00	0.01	1.94	0.16
Metal Products	21.84	0.52	0.22	0.43	0.23	0.21	0.13	0.06	0.01	0.05	0.82	0.21	0.00	0.01	3.32	0.21
Electrical and Machinery	3.74	0.34	0.46	0.36	0.04	0.14	0.06	0.05	0.01	0.04	0.14	0.12	0.00	0.01	0.63	0.15
Transport Equipment	4.26	0.35	0.42	0.25	0.01	0.11	0.00	0.03	0.00	0.06	0.02	0.06	0.00	0.01	0.67	0.12
Other Manufacturing	0.24	0.14	0.09	0.18	0.01	0.09	0.02	0.02	0.01	0.02	0.01	0.08	0.00	0.01	0.05	0.08

Source: Author's calculation based on EORA input-output table for 2015

Finally, this section answers the research questions as following:

1. The figures explain that how ACP countries exploit UK/EU-27 markets (i.e. use UK/EU-27 markets as a bridge) to reach the final destination markets in EU-27/UK. The EU-27 absorbed on average, around $161 million of ACP DVA which amounted to about 8 percent of gross exports of ACP to the UK. This suggests that the ACP countries first export to the UK, and it only reaches EU-27 markets after some processing stages. And the UK absorbed on average, around $356 million of ACP DVA which amounted to about 4 percent of gross exports of ACP to EU-27. This also suggests that the ACP countries first export to the EU-27, and it only reaches the UK market after some processing stages.

2. The ACP blocs with the highest overall GVC-related trade activities in bilateral exports to EU-27 are SADC and WA with around $13 billion (44% of ACP gross exports to the EU-27) and $7 billion (33% of ACP gross exports to the EU-27) respectively (table 8). The ACP blocs with the highest overall GVC-related trade activities in bilateral exports to the UK are SADC and WA with about $3.5 billion (42.5% of ACP gross exports to the UK) and $0.352 billion (29% of ACP gross exports to the UK) respectively (table 7).

3. The ACP blocs GVC-related trade activities in bilateral exports to the UK are mainly driven by downstream linkages between ACP blocs and the UK except for ESA countries (table 7). The ESA countries' GVC-related trade activities in bilateral exports to the UK are based on upstream linkage between the UK and ESA countries. Similarly, The ACP blocs GVC-related trade activities in bilateral exports to the EU-27 are mainly driven by downstream linkages between ACP blocs and the EU-27 except for ESA countries (table 8). The ESA countries' GVC-related trade activities in bilateral exports to the EU-27 are based on upstream linkage between the EU-27 and ESA countries.

4. While the UK GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by upstream linkages between the UK and ACP blocs (table 9). Also, the EU-27 GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by upstream linkages between the EU-27 and ACP blocs (table 10). At this point, the figures suggest that the UK and EU-27 are the main export destination markets for ACP countries at the bloc, country, and sector level. While on the other hand, the ACP markets are not the main destination for the UK and the EU-27 exports.

8. CONCLUSION

In 2015, the UK received around $12.3 billion exports of goods from ACP countries where the share of African EPA blocs amounted to over $11 billion (93%) and the share of Caribbean+Pacific EPA blocs amounted to only $0.906 (7%). Similarly, the EU-27 received around $69 billion exports of goods from ACP countries where the share of African EPA blocs amounted to about $65.6 billion (95%) and the share of Caribbean+Pacific EPA blocs amounted to only $3.6 (5%). Therefore; at the bloc level, African EPA blocs are more dependent on the UK and EU-27 markets than Caribbean+Pacific EPA blocs, distance matters in international trade.

At the country level, the share of DVA of ACP's gross exports to the UK is very high. The UK is the main destination market for some ACP countries such as Botswana, Mauritius, Guyana, Seychelles, Kenya, Jamaica, Swaziland, Belize, the Bahamas, South Africa, Ghana, Malawi, Namibia, Barbados, Gambia, and Saint Lucia. But ACP markets are not the main destination for UK exports. While the EU-27 is the main destination market for almost all ACP countries. But ACP markets are not the main destination for the EU-27 exports.

At the sector level, the share of DVA of gross exports of the UK and the EU-27 to the ACP is very high in all sectors. The UK and the EU-27 exports to ACP countries are mainly final goods and high manufactured products. ACP countries export raw materials and intermediate inputs to the UK and the EU-27. The share of DVA of ACP's gross exports to the UK and EU-27 is very high in all sectors. But

ACP exports to the EU-27 and the UK are mainly dominated by agricultural products, food and beverage, mining and quarrying, and metal products.

The ACP gross exports to the UK that are re-directed to the final destination markets in the EU-27 are very small. Also, ACP's DVA share of EU-27 exports to the UK is very small. On average, less than 1 percent of UK gross exports to the EU-27 are re-directed to the final destination markets in the ACP countries. Also on average, less than 1 percent of EU-27 gross exports to the UK are re-directed to the final destination markets in the ACP countries. The ACP countries supply only small amounts of inputs into the products involved in the UK-EU trade (Winters et al., 2020).

The overall share of ACP DVA in UK bilateral exports to EU-27 at the sector level is not that much, with an exception for some sectors such as metal products, mining and quarrying, petroleum, chemical, and non-metallic mineral products, fishing, and agriculture. Also, the overall share of ACP DVA in EU-27 bilateral exports to the UK at the sector level is very low. The overall share of the UK's DVA in EU-27 bilateral exports to ACP at the industry level is very low. The overall share of the EU's-27 DVA in the UK bilateral exports to ACP at the industry level is very low.

Similarly, on average, less than 1 percent of ACP gross exports to UK/EU-27 reflected back to be consumed in ACP final destination market. The ACP markets that received the highest good reflected back from UK/EU-27 are SADC, Caribbean, and WA. The ACP's DVA exports by industry to UK that reflected back to be consumed in ACP final destination market is very law. The ACP's DVA exports by industry to EU-27 that reflected back to be consumed in ACP final destination market also is very law.

The ACP countries use UK/EU-27 markets as a bridge to reach the final destination markets in EU-27/UK. The figures suggest that ACP first export to the UK and EU-27, and it only reaches EU-27/UK markets after some processing stages. Indirect trade relations with the UK/ EU-27 through EU-27/UK matter for some sectors of ACP countries such as metal products, mining and quarrying, petroleum, chemical, and non-metallic mineral products, fishing, food & beverage, and agriculture.

The ACP blocs with the highest level of overall GVC-related trade activities in bilateral exports to the UK/EU-27 are SADC and the Caribbean (Cariforum countries). The ACP blocs GVC-related trade activities in bilateral exports to the UK are mainly driven by upstream linkages between ACP blocs and the UK except for ESA countries. The ESA countries' GVC-related trade activities in bilateral exports to the UK are based on downstream linkage between the UK and ESA countries. Similarly, The ACP blocs GVC-related trade activities in bilateral exports to the EU-27 are mainly driven by upstream linkages between ACP blocs and the EU-27 except for ESA countries.

While the UK GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the UK and ACP blocs. Also, the EU-27 GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the EU-27 and ACP blocs.

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10. APPENDICES

Appendix A: Koopman et al., (2014)

This appendix presents the general case of *G* countries and *N* sectors of Koopman et al., (2014). Now the focus will be on the general case with any arbitrary number of countries and sectors. The Inter-Country Input-Output (ICIO) model, gross output Breakdown matrix, value-added by source shares matrix, are given by the following matrix notations:

$$\begin{bmatrix}\mathbf{X}_1\\ \mathbf{X}_2\\ \vdots\\ \mathbf{X}_G\end{bmatrix}=\begin{bmatrix}\mathbf{I}-\mathbf{A}_{11} & -\mathbf{A}_{12} & \cdots & -\mathbf{A}_{1G}\\ -\mathbf{A}_{21} & \mathbf{I}-\mathbf{A}_{22} & \cdots & -\mathbf{A}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ -\mathbf{A}_{G1} & -\mathbf{A}_{G2} & \cdots & \mathbf{1}-\mathbf{A}_{GG}\end{bmatrix}^{-1}\begin{bmatrix}\sum_r^G \mathbf{Y}_{1r}\\ \sum_r^G \mathbf{Y}_{2r}\\ \vdots\\ \sum_r^G \mathbf{Y}_{Gr}\end{bmatrix}=\begin{bmatrix}\mathbf{B}_{11} & \mathbf{B}_{12} & \cdots & \mathbf{B}_{1G}\\ \mathbf{B}_{21} & \mathbf{B}_{22} & \cdots & \mathbf{B}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{B}_{G1} & \mathbf{B}_{G2} & \cdots & \mathbf{B}_{GG}\end{bmatrix}\begin{bmatrix}\mathbf{Y}_1\\ \mathbf{Y}_2\\ \vdots\\ \mathbf{Y}_G\end{bmatrix} \quad \text{(A.1)}$$

$$\begin{bmatrix}\mathbf{X}_{11} & \mathbf{X}_{12} & \cdots & \mathbf{X}_{1G}\\ \mathbf{X}_{21} & \mathbf{X}_{22} & \cdots & \mathbf{X}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{X}_{G1} & \mathbf{X}_{G2} & \cdots & \mathbf{X}_{GG}\end{bmatrix}=\begin{bmatrix}\mathbf{B}_{11} & \mathbf{B}_{12} & \cdots & \mathbf{B}_{1G}\\ \mathbf{B}_{21} & \mathbf{B}_{22} & \cdots & \mathbf{B}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{B}_{G1} & \mathbf{B}_{G2} & \cdots & \mathbf{B}_{GG}\end{bmatrix}\begin{bmatrix}\mathbf{Y}_{11} & \mathbf{Y}_{12} & \cdots & \mathbf{Y}_{1G}\\ \mathbf{Y}_{21} & \mathbf{Y}_{22} & \cdots & \mathbf{Y}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{Y}_{G1} & \mathbf{Y}_{G2} & \cdots & \mathbf{Y}_{GG}\end{bmatrix} \quad \text{(A.2)}$$

$$\mathbf{VB}=\begin{bmatrix}\mathbf{V}_1\mathbf{B}_{11} & \mathbf{V}_1\mathbf{B}_{12} & \cdots & \mathbf{V}_1\mathbf{B}_{1G}\\ \mathbf{V}_2\mathbf{B}_{21} & \mathbf{V}_2\mathbf{B}_{22} & \cdots & \mathbf{V}_2\mathbf{B}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{V}_G\mathbf{B}_{G1} & \mathbf{V}_G\mathbf{B}_{G2} & \cdots & \mathbf{V}_G\mathbf{B}_{GG}\end{bmatrix} \quad \text{(A.3)}$$

Where **A** and **B** are *GN* × *GN* matrices, **V** and **VB** are *G* × *GN* matrices. $\mathbf{V}_s$ is a *1* × *N* row vector of direct value-added coefficient, $\mathbf{A}_{sr}$ is an *N* × *N* input-output coefficient matrix, $\mathbf{B}_{sr}$ is the *N* × *N* Leontief inverse matrix, which is the total amount of country *s*'s gross output required to produce an extra unit of the final good in country *r* (for consumption in both countries *s* and *r*). $\mathbf{X}_{sr}$ is a vector of *N* × *1* and denotes gross output produced in *s* and absorbed in *r*'s final demand. $\mathbf{X}_s = \sum_r^G \mathbf{X}_{sr}$is an *N* × *1* vector that accounts for the country *s*' total gross output. $\mathbf{Y}_{sr}$ is an *N* × *1* vector that gives final products produced in *s* and consumed in *r*'s final demand. $\mathbf{Y}_s = \sum_r^G \mathbf{Y}_{sr}$ is an *N* × *1* vector that records the global use of *s*' final goods. The gross output decomposition and final demand matrix in equation (A.2) are *GN* × *G* matrices.

Let $\widehat{\mathbf{V}}_s$ be an *N* × *N* diagonal matrix with direct value-added coefficients along the diagonal. ($\widehat{\mathbf{V}}_s$ has a dimension that is different from $\mathbf{V}_s$) the *GN* × *GN* diagonal value-added coefficient matrix can be defined as follows:

$$\widehat{\mathbf{V}}=\begin{bmatrix}\widehat{\mathbf{V}}_1 & \mathbf{0} & \cdots & \mathbf{0}\\ \mathbf{0} & \widehat{\mathbf{V}}_2 & \cdots & \mathbf{0}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{0} & \mathbf{0} & \cdots & \widehat{\mathbf{V}}_G\end{bmatrix} \quad \text{(A.4)}$$

To obtain the domestic value-added in a country's gross output it is necessary to multiply the value-added coefficient matrix ($\widehat{\mathbf{V}}$) with the right-hand side of equation (A.2), the gross output decomposition matrix. This will give a *GN* × *G* value-added production matrix $\widehat{\mathbf{V}}\mathbf{BY}$ as following:

$$\begin{bmatrix}\widehat{\mathbf{V}}_1 & \mathbf{0} & \cdots & \mathbf{0}\\ \mathbf{0} & \widehat{\mathbf{V}}_2 & \cdots & \mathbf{0}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{0} & \mathbf{0} & \cdots & \widehat{\mathbf{V}}_G\end{bmatrix}\begin{bmatrix}\mathbf{X}_{11} & \mathbf{X}_{12} & \cdots & \mathbf{X}_{1G}\\ \mathbf{X}_{21} & \mathbf{X}_{22} & \cdots & \mathbf{X}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{X}_{G1} & \mathbf{X}_{G2} & \cdots & \mathbf{X}_{GG}\end{bmatrix}$$

$$= \begin{bmatrix} \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{r1} & \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{r2} & \cdots & \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{rG} \\ \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{r1} & \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{r2} & \cdots & \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{rG} \\ \vdots & \vdots & \ddots & \vdots \\ \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{r1} & \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{r2} & \cdots & \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{rG} \end{bmatrix} \quad \text{(A.5)}$$

Elements in the diagonal columns account for each country's production of value-added absorbed domestically. Where exports of value-added can be defined as the elements in the off-diagonal columns of this $GN \times G$ matrix as follows:

$$VT_G = \widehat{\mathbf{V}}_s \mathbf{X}_{sr} = \widehat{\mathbf{V}}_s \sum_g^G \mathbf{B}_{sg}\mathbf{Y}_{gr} \quad \text{(A.6)}$$

This doesn't include the value-added generated by the home country that returns home after being processed abroad. While a country's total value-added exports to the world are given by the following accounting relationship:

$$VT_{s^*} = \sum_{r\neq s}^G \mathbf{V}\mathbf{X}_{sr} = \mathbf{V}_s \sum_{r\neq s}^G \sum_{g=1}^G \mathbf{B}_{sg}\mathbf{Y}_{gr} \quad \text{(A.7)}$$

Now this study can rewrite equation (A.7) into three groups based on where and how the value-added exports are absorbed to get the following decomposition:

$$VT_{s^*} = \mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{ss}\mathbf{Y}_{sr} + \mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{sr}\mathbf{Y}_{rr} + \mathbf{V}_s \sum_{r\neq s}^G \sum_{t\neq s,r}^G \mathbf{B}_{sr}\mathbf{Y}_{rt} \quad \text{(A.8)}$$

Equation (A.8) represents the value-added export breakdown in terms of all countries' final demands. The first term denotes the value-added in the country's final goods exports; the second term accounts for the value-added in the country's intermediate exports used by the direct importer to produce final goods consumed by the direct importer, and the third term records the value-added in the country's intermediate exports used by the direct importing country to produce final goods for third countries.

A country's gross exports to the world are given by the following equation:

$$\mathrm{E}_{s^*} = \sum_{r\neq s}^G \mathbf{E}_{sr} = \sum_{r\neq s}^G (\mathbf{A}_{sr}\mathbf{X}_r + \mathbf{Y}_{sr}) \quad \text{(A.9)}$$

So this study can decompose a country's gross exports to its various components as follows:

$$\begin{aligned} \mathrm{uE}_{s^*} &= \mathbf{V}_s\mathbf{B}_{ss}\mathbf{E}_{s^*} + \sum_{r\neq s}^G \mathbf{V}_r\mathbf{B}_{rs}\mathbf{E}_{s^*} \\ &= \mathbf{V}\mathbf{T}_{s^*} + \{\mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{sr}\mathbf{Y}_{rs} + \mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{sr}\mathbf{A}_{rs}\mathbf{X}_s\} \\ &\quad + \{\sum_{t\neq s}^G \sum_{r\neq s}^G \mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} + \sum_{t\neq s}^G \sum_{r\neq s}^G \mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}\mathbf{X}_r\} \end{aligned} \quad \text{(A.10)}$$

Based on the gross output identity for each country $\mathbf{X}_s = \mathbf{Y}_{ss} + \mathbf{A}_{ss}\mathbf{X}_s + \mathbf{E}_{s^*}$ then,

$$\begin{aligned} \mathbf{X}_s &= (\mathrm{I} - \mathbf{A}_{ss})^{-1} \mathbf{Y}_{ss} + (\mathrm{I} - \mathbf{A}_{ss})^{-1} \mathbf{E}_{s^*} \\ \mathbf{X}_r &= (\mathrm{I} - \mathbf{A}_{rr})^{-1} \mathbf{Y}_{rr} + (\mathrm{I} - \mathbf{A}_{rr})^{-1} \mathbf{E}_{r^*} \end{aligned} \quad \text{(A.11)}$$

Substitute $\mathbf{X}_s$ and $\mathbf{X}_r$ in equation (A.10) and insert equation (A.8) to get the G country, N sector generalized version of gross exports accounting equation as follows:

$$\begin{aligned} \mathrm{uE}_{s^*} &= \{\mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{ss}\mathbf{Y}_{sr} + \mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{sr}\mathbf{Y}_{rr} + \mathbf{V}_s \sum_{r\neq s}^G \sum_{t\neq s,r}^G \mathbf{B}_{sr}\mathbf{Y}_{rt}\} \\ &\quad + \{\mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{sr}\mathbf{Y}_{rs} + \mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{sr}\mathbf{Y}_{rs}(\mathrm{I} - \mathbf{A}_{ss})^{-1}\mathbf{Y}_{ss}\} \\ &\quad + \mathbf{V}_s \sum_{r\neq s}^G \mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I} - \mathbf{A}_{ss})^{-1}\mathbf{E}_{s^*} \\ &\quad + \{\sum_{t\neq s}^G \sum_{r\neq s}^G \mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} + \sum_{t\neq s}^G \sum_{r\neq s}^G \mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr}\} \\ &\quad + \sum_{t\neq s}^G \mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr} \sum_{r\neq s}^G (\mathrm{I} - \mathbf{A}_{rr})^{-1}\mathbf{E}_{r^*} \end{aligned} \quad \text{(A.12)}$$

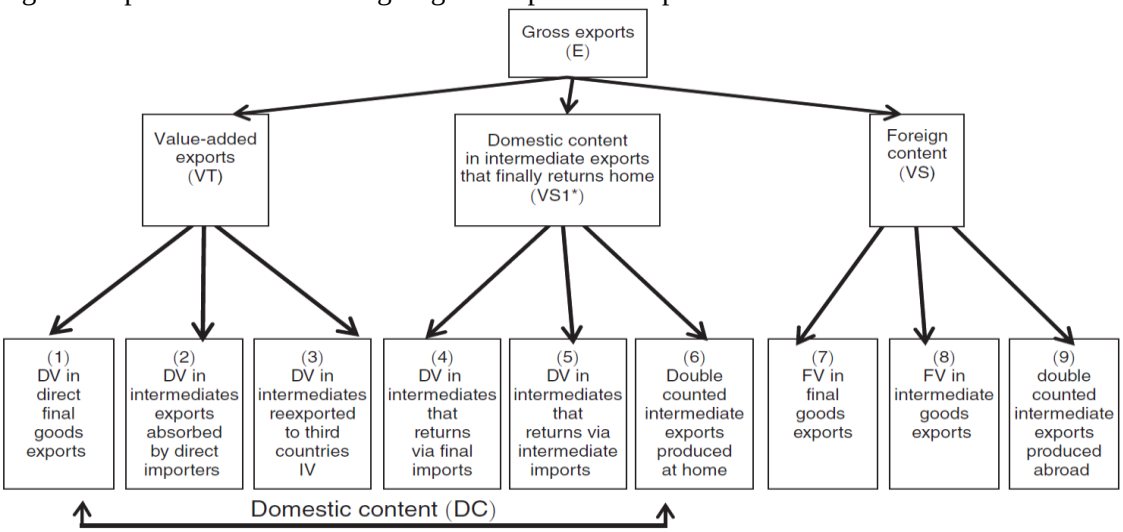
Equation (A.12) consists of nine terms as following:

1. The first three terms are the value-added (in the first bracketed expression)
2. The fourth and fifth terms (in the second bracketed expression) include the source country's value-added in both its final and intermediate goods imports, which are first exported but eventually reflected back and consumed domestically, both of which are parts of the source country's GDP but represent a double-counted portion in official gross export statistics.

The seventh and eighth terms in the third bracketed expression account for foreign value-added (GDP) in the source country's gross exports, comprising foreign GDP embodied in both final and intermediate goods. The sixth and the ninth terms record pure double-counted terms and they sum up the double-

counted portions of two-way intermediate trade from all bilateral routes. Equation (A.12) is also depicted in Figure A1.

Figure A1 presents an accounting of gross exports concepts



Source: Koopman et al., (2014)

To obtain the value-added exports by a country it is necessary to sum the terms (1) + (2) + (3). GDP in exports is the sum of (1) + (2) + (3) + (4) + (5). Domestic content in a country's exports equals to the sum of (1) + (2) + (3) + (4) + (5) + (6). Vertical Specialization (VS) equals (7) + (8) + (9) where the sum of (3) + (4) + (5) + (6) is part of VS1 of Hummels et al., (2001); and the term (4) is the VS1* of Daudin et al., (2011). The sum from (4) through (9) is the value-added that crosses national borders at least twice. Where measures of vertical specialization can be obtained as a linear combination of the first five items in equation (A.12) as follows:

$$DV_s = \mathbf{V}_s(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{E}_{s^*} = \mathbf{VT}_{s^*} + \mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rs} + \mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{Y}_{ss} \geq \sum_{\mathrm{r}}^{\mathrm{G}} VT_{s^*} \quad \text{(A.13)}$$

Equation (A.13) shows that the domestic value-added of exports of a country is generally greater than its value-added exports in aggregate and these two measures are equivalent only when there is no returned domestic value-added in imports, i.e., when both $\mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rs}$ and $\sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{Y}_{ss}$ are zero.

$$VS_s = \sum_{t\neq s}^{G} \sum_{r\neq s}^{G} \mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} + \sum_{t\neq s}^{G} \sum_{r\neq s}^{G} \mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rr} + \sum_{t\neq s}^{G} \mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr} \sum_{r\neq s}^{G} (\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r^*} + \sum_{r\neq s}^{G} \mathbf{V}_r\mathbf{B}_{rs}\mathbf{E}_{s^*} + \sum_{t\neq s}^{G} \sum_{r\neq s}^{G} \mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} + \sum_{t\neq s}^{G} \sum_{r\neq s}^{G} \mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}\mathbf{X}_r \quad \text{(A.14)}$$

which is made up of the last three components in equation (A.12). Applying a single country input-output framework, Koopman et al., (2008, 2012) have shown that:

$$VS \text{ share} = \mathbf{u} - \mathbf{A}_v(\mathrm{I} - \mathbf{A}^D)^{-1} = \mathbf{u}\mathbf{A}^M(\mathrm{I} - \mathbf{A}^D)^{-1} \quad \text{(A.15)}$$

While at the global level, i.e. in the *G*-country world,

$$VS \text{ share} = \sum_{r\neq s}^{G} \mathbf{V}_r\mathbf{B}_{rs} = \mathbf{u} - \mathbf{V}_s\mathbf{B}_{ss} = \mathbf{u} - \mathbf{V}_s(\mathrm{I} - \mathbf{A}_{ss})^{-1} - \sum_{r\neq s}^{G} \mathbf{V}_s\mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I} - \mathbf{A}_{ss})^{-1} \quad \text{(A.16)}$$

Where the last component is the adjustment made for domestic content reflected back to the country of origin. Thus, the foreign content measure of gross exports is a natural generalization of Hummels et al.,'s (2001) VS measure in a multi-country setting with unrestricted intermediate products trade. Because $\sum_{r\neq s}^{G} \mathbf{V}_r\mathbf{B}_{rs} + \mathbf{V}_s\mathbf{B}_{ss} = \mathrm{u}$, a country's domestic content in its exports can be defined as follows:

$$DC_s = \mathbf{V}_s\mathbf{B}_{ss}\mathbf{E}_{s^*} = \mathbf{VT}_{s^*} + \mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rs} + \mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{A}_{rs}\mathbf{X}_s \geq \mathbf{DV}_s \geq \sum_{\mathrm{r}}^{\mathrm{G}} \mathbf{VT}_{sr} \quad \text{(A.17)}$$

Equation (A.17) is the sum of the first six items in equation (A.12) which shows that the domestic content of exports of a country is greater than the part of its GDP in exports and also greater than its total value-added exports. These three terms equal each other only when both $\mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rs}$ and $\mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{A}_{rs}\mathbf{X}_s$ are zero means that there is no returned domestic value in imports. Where the second vertical specialization (VS1) of Hummels et al., (2001) measures the value of the exported goods that are used as imported intermediates by other countries to produce their exports.
According to Koopman et al., (2014), (VS1) can be specified based on the terms of gross exports accounting equations as follows:

$$VS1_s = \mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{E}_{r^*} = \mathbf{V}_s \sum_{r\neq s}^{G} \sum_{t\neq s,r}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rt} + \mathbf{V}_s \sum_{r\neq s}^{G} \sum_{t\neq s,r}^{G} \mathbf{B}_{sr}\mathbf{A}_{rt}\mathbf{X}_t + \mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{A}_{rs}\mathbf{X}_s + \mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rs} \quad (A.18)$$

This is equal to the third term in (A.12) plus the third and fifth components in equation (A.10). The second component in equation (A.18) record the domestic content in exported goods from the source country that is used as imported inputs to produce intermediate goods exports for other countries. It also indicates that VS1 measure is greater than indirect value-added exports because the latter only comprises the first term of (A.18) without domestic content that is reflected back home and the value embodied in intermediate goods exports via third countries, i.e.:

$$IV_s = \mathbf{V}_s \sum_{r\neq s}^{G} \sum_{t\neq s,r}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rt} \leq VS1_s \quad (A.19)$$

Koopman et al., (2014) define VS1* as follows:

$$VS1^*{}_s = \mathbf{V}_s \sum_{r\neq s}^{G} \mathbf{B}_{sr}\mathbf{E}_{r^*} = \mathbf{V}_s \sum_{r\neq s}^{G} \sum_{t\neq s,r}^{G} \mathbf{B}_{sr}\mathbf{Y}_{rt} + \mathbf{V}_s \sum_{r\neq s}^{G} \sum_{t\neq s,r}^{G} \mathbf{B}_{sr}\mathbf{A}_{rt}\mathbf{X}_t \quad (A.20)$$

Where VS1* is defined as a subset of VS1 similar to Daudin et al., (2011). Whereas this definition of Koopman et al., (2014) differs from theirs as they include only domestic value-added reflected back home in final goods imports (the first component in equation (A.20)) and exclude domestic content returned home by being embodied in the imports of intermediate inputs (the second term in equation (A.20)). Even the second term itself can be further decomposed into two components (the fifth and sixth terms in equation (A.12))

Hummels et al., (2001) introduced two measures of vertical specialization to show a complete picture of vertical specialization and a county's position in a vertically integrated production network (Koopman et al., (2014). For example, for a given country, the ratio of the two measures shows the country's position in global value chains. Downstream countries tend to have a higher share of VS from the import side (higher foreign content (VS)) in their exports, where upstream countries tend to have a higher share of VS from the export side (VS1), a higher share of exports through third countries.

According to Koopman et al., (2014), Equation (A.12) (or Figure A1) shows that how various double-counted items in gross exports can be used to better understand the level of a country's participation in global production networks. Moreover, the previous vertical specialization literature only decomposes gross exports into two components (domestic and foreign content) while equation (A.12) decomposes a country's domestic content into subcomponents to show the destinations for a country's exported value-added, including its own value-added returned home and the double-counted items due to cross border intermediate goods trade.

Appendix B: B&M (2019) framework

This appendix shows B&M (2019) general case of *G* countries producing *N* goods that are globally traded both as intermediate inputs and as final products with similar notation proposed by Koopman et al., (2014) in appendix A. Where $\mathbf{X}_s = (x_1^s x_1^s \ldots x_N^s)'$ is the *N × 1* vector of the gross output of country *s* and $\mathbf{Y}_s$ is the *N × 1* vector of final products which accounts for the final demand for goods generated in country *s* in each country of destination *r*: $\sum_r^G \mathbf{Y}_{sr}$. To generate one unit of gross output of good *i* a country uses a specific amount *a* of intermediate good *j* produced domestically or imported from abroad.

Therefore each unit of gross output can be either consumed as a final good or used as an intermediate good domestically or abroad:

$$\mathbf{X}_s = \sum_r^G \mathbf{A}_{sr}\mathbf{X}_r + \mathbf{Y}_{sr}$$

Where $\mathbf{A}_{sr}$ is the $N\times N$ coefficients matrix for intermediate inputs produced in s and processed further in r:

$$\mathbf{A}_{sr} = \begin{bmatrix} a_{sr,11} & a_{sr,12} & \cdots & a_{sr,1N} \\ a_{sr,21} & a_{sr,22} & \cdots & a_{sr,2N} \\ \vdots & \vdots & \ddots & \vdots \\ a_{sr,N1} & a_{sr,N2} & \cdots & a_{sr,NN} \end{bmatrix}$$

The general framework of production and trade with G countries and N goods can be expressed by the following block matrix notation:

$$\underset{(NG\times 1)}{\begin{bmatrix}\mathbf{X}_1\\ \mathbf{X}_2\\ \vdots\\ \mathbf{X}_G\end{bmatrix}} = \underset{(NG\times NG)}{\begin{bmatrix}\mathbf{A}_{11} & \mathbf{A}_{12} & \cdots & \mathbf{A}_{1G}\\ \mathbf{A}_{21} & \mathbf{A}_{22} & \cdots & \mathbf{A}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{A}_{G1} & \mathbf{A}_{G2} & \cdots & \mathbf{A}_{GG}\end{bmatrix}} \underset{(NG\times 1)}{\begin{bmatrix}\mathbf{X}_1\\ \mathbf{X}_2\\ \vdots\\ \mathbf{X}_G\end{bmatrix}} + \underset{(NG\times G)}{\begin{bmatrix}\mathbf{Y}_{11} & \mathbf{Y}_{12} & \cdots & \mathbf{Y}_{1G}\\ \mathbf{Y}_{21} & \mathbf{Y}_{22} & \cdots & \mathbf{Y}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{Y}_{G1} & \mathbf{Y}_{G2} & \cdots & \mathbf{Y}_{GG}\end{bmatrix}} \underset{(G\times 1)}{\begin{bmatrix}1\\ 1\\ \vdots\\ 1\end{bmatrix}} \tag{B.1}$$

from which the relationship between gross output and final demand is given by the following matrix notation:

$$\begin{bmatrix}\mathbf{X}_1\\ \mathbf{X}_2\\ \vdots\\ \mathbf{X}_G\end{bmatrix} = \begin{bmatrix}\mathbf{I}-\mathbf{A}_{11} & -\mathbf{A}_{12} & \cdots & -\mathbf{A}_{1G}\\ -\mathbf{A}_{21} & \mathbf{I}-\mathbf{A}_{22} & \cdots & -\mathbf{A}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ -\mathbf{A}_{G1} & -\mathbf{A}_{G2} & \cdots & \mathbf{1}-\mathbf{A}_{GG}\end{bmatrix}^{-1} \begin{bmatrix}\sum_r^G \mathbf{Y}_{1r}\\ \sum_r^G \mathbf{Y}_{2r}\\ \vdots\\ \sum_r^G \mathbf{Y}_{1G}\end{bmatrix}$$

$$= \begin{bmatrix}\mathbf{B}_{11} & \mathbf{B}_{12} & \cdots & \mathbf{B}_{1N}\\ \mathbf{B}_{21} & \mathbf{B}_{22} & \cdots & \mathbf{B}_{2N}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{B}_{G1} & \mathbf{B}_{G2} & \cdots & \mathbf{B}_{GG}\end{bmatrix} \begin{bmatrix}\sum_r^G \mathbf{Y}_{1r}\\ \sum_r^G \mathbf{Y}_{2r}\\ \vdots\\ \sum_r^G \mathbf{Y}_{1G}\end{bmatrix} \tag{B.2}$$

where $\mathbf{B}_{sr}$ is the $N\times N$ block of the Leontief inverse matrix in a global input-output framework. It shows how much of the gross output of country s of a specific product is needed to generate an extra unit of final production in country r. So the direct value-added share in each unit of gross output generated in country s is equal to one minus the sum of the direct intermediate input share of all the domestic and foreign suppliers:

$$\mathbf{V}_s = \mathbf{u}_N \left(1 - \sum_r^G \mathbf{A}_{rs}\right) \tag{B.3}$$

Where $\mathbf{u}_N$ is the $1\times N$ unit row vector. Thus the $G\times GN$ direct domestic value-added matrix for all countries is defined as:

$$\mathbf{V} = \begin{bmatrix}\mathbf{V}_1 & \mathbf{0} & \cdots & \mathbf{0}\\ \mathbf{0} & \mathbf{V}_2 & \cdots & \mathbf{0}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{V}_G\end{bmatrix}$$

While the value-added share $G\times GN$ matrix can be derived by multiplying the $\mathbf{V}$ matrix by the Leontief inverse $\mathbf{B}$:

$$\mathbf{VB} = \begin{bmatrix}\mathbf{V}_1\mathbf{B}_{11} & \mathbf{V}_1\mathbf{B}_{12} & \cdots & \mathbf{V}_1\mathbf{B}_{1G}\\ \mathbf{V}_2\mathbf{B}_{21} & \mathbf{V}_2\mathbf{B}_{22} & \cdots & \mathbf{V}_2\mathbf{B}_{2G}\\ \vdots & \vdots & \ddots & \vdots\\ \mathbf{V}_G\mathbf{B}_{G1} & \mathbf{V}_G\mathbf{B}_{G2} & \cdots & \mathbf{V}_G\mathbf{B}_{GG}\end{bmatrix}$$

Since the value-added shares of different countries in final demand have to sum to one

the following property holds:

$$\sum_t^G \mathbf{V}_t \mathbf{B}_{tr} = \mathbf{u}_N \tag{B.4}$$

The final demand $GN \times G$ matrix is defined as:

$$\mathbf{Y} = \begin{bmatrix} \mathbf{Y}_{11} & \mathbf{Y}_{12} & \cdots & \mathbf{Y}_{1G} \\ \mathbf{Y}_{21} & \mathbf{Y}_{22} & \cdots & \mathbf{Y}_{2G} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{Y}_{G1} & \mathbf{Y}_{G2} & \cdots & \mathbf{Y}_{GG} \end{bmatrix}$$

Where the value-added $G \times G$ matrix by pairs of source-absorption countries can be derived as follows:

$$\overline{\mathbf{VA}} \equiv \mathbf{VBY} = \begin{bmatrix} \mathbf{V}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{r1} & \mathbf{V}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{r2} & \cdots & \mathbf{V}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{rG} \\ \mathbf{V}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{r2} & \mathbf{V}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{r2} & \cdots & \mathbf{V}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{rG} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{V}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{rG} & \mathbf{V}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{rG} & \cdots & \mathbf{V}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{rG} \end{bmatrix} \tag{B.5}$$

To derive the domestic value-added by sector, it is necessary to use a different form of the direct value-added matrix. Where $\widehat{\mathbf{V}}_1$ is defined as the $N \times N$ diagonal matrix with the direct value-added coefficients along the principal diagonal, the $GN \times GN$ block diagonal matrix for all countries and sectors of origin becomes:

$$\widehat{\mathbf{V}} = \begin{bmatrix} \widehat{\mathbf{V}}_1 & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \widehat{\mathbf{V}}_2 & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \widehat{\mathbf{V}}_G \end{bmatrix}$$

The $GN \times G$ matrix that regenerates the breakdown of value-added by sector-county of origin and country of final destination is:

$$\mathbf{VA} \equiv \widehat{\mathbf{V}}\mathbf{BY} = \begin{bmatrix} \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{r1} & \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{r2} & \cdots & \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\mathbf{Y}_{rG} \\ \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{r2} & \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{r2} & \cdots & \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\mathbf{Y}_{rG} \\ \vdots & \vdots & \ddots & \vdots \\ \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{rG} & \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{rG} & \cdots & \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\mathbf{Y}_{rG} \end{bmatrix} \tag{B.6}$$

The off-diagonal components of the **VA** matrix correspond to the value-added exports proposed by Koopman et al., (2014) i.e. the vector of domestic value-added originated in country *s* and absorbed by final demand in country *r*:

$$\mathbf{VT}_{sr} = \mathbf{VA}_{sr} = \widehat{\mathbf{V}}_s \sum_g^G \mathbf{B}_{sg}\mathbf{Y}_{gr} \tag{B.7}$$

To relate the sector/country in which the value-added is originated with the sector/country of final demand absorption, it is sufficient to modify the final demand matrix **Y** of equation (B.6). Where $\widehat{\mathbf{Y}}_{sr}$ is defined as the $N \times N$ diagonal matrix with country *r's* demand for final goods generated in country *s* along the principal diagonal:

$$\widehat{\mathbf{Y}}_{sr} = \begin{bmatrix} y_{sr,1} & 0 & \cdots & 0 \\ 0 & y_{sr,2} & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & y_{sr,N} \end{bmatrix}$$

Therefore the distribution of global value-added by combinations of sector/county of origin and sector-country of final destination is determined by $GN \times GN$ matrix as follows:

$$\widehat{\mathbf{VA}} \equiv \widehat{\mathbf{V}}\mathbf{B}\widehat{\mathbf{Y}} =$$

$$= \begin{bmatrix} \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\widehat{\mathbf{Y}}_{r1} & \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\widehat{\mathbf{Y}}_{r2} & \cdots & \widehat{\mathbf{V}}_1 \sum_r^G \mathbf{B}_{1r}\widehat{\mathbf{Y}}_{rG} \\ \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\widehat{\mathbf{Y}}_{r2} & \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\widehat{\mathbf{Y}}_{r2} & \cdots & \widehat{\mathbf{V}}_2 \sum_r^G \mathbf{B}_{2r}\widehat{\mathbf{Y}}_{rG} \\ \vdots & \vdots & \ddots & \vdots \\ \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\widehat{\mathbf{Y}}_{rG} & \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\widehat{\mathbf{Y}}_{rG} & \cdots & \widehat{\mathbf{V}}_G \sum_r^G \mathbf{B}_{Gr}\widehat{\mathbf{Y}}_{rG} \end{bmatrix} \quad \text{(B.8)}$$

Appendix C: Equivalences in ICIO modeling

This appendix shows the commonly used equivalences in the ICIO framework to set relationships between components. Based on B&M (2019) decomposition framework, the property of inverse matrix **B** is considered by the following accounting relationship:

$$\mathbf{B(I - A) = (I - A)B = I}$$

The generic block diagonal element $\mathbf{B}_{ss}$ is given by:

$$\begin{aligned} \mathbf{B}_{ss} = & \sum_{t\neq s}^G \mathbf{B}_{st}\mathbf{A}_{ts}(\mathrm{I} - \mathbf{A}_{ss})^{-1} + (\mathrm{I} - \mathbf{A}_{ss})^{-1} \\ & = (\mathrm{I} - \mathbf{A}_{ss})^{-1} + (\mathrm{I} - \mathbf{A}_{ss})^{-1} \sum_{t\neq s}^G \mathbf{A}_{st}\mathbf{B}_{ts} \end{aligned} \quad \text{(C.1)}$$

While the generic off-diagonal block element $\mathbf{B}_{rs}$ is accounted for by the following equation:

$$\begin{aligned} \mathbf{B}_{rs} = & \sum_{t\neq s}^G \mathbf{B}_{rt}\mathbf{A}_{ts}(\mathrm{I} - \mathbf{A}_{ss})^{-1} \\ & = (\mathrm{I} - \mathbf{A}_{rr})^{-1} \sum_{t\neq r}^G \mathbf{A}_{rt}\mathbf{B}_{ts} \end{aligned} \quad \text{(C.2)}$$

B&M (2019) introduce an amended version of the Leontief inverse matrix ($\mathbf{B}^{\$}$) to derive bilateral decompositions. Where they set equal to 0 the coefficients that identify the requirement of inputs from country *s* in the **A** matrix with exception to $\mathbf{A}_{ss}$ (i.e.the domestic input requirement matrix). Therefore; the amended matrix of input requirements $\mathbf{A}^{\$}$:

$$\mathbf{A}^{\$} = \mathbf{A}\text{-}\mathbf{A}^{s} \quad \text{(C.3)}$$

Where $\mathbf{A}^{s}$ is the *GN*×*GN* matrix with the coefficients of intermediate goods imported from *s* in the corresponding sub-matrices and zero elsewhere. The $\mathbf{B}^{s}$ is the inverse of ($\mathbf{I} - \mathbf{A}^{\$}$) thus the following relationships hold:

$$(\mathbf{I} - \mathbf{A}^{\$})\,\mathbf{B}^{\$} = \mathbf{B}^{\$}(\mathbf{I} - \mathbf{A}^{\$}) = \mathbf{I} \quad \text{(C.4)}$$

By substituting (C.3) into (C.4) produce:

$$(\mathbf{I} - \mathbf{A})\,\mathbf{B}^{\$} + \mathbf{A}^{s}\mathbf{B}^{\$} = \mathbf{B}^{\$}\,(\mathbf{I} - \mathbf{A}) + \mathbf{B}^{\$}\mathbf{A}^{s} = \mathbf{I} \quad \text{(C.5)}$$

By multiplying both sides of (C.5) by $\mathbf{B} \equiv (\mathbf{I} - \mathbf{A})^{-1}$ produce the following equivalence:

$$\mathbf{B} = \mathbf{B}^{\$} + \mathbf{B}\mathbf{A}^{s}\mathbf{B}^{\$} \quad \text{(C.6)}$$

At this point, they focus on the off-diagonal block element $\mathbf{B}_{rs}$ to account for the gross output produced in *s* necessary to generate one unit of *r*'s final good. Based on equation (C.6) this sub-matrix can be expressed as:

$$\mathbf{B}_{sr} = \mathbf{B}^{\$}_{sr} + \mathbf{B}_{ss} \sum_{t\neq s} \mathbf{A}_{st}\,\mathbf{B}^{\$}_{tr} \quad \text{(C.7)}$$

Where $\mathbf{B}_{sr}^{\$}$ is equal to zero for each $r \neq s$ (it corresponds to a summation of infinite components all equal to the null matrix). Thus, they single out the $\mathbf{B}_{rr}^{\$}$ component from the final summation of the RHS of equation (C.7) to obtain:

$$\mathbf{B}_{sr} = \mathbf{B}_{ss}\mathbf{A}_{sr}\mathbf{B}_{rr}^{\$} + \mathbf{B}_{ss}\sum_{t\neq s,r}\mathbf{A}_{st}\,\mathbf{B}_{tr}^{\$} \tag{C.8}$$

By applying to the components of the matrix $\mathbf{B}^{\$}$ the properties of **B** sub-matrices identified in (C.1) and (C.2):

$$\mathbf{B}_{rr}^{\$} = (\mathbf{I} - \mathbf{A}_{rr})^{-1} + (\mathbf{I} - \mathbf{A}_{rr})^{-1}\sum_{j\neq r}\mathbf{A}_{rj}\,\mathbf{B}_{jr}^{\$} \tag{C.9}$$

$$\mathbf{B}_{tr}^{\$} = (\mathbf{I} - \mathbf{A}_{tt})^{-1}\sum_{j\neq t}\mathbf{A}_{tj}\,\mathbf{B}_{jr}^{\$} \tag{C.10}$$

Appendix D: proofs

This appendix shows how B&M (2019) derive the equivalence between their domestic value-added source-based approach and the complement of the import content of exports proposed by Hummels et al., (2001). They prove that the numerator of the $\mathbf{VS}_{sr}$ indicator in equation (1) is equal to the complement of the domestic value-added ($\mathbf{DVA}source_{sr}$) in the source-based breakdown of bilateral exports flows from country *s* to country *r* of equation (H.5). It means that

$$\mathbf{u}_N\sum_{j\neq s}\mathbf{A}_{js}\,(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{E}_{sr} \tag{D.1}$$

Should be equal to

$$\mathbf{V}_s\mathbf{B}_{ss}^{\$}\sum_{j\neq s}\mathbf{A}_{sj}\,\mathbf{B}_{js}\mathbf{E}_{sr} + \sum_{t\neq s}\mathbf{V}_t\,\mathbf{B}_{ts}^{\$}\mathbf{E}_{sr} + \sum_{t\neq s}\mathbf{V}_t\,\mathbf{B}_{ts}^{\$}\sum_{j\neq s}\mathbf{A}_{sj}\,\mathbf{B}_{js}\mathbf{E}_{sr} \tag{D.2}$$

Since $\mathbf{u}_N = \sum_t \mathbf{V}_t\,\mathbf{B}_{tj}$ (see (B.4)), the equation (D.1) can be expressed as:

$$\mathbf{V}_s\mathbf{B}_{sj}\sum_{j\neq s}\mathbf{A}_{sj}\,(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{E}_{sr} + \sum_{t\neq s}\mathbf{V}_t\,\mathbf{B}_{tj}^{\$}\sum_{j\neq s}\mathbf{A}_{sj}\,(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{E}_{sr} \tag{D.3}$$

While from equation (H.4) it follows that the expression in (D.2) corresponds to:

$$\mathbf{V}_s(\mathrm{I} - \mathbf{A}_{ss})^{-1}\sum_{j\neq s}\mathbf{A}_{sj}\,\mathbf{B}_{js}\mathbf{E}_{sr} + \sum_{t\neq s}\mathbf{V}_t\,\mathbf{B}_{ts}\mathbf{E}_{sr} \tag{D.4}$$

Where in (D.4) they make use of the equivalence between $\mathbf{B}_{ss}^{\$}$ and $(\mathrm{I} - \mathbf{A}_{ss})^{-1}$. From equivalence in (B.1):

$$\mathbf{V}_s\mathbf{B}_{sj}\sum_{j\neq s}\mathbf{A}_{js}\,(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{E}_{sr} = \mathbf{V}_s(\mathrm{I} - \mathbf{A}_{ss})^{-1}\sum_{j\neq s}\mathbf{A}_{sj}\,\mathbf{B}_{js}\mathbf{E}_{sr} \tag{D.5}$$

While from (C.2)

$$\sum_{t\neq s}\mathbf{V}_t\,\mathbf{B}_{tj}\sum_{j\neq s}\mathbf{A}_{js}\,(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{E}_{sr} = \sum_{t\neq s}\mathbf{V}_t\,\mathbf{B}_{ts}\mathbf{E}_{sr} \tag{D.6}$$

Then, it is proved that (D.1) is equal to (D.2).

Whereas in the equivalence between the source-based value-added in exports and the sink-based one for gross exports of a country, B&M (2019) decomposition framework shows that the domestic (foreign) value-added in the gross exports of country *s* can be obtained by summing across the bilateral importers *r* the expressions in equation (H.11) (equation (H.12)), for the source-based approach, and in equation (18) (equation (19)), for the sink-based approach. By refraining from maintaining the track of the country of re-export, the total value-added generated in country *j* and exported by country *s*:

$$\mathbf{VA}source_s^j = \mathbf{V}_j\mathbf{B}_{js}^{\not s}\sum_{r\neq s}^{G}\mathbf{Y}_{sr} + \mathbf{V}_j\mathbf{B}_{js}^{\not s}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\sum_{k}^{G}\sum_{l}^{G}\mathbf{B}_{jk}\mathbf{K}_{kl} \quad (D.7)$$

$$\mathbf{VA}sink_s^j = \mathbf{V}_j\mathbf{B}_{js}\sum_{r\neq s}^{G}\mathbf{Y}_{sr} + \mathbf{V}_j\mathbf{B}_{js}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\mathbf{B}_{rs}^{\not s}\mathbf{Y}_{ss} + \mathbf{V}_j\mathbf{B}_{js}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\sum_{k\neq s}^{G}\sum_{l}^{G}\mathbf{B}_{rk}^{\not s}\mathbf{Y}_{kl} \quad (D.8)$$

From equation (C.6) $\mathbf{B}_{js} = \mathbf{B}_{js}^{\not s} + \mathbf{B}_{js}^{\not s}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\mathbf{B}_{rs}$ then equation (D.8) can be re-expressed as:

$$\mathbf{VA}sink_s^j = \mathbf{V}_j\mathbf{B}_{js}^{\not s}\sum_{r\neq s}^{G}\mathbf{Y}_{sr} + \mathbf{V}_j\mathbf{B}_{js}^{\not s}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\mathbf{B}_{rs}\sum_{l\neq s}^{G}\mathbf{Y}_{sl} + \mathbf{V}_j\mathbf{B}_{js}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\mathbf{B}_{rs}^{\not s}\mathbf{Y}_{ss} + \mathbf{V}_j\mathbf{B}_{js}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\sum_{k\neq s}^{G}\sum_{l}^{G}\mathbf{B}_{rk}^{\not s}\mathbf{Y}_{kl} \quad (D.9)$$

Where $\sum_{l\neq s}^{G}\mathbf{Y}_{sl} \equiv \sum_{r\neq s}^{G}\mathbf{Y}_{sr}$.

Since $\mathbf{B}_{js}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\mathbf{B}_{rk}^{\not s} = \mathbf{B}_{js}^{\not s}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\mathbf{B}_{rk}$, equation (D.9) can be re-expressed as

$$\mathbf{VA}sink_s^j = \mathbf{V}_j\mathbf{B}_{js}^{\not s}\sum_{r\neq s}^{G}\mathbf{Y}_{sr} + \mathbf{V}_j\mathbf{B}_{js}^{\not s}\sum_{r\neq s}^{G}\mathbf{A}_{sr}\sum_{k}^{G}\sum_{l}^{G}\mathbf{B}_{jk}\mathbf{Y}_{kl} \quad (D.10)$$

Equation (D.10) is equal to the value-added generated in *j* and exported by *s* according to the source-based framework of equation (C.7)

Appendix E: comparison between B&M (2019) and Koopman et al., (2014)

The Koopman et al., (2014) breakdown of gross exports of country *s* ($\mathbf{u}_N\mathbf{E}_{s*}$) is given by the following accounting relationship:

$$\begin{aligned}\mathbf{u}_N\mathbf{E}_{s*} = {} & \{\mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{ss}\mathbf{Y}_{sr} + \mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{sr}\mathbf{Y}_{rr} + \mathbf{V}_s\sum_{r\neq s}^{G}\sum_{t\neq s,r}^{G}\mathbf{B}_{sr}\mathbf{Y}_{rt}\} \\ & + \{\mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{sr}\mathbf{Y}_{rs} + \mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I}-\mathbf{A}_{ss})^{-1}\mathbf{Y}_{ss}\} \\ & + \mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I}-\mathbf{A}_{ss})^{-1}\mathbf{E}_{s*} \\ & + \{\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} + \sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr}\} \\ & + \sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{E}_{r*}\end{aligned} \quad (E.1)$$

The nine terms are defined as follows (KWW denotes Koopman et al., (2014):
Term 1 (KWW1) $\mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{ss}\mathbf{Y}_{sr}$ is the domestic value-added in direct final goods exports.
Term 2 (KWW2): $\mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{sr}\mathbf{Y}_{rr}$ is domestic value-added in intermediate exports absorbed by direct importers.
Term 3 (KWW3): $\mathbf{V}_s\sum_{r\neq s}^{G}\sum_{t\neq s,r}^{G}\mathbf{B}_{sr}\mathbf{Y}_{rt}$ is the domestic value-added in intermediate goods re-exported to third countries.
Term 4 (KWW4): $\mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{sr}\mathbf{Y}_{rs}$ is the domestic value-added in intermediate exports reimported as final goods.
Term 5 (KWW5): $\mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I}-\mathbf{A}_{ss})^{-1}\mathbf{Y}_{ss}$ is the domestic value-added in intermediate inputs reimported as intermediate goods and finally consumed at home.
Term 6 (KWW6): $\mathbf{V}_s\sum_{r\neq s}^{G}\mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I}-\mathbf{A}_{ss})^{-1}\mathbf{E}_{s*}$ is the double-counted intermediate exports originally produced at home.
Term 7 (KWW7): $\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr}$ is the foreign value-added in exports of final goods.
Term 8 (KWW8): $\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr}$ is the foreign value-added in exports of intermediate goods.
Term 9 (KWW9): $\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{E}_{r*}$ is the double-counted intermediate exports originally produced abroad.

While B&M (2019) sink-based decomposition of bilateral exports from country *s* to country *r* is summarized by the following equation:

$$
\begin{aligned}
\mathbf{u}_N\mathbf{E}_{sr} = {} & \mathbf{V}_s\mathbf{B}_{ss}\mathbf{Y}_{sr} \\
& + \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\mathbf{Y}_{rr}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kk}\right] \\
& + \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r,s}^{G}\mathbf{Y}_{rj}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{l\neq s,r}^{G}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rl}\right. \\
& \left. + \sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{kr}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r,l}^{G}\sum_{l\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kl}\right] \\
& + \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\mathbf{Y}_{rs}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rs}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{ks}\right] \\
& + \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{js}^{\$}\mathbf{Y}_{ss} \\
& \quad + \mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{js}^{\$}\mathbf{E}_{s*} \\
& \quad + \sum_{t\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr} \\
& \quad + \sum_{t\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} \\
& + \mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{Y}_{rj}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\mathbf{Y}_{jj}\right] \\
& + \sum_{t\neq s,r}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{E}_{r*} \\
& \quad + \mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\mathbf{E}_{j*} \qquad \text{(E.2)}
\end{aligned}
$$

While the terms of the bilateral decomposition of gross exports can be defined as follows (BM means B&M, 2019):

Term 1 (BM1): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{Y}_{sr}$ is domestic value-added in direct final good exports.

Term 2 (BM2a): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\mathbf{Y}_{rr}\right]$ is domestic value-added in intermediate exports absorbed by direct importers as local final goods.

Term 2 (BM2b): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr}\right]$ is domestic value-added in intermediate exports absorbed by direct importers as local final goods only after additional processing stages abroad.

Term 2 (BM2c): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kk}\right]$ is domestic value-added in intermediate exports absorbed by third countries as local final goods.

Term 3 (BM3a): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r,s}^{G}\mathbf{Y}_{rj}\right]$ is domestic value-added in intermediate exports absorbed by third countries as final goods from direct bilateral importers.

Term 3 (BM3b): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{l\neq s,r}^{G}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rl}\right]$ is domestic value-added in intermediate exports absorbed by third countries as final goods from direct bilateral importers only after further processing stages abroad.

Term 3 (BM3c): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{kr}\right]$ is domestic value-added in intermediate exports absorbed by direct importers as final goods from third countries.

Term 3 (BM3d): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r,l}^{G}\sum_{l\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kl}\right]$ is domestic value-added in intermediate exports absorbed by third countries as final goods from other third countries.

Term 4 (BM4a): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\mathbf{Y}_{rs}\right]$ is domestic value-added in intermediate exports absorbed at home as final goods of the bilateral importers.

Term 4 (BM4b): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rs}\right]$ is domestic value-added in intermediate exports absorbed at home as final goods of the bilateral importers after additional processing stages abroad.

Term 4 (BM4c): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{ks}\right]$ is domestic value-added in intermediate exports absorbed at home as final goods of a third country.

Term 5 (BM5): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{js}^{\$}\mathbf{Y}_{ss}$ is domestic value-added in intermediate exports absorbed at home as domestic final goods.

Term 6 (BM6): $\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{js}^{\$}\mathbf{E}_{s*}$ is double-counted intermediate exports originally produced at home.

Term 7 (BM7): $\sum_{t\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{Y}_{sr}$ is foreign value-added in exports of final goods.

Term 8 (BM8): $\sum_{t\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr}$ is foreign value-added in exports of intermediate goods directly absorbed by the importing country *r*.

Term 9 (BM9a): $\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{Y}_{rj}\right]$ plus Term 9 (BM9b): $\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left[\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\mathbf{Y}_{jj}\right]$ to account for foreign value-added in exports of intermediate goods re-exported by *r* directly to the country of final consumption.

Term 9 (BM9c): $\sum_{t\neq s,r}^{G} \mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*}$ plus Term 9 (BM9d): $\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}\ (\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\,\mathbf{E}_{j*}$ to account for double-counted intermediate exports originally produced abroad.

Classification of the items in equation (E.2) is similar to those proposed by Koopman et al., (2014) in equation (E.1). For instance, the sum over the importing countries *r* of the corresponding items in (E.2) bilateral decomposition corresponds to the following items in (E.1) (B&M, 2019): 1) The domestic value-added indirect final goods exports. 2) The foreign value-added in exports of final goods. 3) The foreign value-added in exports of intermediate goods.

Koopman et al., (2014) consider the 9th component ($\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\,\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*}$) in the RHS in (E.1) breakdown as foreign double-counted item while B&M (2019) refine this item by splitting it into the foreign value-added ($\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}\ (\mathrm{I}-\mathbf{A}_{rr})^{-1}\ [\sum_{j\neq r}^{G}\mathbf{Y}_{rj}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\mathbf{Y}_{jj}]$) in equation (E.2) and foreign double-counted components ($\sum_{t\neq s,r}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*}+\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}\ (\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\,\mathbf{E}_{j*}$) in equation (E.2). To prove this, B&M (2019) decompose term 9th of equation (E.1) into the part originally produced by the importing country *r* and that generated in other economies as following:

$$\begin{aligned}\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*} &= \sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*}\\ &+\sum_{t\neq s}^{G}\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*}\end{aligned}\qquad(\mathrm{E.3})$$

Where the first component on the RHS of equation (E.3) consistent with the sum across bilateral partners of the component ($\sum_{t\neq s,r}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*}$) in (E.2). While items ($\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}\ (\mathrm{I}-\mathbf{A}_{rr})^{-1}\ [\sum_{j\neq r}^{G}\mathbf{Y}_{rj}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\mathbf{Y}_{jj}]$ and $\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}\ (\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\,\mathbf{E}_{j*}$) in (E.2) are accounting for starting from the second item on the RHS of equation (E.3) and expressing the exports from *r* ($\mathbf{E}_{r*}$) based on the accounting relationship in equations (12)–(14) as following:

$$\begin{aligned}&\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*} =\\ &=\sum_{t\neq s}^{G}\sum_{r\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*}\\ &+\sum_{r\neq s}^{G}\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\,\mathbf{Y}_{jj}\\ &+\sum_{r\neq s}^{G}\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}(\mathrm{I}-\mathbf{A}_{jj})^{-1}\,\mathbf{E}_{r*}\\ &\quad+\sum_{r\neq s}^{G}\mathbf{V}_r\mathbf{B}_{rs}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{Y}_{rj}\end{aligned}\qquad(\mathrm{E.4})$$

To prove the equivalence between (E.1) and (E.2) of the remaining items according to B&M (2019), plug (C.9) and (C.10) into (C.8) to get $\mathbf{B}_{rs}$:

$$\begin{aligned}\mathbf{B}_{rs} = \mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1} &+\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}\mathbf{A}_{rj}\,\mathbf{B}_{jr}^{\$}\\ &+\mathbf{B}_{ss}\sum_{t\neq s,r}\mathbf{A}_{st}\,(\mathrm{I}-\mathbf{A}_{tt})^{-1}\sum_{j\neq t}^{G}\mathbf{A}_{tj}\mathbf{B}_{jr}^{\$}\end{aligned}\qquad(\mathrm{E.5})$$

Then sum across the *G*−1 foreign countries (i.e. $\sum_{r\neq s}^{G}$) to show how the remaining components that account for the bilateral trade flow in equation (E.2) can be mapped into the corresponding components of aggregate exports decomposition in equation (E.1). For example, pre-multiplying by matrix $\mathbf{V}_s$, post-multiplying by $\mathbf{Y}_{rr}$ and summing across *r* both sides of equation (E.5) to obtain the second component of Koopman et al., (2014) decomposition:

$$\begin{aligned}\mathbf{V}_s\sum_{r\neq s}\mathbf{B}_{sr}\,\mathbf{Y}_{rr} = \mathbf{V}_s\sum_{r\neq s}\mathbf{B}_{ss}\,\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rr}&\\ +\mathbf{V}_s\sum_{r\neq s}\mathbf{B}_{ss}\,\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}\mathbf{A}_{rj}\,\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr}&\\ +\mathbf{V}_s\sum_{r\neq s}\mathbf{B}_{ss}\sum_{t\neq s,r}\mathbf{A}_{st}\,(\mathrm{I}-\mathbf{A}_{tt})^{-1}\sum_{j\neq t}^{G}\mathbf{A}_{tj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr}&\end{aligned}\qquad(\mathrm{E.6})$$

Where the left-hand side (LHS) of equation (E.6) is consistent with the sum across all direct importers (r) of the items ($\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}[\mathbf{Y}_{rr}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kk}]$) in equation (E.2):

$$\begin{aligned}\sum_{r\neq s}\mathbf{V}_s\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}[\mathbf{Y}_{rr}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kk}] &= \\ &= \mathbf{V}_s\sum_{r\neq s}\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\mathbf{Y}_{rr} \\ &+ \mathbf{V}_s\sum_{r\neq s}\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\mathbf{B}_{jr}^{\$}\mathbf{Y}_{rr} \\ &+ \mathbf{V}_s\sum_{r\neq s}\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k\neq s,r}^{G}\mathbf{B}_{jk}^{\$}\mathbf{Y}_{kk} \qquad \text{(E.7)}\end{aligned}$$

Based on the definition of the $\mathbf{B}_{rs}$ the matrix in equation (E.5) and following the same procedure applied to obtain the second component of Koopman et al., (2014) decomposition, proves that the third and fourth components too in (E.1) can be obtained as the sum of the corresponding items in B&M (2019) bilateral decomposition across all the destinations.

While to obtain the fifth and sixth terms in (E.1), B&M (2019) start by singling out the block matrix $\mathbf{B}_{ss}$ from the principal diagonal of the **B** matrix. Based on equation (E.6) this matrix corresponds to:

$$\mathbf{B}_{ss} = \mathbf{B}_{ss}^{\$} + \mathbf{B}_{ss}\sum_{r\neq s}\mathbf{A}_{sr}\mathbf{B}_{rs}^{\$} \qquad \text{(E.8)}$$

Then they apply to the $\mathbf{B}^{\$}$ the property of the block diagonal elements of the **B** matrix as explained in equation (C.1):

$$\mathbf{B}_{ss}^{\$} = (\mathrm{I}-\mathbf{A}_{ss}^{\$})^{-1} + \sum_{t\neq s}\mathbf{B}_{st}^{\$}\mathbf{A}_{ts}(\mathrm{I}-\mathbf{A}_{ss}^{\$})^{-1} = (\mathrm{I}-\mathbf{A}_{ss})^{-1} \qquad \text{(E.9)}$$

Where the last equality follows from the fact that $\mathbf{B}_{st}^{\$}$ is equal to zero for each $t \neq s$. Thus (E.8) can be re-expressed as:

$$\mathbf{B}_{ss} = (\mathrm{I}-\mathbf{A}_{ss})^{-1} + \mathbf{B}_{ss}\sum_{r\neq s}\mathbf{A}_{sr}\mathbf{B}_{rs}^{\$} \qquad \text{(E.10)}$$

By using the same property of the block diagonal elements of the **B** matrix to the LHS of (E.10) and rearranging to get:

$$\sum_{r\neq s}\mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I}-\mathbf{A}_{ss})^{-1} = \sum_{r\neq s}\mathbf{B}_{ss}\mathbf{A}_{sr}\mathbf{B}_{rs}^{\$} \qquad \text{(E.11)}$$

By applying the property presented in (C.2) to the $\mathbf{B}_{rs}^{\$}$ the matrix can obtain:

$$\sum_{r\neq s}\mathbf{B}_{sr}\mathbf{A}_{rs}(\mathrm{I}-\mathbf{A}_{ss})^{-1} = \sum_{r\neq s}\mathbf{B}_{ss}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}\mathbf{A}_{rj}\mathbf{B}_{js}^{\$} \qquad \text{(E.12)}$$

The fifth and sixth components in (E.1) of Koopman et al.,'s (2014) decomposition are the sum of the same terms across all the bilateral destinations in equation (E.2) of B&M (2019).

Appendix F: Los and Timmer (2019).

A unified approach for bilateral value-added export measures

Notation:

Figure F.1 shows the structure of a global IO table

			Use by country-industries							Final use by countries			Total use
			Country 1			…	Country M			Country 1	…	Country M	
Supply country-industries	Country 1	Country 1	Industry 1	…	Industry N	…	Industry 1	…	Industry N				
		…											
		Country N											
	Country M	Industry 1											
		…											
		Industry N											
Value added by labour													
Gross output													

Source: Timmer et al., (2015)
Notes: Country M denotes the Rest of the World (ROW).

Assume that countries in a global IO table can be grouped into three groups: 1) The country/group of countries for which VAX-indicators, denoted by *r*. 2) The country/group of countries that represent the destination of the VAX, denoted by *s*. 3) The other countries in the world, denoted by *t*.

The input-output structure of figure 1 can be explained by the following matrices and vectors: [10]

$$\mathbf{Z} \equiv \begin{bmatrix} \boldsymbol{Z}_{rr} & \boldsymbol{Z}_{rs} & \boldsymbol{Z}_{rt} \\ \boldsymbol{Z}_{sr} & \boldsymbol{Z}_{ss} & \boldsymbol{Z}_{st} \\ \boldsymbol{Z}_{tr} & \boldsymbol{Z}_{ts} & \boldsymbol{Z}_{tt} \end{bmatrix}; \mathbf{Y} \equiv \begin{bmatrix} \boldsymbol{Y}_{rr} & \boldsymbol{Y}_{rs} & \boldsymbol{Y}_{rt} \\ \boldsymbol{Y}_{sr} & \boldsymbol{Y}_{ss} & \boldsymbol{Y}_{st} \\ \boldsymbol{Y}_{tr} & \boldsymbol{Y}_{ts} & \boldsymbol{Y}_{tt} \end{bmatrix}; \mathbf{W} \equiv \begin{bmatrix} \boldsymbol{W}_{r} \\ \boldsymbol{W}_{s} \\ \boldsymbol{W}_{t} \end{bmatrix}; \mathbf{X} \equiv \begin{bmatrix} \boldsymbol{X}_{r} \\ \boldsymbol{X}_{s} \\ \boldsymbol{X}_{t} \end{bmatrix}$$

With *M* countries and each country with *N* industries, **Z** is the *NM* x *NM* matrix and its elements denote the transaction values of sales among industries in the accounting period, usually a year. The rows represent the supplying industries, the columns indicate using industries. Both transactions within a country (in the diagonal submatrices) and cross-border transactions (in the off-diagonal submatrices) are comprised in this matrix. If *r* is a single country, $\boldsymbol{Z}_{rr}$ has *N* rows and columns. If *s* is a group of M_s countries, $\boldsymbol{Z}_{ss}$ has NM_s rows and columns.

Y denotes the rectangular matrix and its elements refer to the transaction values of sales by industries to final users. Such as in **Z**, both domestic and international transactions are included in this matrix. Since this study treats all final use categories (household consumption, gross fixed capital formation, etc.) in the same way, **Y** contains *M* columns (one column for each country). Since all industries in all countries can sell to final users, the number of rows is *NM*. The dimensions of the submatrices vary, depending on the numbers of countries included in *r, s,* and *t*.

Value-added in each sector for each country is included in the *NM*-vector **w**, and gross output levels in the *NM*-vector **x**. The sum of intermediate sales and sales to final users equals gross output, $\mathbf{x} = \mathbf{Zi} + \mathbf{Yi}$, in which **i** denotes a summation vector containing ones; the sum of purchases of intermediate inputs and payments for production factors (value-added) also add up to these values, $\mathbf{x} = \boldsymbol{i}'\boldsymbol{Z} + \boldsymbol{w}$

The production ingredients *per unit of output* are given by the *NM* x *NM* matrix **A** (for intermediate inputs) and the *NM*-vector **v** (for factor payments):

$$\mathbf{A} = \boldsymbol{Z}\hat{x}^{-1} = \begin{bmatrix} \boldsymbol{A}_{rr} & \boldsymbol{A}_{rs} & \boldsymbol{A}_{rt} \\ \boldsymbol{A}_{sr} & \boldsymbol{A}_{ss} & \boldsymbol{A}_{st} \\ \boldsymbol{A}_{tr} & \boldsymbol{A}_{ts} & \boldsymbol{A}_{tt} \end{bmatrix}; \ \mathbf{v} = \hat{x}^{-1}\boldsymbol{w} \equiv \begin{bmatrix} \boldsymbol{v}_{r} \\ \boldsymbol{v}_{s} \\ \boldsymbol{v}_{t} \end{bmatrix} \qquad \text{(F.1)}$$

Country *r*'s GDP can now be obtained by linking value-added generation to the final demand levels in **Y** by means of Leontief's demand-driven input-output model:

[10] Matrices are indicated by bold capitals, column vectors by bold lowercases and scalars by italics. Primes denote transposition and hats stand for diagonal matrices

$$GDP_r = \tilde{\mathbf{v}}_r' (I - A)^{-1}\mathbf{Yi} \quad \text{(F.2)}$$

Where $\tilde{\mathbf{V}}_r$denotes the *NM*-vector that is identical to **v** as defined in (1) with respect to the part $\mathbf{v}_r$, but in which all other elements are set equal to zero (If the vector **v** would be used instead, we would obtain world GDP rather than GDP of *r*). The matrix $(I - A)^{-1}$ is the Leontief inverse which considers the industry that is producing the final product often does not only use its own production factors, but also intermediate inputs from first-tier suppliers. These can be located in the same country, but also elsewhere. First-tier suppliers generate value-added themselves, but might also use intermediate inputs for their activities. The same goes for second-tier suppliers producing these, and so on.

In their comment on Koopman et al., (2014), Los et al., (2016) showed that using a particular type of the "Hypothetical Extraction Method" (HEM) as pioneered by Paelinck et al., (1965) and Strassert (1968) can be used to derive VAX-D. The main part of Los et al., (2016) dealt with the aggregate case, in which domestic value-added in the exports of country *r* to all other countries are considered at once.

The hypothetical extraction method (HEM):

Los et al., (2016) showed that using a specific type of the "Hypothetical Extraction Method" (HEM) to derive VAX-D. HEM applications usually "extract" industries or countries from input-output structures by setting corresponding parts of matrices that are involved in the computations to zero. Equation (F.2) is then recomputed for the modified matrices: the result is called the hypothetical GDP level. The difference between the actual and the hypothetical GDP levels is a measure of the importance of the extracted industry. In computing VAX-D, this study does not extract entire industries (or countries) from the system, but just some transactions. If the focus is on VAX-D between *r* and *s*, this study sets all elements of $\mathbf{A}_{rs}$ and $\mathbf{Y}_{rs}$ to zero, assuming that *s* does not use any imports of intermediate and final products from *r*. One might think of this as a situation in which *s* sets import tariffs on goods from *r* that are prohibitively high. The modified matrices indicated with a *:

$$A_r^{*s} \equiv \begin{bmatrix} \boldsymbol{A}_{rr} & \mathbf{0} & \boldsymbol{A}_{rt} \\ \boldsymbol{A}_{sr} & \boldsymbol{A}_{ss} & \boldsymbol{A}_{st} \\ \boldsymbol{A}_{tr} & \boldsymbol{A}_{ts} & \boldsymbol{A}_{tt} \end{bmatrix};\ Y_r^{*s} \equiv \begin{bmatrix} \boldsymbol{Y}_{rr} & \mathbf{0} & \boldsymbol{Y}_{rt} \\ \boldsymbol{Y}_{sr} & \boldsymbol{Y}_{ss} & \boldsymbol{Y}_{st} \\ \boldsymbol{Y}_{tr} & \boldsymbol{Y}_{ts} & \boldsymbol{Y}_{tt} \end{bmatrix} \quad \text{(F.3)}$$

Next, this study computes the GDP level in *r* for the situation in which these matrices would have represented the global production structure and final demand levels:

$$GDP_r^{*s} = \tilde{\mathbf{v}}_r' (I - \boldsymbol{A}_r^{*s})^{-1}\boldsymbol{Y}_r^{*s}\mathbf{i} \quad \text{(F.4)}$$

The value-added of *r* contained indirect exports to *s* is now given by the difference between *r*'s actual GDP level and its hypothetical GDP level:

$$VAXD_{rs} = GDP_r - GDP_r^{*s} \quad \text{(F.5)}$$

GDP_r^{*s}should not be seen as the GDP level that would result if exports to *s* would be prohibitive. In a general setting with more flexible production and demand functions, substitution effects will occur. As a consequence, the global production structure and final demand levels will change and the global production structure after the tariff shock will not be represented by $\boldsymbol{A}_r^{*s}$ and $\boldsymbol{Y}_r^{*s}$. $VAXD_{rs}$ should therefore be regarded as an upper limit to the loss and is most meaningful if compared to other scenarios of extracted transactions. Put otherwise, it is a measure of the relative importance of country *s* for exports of value-added by *r*.

This study now shows how VAX-P can be computed in a similar framework by setting elements of one or more matrices in (F.2) to zero (see below for a simpler computational formula). VAX-P is the amount of value-added used abroad for final production. If hypothetically extracted all final demand for output produced by industries in country *s*, then

$$Y_r^{\#s} \equiv \begin{bmatrix} \boldsymbol{Y}_{rr} & \boldsymbol{Y}_{rs} & \boldsymbol{Y}_{rt} \\ \mathbf{0} & \mathbf{0} & \mathbf{0} \\ \boldsymbol{Y}_{tr} & \boldsymbol{Y}_{ts} & \boldsymbol{Y}_{tt} \end{bmatrix} \tag{F.6}$$

And hypothetical GDP in *r* is given by

$$GDP_r^{\#s} = \tilde{\mathrm{v}}_r' \, (I - \boldsymbol{A})^{-1} \boldsymbol{Y}_r^{\#s} \mathbf{i} \tag{F.7}$$

VAX-P can be expressed as

$$VAXP_{rs} = GDP_r - GDP_r^{\#s} \tag{F.8}$$

VAX-C indicator can also easily be considered within this HEM-approach (see below for a simpler computational formula for VAX-C). If hypothetically extracted all demand by final users in country *s*, then:

$$Y_r^{s} \equiv \begin{bmatrix} \boldsymbol{Y}_{rr} & \mathbf{0} & \boldsymbol{Y}_{rt} \\ \boldsymbol{Y}_{sr} & \mathbf{0} & \boldsymbol{Y}_{st} \\ \boldsymbol{Y}_{tr} & \mathbf{0} & \boldsymbol{Y}_{tt} \end{bmatrix} \tag{F.9}$$

The hypothetical GDP level associated with this extraction reads

$$GDP_r^{s} = \tilde{\mathrm{v}}_r' \, (I - \boldsymbol{A})^{-1} \boldsymbol{Y}_r^{s} \mathbf{i} \tag{F.10}$$

And obtain the following expression for VAX-C:

$$VAXC_{rs} = GDP_r - GDP_r^{s} \tag{F.11}$$

The aggregate indicator of VAX-D can be computed by means of slightly modified versions of (F.3), (F.4), and (F.5). $\boldsymbol{A}_r^{*st}$ and $\boldsymbol{Y}_r^{*st}$ are obtained by simultaneously setting $\boldsymbol{A}_{rs}$, $\boldsymbol{A}_{rt}$, $\boldsymbol{Y}_{rs}$, $\boldsymbol{Y}_{rt}$ equal to zero, after which they are substituted for $\boldsymbol{A}_r^{*st}$ and $\boldsymbol{Y}_r^{*st}$ in (F.4). The results (GDP_r^{*st}) is then subtracted from actual GDP, as in (F.5). The aggregate counterpart of VAX-P is computed by not only setting the row associated with the final demand for output from country *s* but also the row for output from country *t* equal to zero in (F.6). Finally, setting both columns for consumption in *s* and in *t* in (F.9) to zero, (F.10) and (F.11) yield the aggregate VAX-C.

Appendix G

Table G.1 classification of the main measures of value-added in exports proposed in the literature

	Content	Exports flow decomposition	Perspective	Approach
Hummels et. al. (2001) (1)	Domestic	Total/bilateral	Country	Source
	Foreign	N/A	N/A	N/A
Johnson and Noguera (2012) (2)	Domestic	Total	Exp. Country	
	Foreign	N/A	N/A	N/A
Koopman et al. (2014)	Domestic	Total	Exp. Country	
	Foreign	Total	World	Sink (3)
Wang et al. (2013)	Domestic	Total/bilateral	Exp. Country	Mixed
	Foreign	Total/bilateral	World	Sink (3)
Los et al. (2016) - section I	Domestic	Total	Exp. Country	
	Foreign	N/A	N/A	N/A
Los et al. (2016) - section III	Domestic	Bilateral	Bilateral	
	Foreign	N/A	N/A	N/A
Nagengast and Stehrer (2016) - section A3a	Domestic	Bilateral	Exp. Country	Sour/Mixed (4)
	Foreign	Bilateral	Exp. Country	Mixed (4)
Nagengast and Stehrer (2016) - section A3b	Domestic	Bilateral	Exp. Country	Sink/Mixed (4)
	Foreign	Bilateral	Exp. Country	Mixed (4)
Johnson (2018)	Domestic	Bilateral	Bilateral	
	Foreign	Bilateral	Bilateral	
Miroudot and Ye (2018)	Domestic	Total	Exp. Country	Source
	Foreign	Total	World	Source
Borin and Mancini (2019) - section 3.1	Domestic	Total/bilateral exp. (5)	Exp. Country	Source
	Foreign	Total/bilateral exp. (5)	Exp. Country	Source
Borin and Mancini (2019) - section 3.2	Domestic	Total/bilateral exp. (5)	Exp. Country	Sink
	Foreign	Total/bilateral exp. (5)	Exp. Country	Sink
Borin and Mancini (2019) - section 4.1	Domestic	Bilateral	Bilateral	
	Foreign	Bilateral	Bilateral	
Borin and Mancini (2019) - section 4.2	Domestic	Sectoral-bilateral	Sectoral-bilateral	
	Foreign	Sectoral-bilateral	Sectoral-bilateral	
Borin and Mancini (2019) - section 4.3	Domestic	Sectoral exp.	Exp. sector	
	Foreign	Sectoral exp.	Exp. sector	
Borin and Mancini (2019)- section 4.3	Country of origin	Total imports	Imp. country	
Borin and Mancini (2019)- section 4.3	Country of origin	Sectoral imports	Imp. sector	
Borin and Mancini (2019)- section 5	Domestic	N/A	N/A	N/A
	Foreign	Bilateral (5)	World	Source
	Domestic	Bilateral (5)	World	Sink

Source: B&M (2019)

Notes: (1) For Hummels et al., (2001) B&M (2019) consider the complement to the import content of exports (i.e. VS). (2) Johnson and Noguera (2012) single out only the portion of DVA in aggregate exports that are consumed abroad (VAX) and they don't account for the reflection part of DVA. (3) Koopman et al., (2014) and Wang et al., (2013) underestimate the correct measure of FVA in exports (4) Nagengast and Stehrer (2016) distinguish between sink and source is implemented only for a sub-

portion of their decompositions (i.e. for the direct consumption of DVA by the bilateral partner). Moreover, even for this sub-portion, the sink decomposition is incorrectly specified. (5) Correspondent decompositions for gross exports can be obtained by summing across importing countries. In this case, sink and source breakdowns generate the same results for DVA and FVA.

Appendix H: The bilateral source-based breakdown of B&M (2019)

In Koopman et al.,'s (2014) methodology of gross exports breakdown presented in equation (2), the Leontief inverse matrix **B** considers all the backward production networks that precede particular export flow, creates the double-counting issue (B&M, 2019). To address this limitation, B&M (2019) propose an approach to separate the value-added items by amending matrix **B**. To do this, they consider the representation of the global Leontief inverse as a sum of infinite series of the gross output produced in all the upstream stages of the production process which is given by the following equation:

$$\mathbf{B} = \mathbf{I}+\mathbf{A}+\mathbf{A^2}+\mathbf{A^3}+\ldots+\mathbf{A^n} \quad n \to \infty \tag{H.1}$$

They divide the production process along national borders of country *s* by cutting out its intermediate export linkages in any production stage in (H.1) where the coefficients of matrix **A** set to zero which identifies the direct requirement of intermediate inputs from country *s* ($\mathbf{A}_{sj}$ = 0 ∀ j ≠ s) as follows:

$$\mathbf{A}^{\$} = \begin{bmatrix} \mathbf{A}_{11} & \mathbf{A}_{12} & \cdots & \mathbf{A}_{1s} & \cdots & \mathbf{A}_{1G} \\ \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \mathbf{A}_{ss} & \cdots & \mathbf{0} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ \mathbf{A}_{G1} & \mathbf{A}_{G2} & \cdots & \mathbf{A}_{Gs} & \cdots & \mathbf{A}_{GG} \end{bmatrix} \tag{H.2}$$

The corresponding inverse Leontief matrix is:

$$\mathbf{B}^{\$} = (\mathrm{I} - \mathbf{A}^{\$})^{-1} \tag{H.3}$$

Appendix C shows how $\mathbf{B}^{\$}$ is related to the original global Leontief inverse matrix so that the following relation holds:

$$\mathbf{B}_{is} = \mathbf{B}^{s}_{is} + \mathbf{B}^{s}_{is} \sum_{j \neq s} \mathbf{A}_{sj}\, \mathbf{B}_{js} \tag{H.4}$$

Where *i* could be *s* or another country.

B&M (2019) use the accounting relationship in equation (H.4) to refine the bilateral decomposition in equation (2) to separate the value-added and double-counted terms within each component:

$$\begin{aligned} \mathbf{u}_N \mathbf{E}_{sr} \; &= \mathbf{V}_s \mathbf{B}^{\$}_{ss} \mathbf{E}_{sr} + \mathbf{V}_s \mathbf{B}^{\$}_{ss} \sum_{j \neq s} \mathbf{A}_{sj}\, \mathbf{B}_{js} \mathbf{E}_{sr} + \sum_{t \neq s}^{G} \mathbf{V}_t \mathbf{B}^{\$}_{ts} \mathbf{E}_{sr} \\ &\quad + \sum_{t \neq s}^{G} \mathbf{V}_t \mathbf{B}^{s}_{ts} \sum_{j \neq s} \mathbf{A}_{sj}\, \mathbf{B}_{js} \mathbf{E}_{sr} \end{aligned} \tag{H.5}$$

Where the first term in the RHS of equation (H.5) is domestic value-added ($\mathbf{DVA}source_{sr}$), the second term in the RHS is domestic double counted ($\mathbf{DDC}source_{sr}$) and the sum of these two terms account for the domestic content ($\mathbf{DC}_{sr}$) component. The third term in the RHS is foreign value-added ($\mathbf{FVA}source_{sr}$), the fourth term in the RHS is foreign double counted ($\mathbf{FDC}source_{sr}$) and the sum of these two terms account for the foreign content ($\mathbf{FC}_{sr}$) component.

The source-based approach in (H.5) accounts for bilateral exports based on Koopman et al., (2014) gross exports decomposition where the double-counted components are recorded by separating the share of exports of country *s* to *r* that have been already exported by *s* in a previous stage of the production process (B&M 2019). This means that a portion of the intermediate inputs exported by country *s* ($\sum_{j \neq s}^{G} \mathbf{A}_{sj}\mathbf{X}_j$) are returned back to *s* and re-exported again by *s* which leads to double-counted

issues in a source-based approach. Whereas B&M (2019) is particularly interested in the intermediate inputs exported by country *s* that re-enter in its exports to *r* and can be recorded as $\sum_{j\neq s}^{G} \mathbf{A}_{sj}\mathbf{B}_{js}\mathbf{E}_{sr}$.

In equation (H.5), it's important to note that $\mathbf{B}_{ss}^{s}$ corresponds to local Leontief matrix $(\mathrm{I}-\mathbf{A}_{ss})^{-1}$ i.e. the domestic components (see equation (E.9) in Appendix E). Based on B&M (2019) source-based framework, the domestic value-added in exports is computed by separating all the domestic production stages required to produce the exported products without accounting for the domestic content of imported inputs as follows:

$$\mathbf{DVA}source_{sr} = \mathbf{V}_s(\mathrm{I}-\mathbf{A}_{ss})^{-1}\,\mathbf{E}_{sr} \tag{H.6}$$

This indicator of domestic value-added in exports is the complement to the import content of exports proposed by Hummels et al., (2001) and also corresponds to the indicator of domestic value-added proposed by Johnson (2018) in the two-country world framework (B&M, 2019).

Up to now, the decomposition framework of bilateral value-added stems from the country of origin, and the literature has also considered the final destination market (Koopman et al., (2014). While B&M (2019) consider the direct importer, the second destination of re-export, the country of completion of final goods, and the final destination market. Therefore they start by dividing the bilateral exports $\mathbf{E}_{sr}$ into final products ($\mathbf{Y}_{sr}$) and intermediate goods for gross output production of country *r* ($\mathbf{X}_r$):

$$\mathbf{E}_{sr} = \mathbf{Y}_{sr} + \mathbf{A}_{sr}\mathbf{X}_r \tag{H.7}$$

Where country *r* processes these intermediate inputs imported from *s* to generate final products for domestic consumption or for re-export (both intermediate and final goods) as follows:

$$\mathbf{A}_{sr}\mathbf{X}_r = \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rr} + \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{E}_{r*} \tag{H.8}$$

Again the (re)exports from country *r* can also be divided into intermediate inputs and final goods:

$$\mathbf{E}_{r*} = \sum_{j\neq r}^{G}\mathbf{Y}_{rj} + \sum_{j\neq r}^{G}\mathbf{A}_{rj}\,\mathbf{X}_j \tag{H.9}$$

At this stage, they link the intermediate inputs imported by country *j* with the country of final completion and final destination market while other remaining (and potentially infinite) production stages are accounted for by the Leontief inverse matrix **B** (see equation B.2 in appendix B):

$$\sum_{j\neq r}^{G}\mathbf{A}_{rj}\,\mathbf{X}_j = \sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k}^{G}\sum_{l}^{G}\mathbf{B}_{jk}\mathbf{K}_{kl} \tag{H.10}$$

They integrate equation (H.6) with (H.10) to derive the comprehensive source-based decomposition of domestic and foreign value-added of bilateral exports flows from *s* to *r*:

$$\begin{aligned}\mathbf{DVA}source_{sr} = \mathbf{V}_s(\mathrm{I}-\mathbf{A}_{ss})^{-1}[&\mathbf{Y}_{sr} + \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rr}\\ &+ \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{Y}_{rj}\\ &+ \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k}^{G}\sum_{l}^{G}\mathbf{B}_{jk}\mathbf{K}_{kl}]\end{aligned} \tag{H.11}$$

$$\begin{aligned}\mathbf{FVA}source_{sr} = \sum_{t\neq s}^{G}\mathbf{V}_t\,\mathbf{B}_{ts}^{s}[&\mathbf{Y}_{sr} + \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rr}\\ &+ \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{Y}_{rj}\\ &+ \mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k}^{G}\sum_{l}^{G}\mathbf{B}_{jk}\mathbf{K}_{kl}]\end{aligned} \tag{H.12}$$

Where the two subscripts on final demand matrix **Y** corresponds to the country of final completion and the final destination market. At this point, they aimed at separating the domestic value-added eventually consumed by final demand in the country of origin *s* (reflection) from domestic value-added consumed in a foreign market (value-added exports $\mathbf{VAX}_{sr}$ measure proposed by Johnson and Noguera (2012):

$$\mathbf{REF}source_{sr} = \mathbf{V}_s(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,[\mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rs} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\textstyle\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k}^{G}\,\mathbf{B}_{jk}\mathbf{Y}_{ks}] \quad \text{(H.13)}$$

$$\mathbf{VAX}source_{sr} = \mathbf{V}_s(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,[\mathbf{Y}_{sr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rr} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\textstyle\sum_{j\neq r,s}^{G}\mathbf{Y}_{rj} + \mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k}^{G}\,\sum_{l\neq s}^{G}\,\mathbf{B}_{jk}\mathbf{Y}_{kl}] \quad \text{(H.14)}$$

Where the first two components of the RSH of equation (H.14) account for the value-added originated in *s* and consumed directly by final demand in the importing country *r* without any further re-export (directly absorbed value-added in exports or $\mathbf{DAVAX}_{sr}$):

$$\mathbf{DAVAX}_{sr} = \mathbf{V}_s(\mathrm{I} - \mathbf{A}_{ss})^{-1}\,\mathbf{Y}_{sr} + \mathbf{V}_s(\mathrm{I} - \mathbf{A}_{SS})^{-1}\,\mathbf{A}_{sr}(\mathrm{I} - \mathbf{A}_{rr})^{-1}\,\mathbf{Y}_{rr} \quad \text{(H.15)}$$

So far the country-level perspective accounted for each item of domestic or foreign value-added that relates to parts of production (GDP) generated by a country and contained in its own exports, or in exports of another country. This method can be used to tackle various empirical questions. But there are other empirical issues that need a breakdown approach from a different perspective. For example, accounting for the total value-added that crosses a specific bilateral border (*s*-*r*), regardless of whether the same items are also share of the exports of *s* or *r* to other countries or not i.e. they are double-counted items from a country-level perspective (B&M, 2019).

To tackle this issue, B&M (2019) propose a decomposition framework to record value-added in bilateral exports that excludes from gross trade values only the components that are double-counted in the same bilateral trade flow. To do this, they amend the input coefficient matrix **A** to divide the production stages along the new perimeter and distinguish the value-added and double-counted components. In the country-level perspective, they set to zero the coefficients that identify the direct requirement of intermediate goods from country *s* to all the other countries but here they only set the bilateral coefficient matrix $\mathbf{A}_{sr}$ to zero as follows:

$$\mathbf{A}^{s\not r} = \begin{bmatrix} \mathbf{A}_{11} & \cdots & \mathbf{A}_{1s} & \cdots & \mathbf{A}_{1r} & \cdots & \mathbf{A}_{1G} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \mathbf{A}_{s1} & \cdots & \mathbf{A}_{ss} & \cdots & \mathbf{0} & \cdots & \mathbf{A}_{sG} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ \mathbf{A}_{G1} & \cdots & \mathbf{A}_{G2} & \cdots & \mathbf{A}_{Gr} & \cdots & \mathbf{A}_{GG} \end{bmatrix} \quad \text{(H.16)}$$

Thus the Leontief inverse matrix can be expressed as:

$$\mathbf{B}^{s\not r} = (\mathrm{I} - \mathbf{A}^{s\not r})^{-1} \quad \text{(H.17)}$$

Where $\mathbf{B}_{is}^{s\not r}$ accounts for the total amount of gross output of country *i* needed to produce one unit of final products in country *s*, and also the following relationship holds true:

$$\mathbf{B}_{is}^{s\not r} = \mathbf{B}_{is}^{s\not r} + \mathbf{B}_{is}^{s\not r}\mathbf{A}_{sr}\mathbf{B}_{rs} \quad \text{(H.18)}$$

With the similar derivation of the source-based framework in equation (H.5), the complete decomposition of bilateral exports based on a *pure bilateral perspective* is given by the following accounting relationship[11]:

$$\mathbf{u}_N\mathbf{E}_{sr} = \mathbf{V}_s\mathbf{B}_{ss}^{s\not r}\mathbf{E}_{sr} + \mathbf{V}_s\mathbf{B}_{ss}^{s\not r}\mathbf{A}_{sr}\mathbf{B}_{rs}\mathbf{E}_{sr} + \textstyle\sum_{t\neq s}^{G}\,\mathbf{V}_t\mathbf{B}_{ts}^{s\not r}\mathbf{E}_{sr} + \sum_{t\neq s}^{G}\,\mathbf{V}_t\mathbf{B}_{ts}^{s\not r}\mathbf{A}_{sr}\mathbf{B}_{rs}\mathbf{E}_{sr} \quad \text{(H.19)}$$

[11] The components in equation (24) are uniquely defined for a specific bilateral flow *s*-*r*, because the perimeter for the definition of double counted components is the bilateral relationship itself (BM, 2019).

Where the first term in the RHS of equation (H.19) is a bilateral perspective domestic value-added ($\mathbf{DVA}^{*}_{sr}$), the second term in the RHS is bilateral perspective domestic double counted ($\mathbf{DDC}^{*}_{sr}$) and the sum of these two terms account for the domestic content ($\mathbf{DC}_{sr}$) component. The third term in the RHS is bilateral perspective foreign value-added ($\mathbf{FVA}^{*}_{sr}$),), the fourth term in the RHS is bilateral perspective foreign double counted ($\mathbf{FDC}^{*}_{sr}$),) and the sum of these two terms account for the foreign content ($\mathbf{FC}_{sr}$) component. The $\mathbf{DVA}^{*}_{sr}$ and $\mathbf{FVA}^{*}_{sr}$ correspond to the measures of domestic value-added and foreign value-added proposed by Johnson (2018) in a two-country world and the same indicator of domestic value-added in bilateral exports is also proposed by Los et al., (2016) by applying a hypothetical extraction procedure (B&M, 2019) see Table G.1 appendix G.

Again B&M (2019) decompose the double-counted components of the decompositions based on a country-level perspective to distinguish the subcomponents that are classified based on the perspective adopted. As for the domestic double-counted item ($\mathbf{DDC}_{sr}$), they re-express the original measures as follows:

$$\mathbf{DDC}source_{sr} = \mathbf{V}_{s}\mathbf{B}^{s}_{ss}\sum_{j\neq s,r}\mathbf{A}_{sj}\,\mathbf{B}^{sr}_{js}\mathbf{E}_{sr} + \mathbf{DDC}^{*}_{sr} \tag{H.20}$$

$$\begin{aligned}\mathbf{DDC}sink_{sr} = \mathbf{V}_{s}\mathbf{B}_{ss}\mathbf{A}_{sr}\mathbf{B}^{s}_{rs}\sum_{j\neq s,r}[\mathbf{Y}_{si} + \mathbf{A}_{si}\mathbf{B}^{sr}_{is}\sum^{G}_{l\neq r}\mathbf{Y}_{sl} \\ + \mathbf{A}_{si}\sum^{G}_{k\neq s}\sum^{G}_{l}\mathbf{B}^{s}_{ts}\mathbf{Y}_{kl}] + \mathbf{DDC}^{*}_{sr}\end{aligned} \tag{H.21}$$

Where the first component of the RHS of equation (H.20) accounts for double-counted item of source-based approach at country level perspective ($\mathbf{DVA}^{*(\mathrm{DDC}source)}_{sr}$). The sum of components of the RHS of equation (H.21) without $\mathbf{DDC}^{*}_{sr}$ record the double-counted component of sink-based approach at country level perspective ($\mathbf{DVA}^{*(\mathrm{DDC}sink)}_{sr}$). In a purely bilateral perspective, $\mathbf{DVA}^{*(\mathrm{DDC}source)}_{sr}$ and $\mathbf{DVA}^{*(\mathrm{DDC}sink)}_{sr}$ are distinguished as domestic value-added. And the following relationship holds true:

$$\mathbf{DVA}^{*}_{sr} = \mathbf{DVA}source_{sr} + \mathbf{DVA}^{*(\mathrm{DDC}source)}_{sr} = \mathbf{DVA}sink_{sr} + \mathbf{DVA}^{*(\mathrm{DDC}sink)}_{sr} \tag{H.22}$$

Where the derivation of equations (H.20)–(H.22) can be used to differentiate the foreign value-added in a bilateral-level perspective ($\mathbf{FVA}^{*}_{sr}$) from those identified in a country-level perspective ($\mathbf{FVA}source_{sr}$ and $\mathbf{FVA}sink_{sr}$).

Appendix I: Tables and figures

Table 3 presents 188 countries included in the EORA input-output table for 2015

No	Country code	Country name	No	Country code	Country name
1	ABW	Aruba	48	DEU	Germany
2	AFG	Afghanistan	49	DJI	Djibouti
3	AGO	Angola	50	DNK	Denmark
4	ALB	Albania	51	DOM	Dominican Republic
5	AND	Andorra	52	DZA	Algeria
6	ANT	Netherlands Antilles	53	ECU	Ecuador
7	ARE	UAE	54	EGY	Egypt
8	ARG	Argentina	55	ERI	Eritrea
9	ARM	Armenia	56	ESP	Spain
10	ATG	Antigua	57	EST	Estonia
11	AUS	Australia	58	ETH	Ethiopia
12	AUT	Austria	59	FIN	Finland
13	AZE	Azerbaijan	60	FJI	Fiji
14	BDI	Burundi	61	FRA	France
15	BEL	Belgium	62	GAB	Gabon
16	BEN	Benin	63	GBR	UK
17	BFA	Burkina Faso	64	GEO	Georgia
18	BGD	Bangladesh	65	GHA	Ghana
19	BGR	Bulgaria	66	GIN	Guinea
20	BHR	Bahrain	67	GMB	Gambia
21	BHS	Bahamas	68	GRC	Greece
22	BIH	Bosnia and Herzegovina	69	GRL	Greenland
23	BLR	Belarus	70	GTM	Guatemala
24	BLZ	Belize	71	GUY	Guyana
25	BMU	Bermuda	72	HKG	Hong Kong
26	BOL	Bolivia	73	HND	Honduras
27	BRA	Brazil	74	HRV	Croatia
28	BRB	Barbados	75	HTI	Haiti
29	BRN	Brunei	76	HUN	Hungary
30	BTN	Bhutan	77	IDN	Indonesia
31	BWA	Botswana	78	IND	India
32	CAF	Central African Republic	79	IRL	Ireland
33	CAN	Canada	80	IRN	Iran
34	CHE	Switzerland	81	IRQ	Iraq
35	CHL	Chile	82	ISL	Iceland
36	CHN	China	83	ISR	Israel
37	CIV	Cote dIvoire	84	ITA	Italy
38	CMR	Cameroon	85	JAM	Jamaica
39	COD	DR Congo	86	JOR	Jordan
40	COG	Congo	87	JPN	Japan
41	COL	Colombia	88	KAZ	Kazakhstan
42	CPV	Cape Verde	89	KEN	Kenya
43	CRI	Costa Rica	90	KGZ	Kyrgyzstan
44	CUB	Cuba	91	KHM	Cambodia
45	CYM	Cayman Islands	92	KOR	South Korea
46	CYP	Cyprus	93	KWT	Kuwait
47	CZE	Czech Republic	94	LAO	Laos

Table 3 continues

No	Country code	Country name	No	Country code	Country name
95	LBN	Lebanon	142	PYF	French Polynesia
96	LBR	Liberia	143	QAT	Qatar
97	LBY	Libya	144	ROU	Romania
98	LIE	Liechtenstein	145	RUS	Russia
99	LKA	Sri Lanka	146	RWA	Rwanda
100	LSO	Lesotho	147	SAU	Saudi Arabia
101	LTU	Lithuania	148	SDS	South Sudan
102	LUX	Luxembourg	149	SEN	Senegal
103	LVA	Latvia	150	SGP	Singapore
104	MAC	Macao SAR	151	SLE	Sierra Leone
105	MAR	Morocco	152	SLV	El Salvador
106	MCO	Monaco	153	SMR	San Marino
107	MDA	Moldova	154	SOM	Somalia
108	MDG	Madagascar	155	SRB	Serbia
109	MDV	Maldives	156	STP	Sao Tome and Principe
110	MEX	Mexico	157	SUD	Sudan
111	MKD	TFYR Macedonia	158	SUR	Suriname
112	MLI	Mali	159	SVK	Slovakia
113	MLT	Malta	160	SVN	Slovenia
114	MMR	Myanmar	161	SWE	Sweden
115	MNE	Montenegro	162	SWZ	Swaziland
116	MNG	Mongolia	163	SYC	Seychelles
117	MOZ	Mozambique	164	SYR	Syria
118	MRT	Mauritania	165	TCD	Chad
119	MUS	Mauritius	166	TGO	Togo
120	MWI	Malawi	167	THA	Thailand
121	MYS	Malaysia	168	TJK	Tajikistan
122	NAM	Namibia	169	TKM	Turkmenistan
123	NCL	New Caledonia	170	TTO	Trinidad and Tobago
124	NER	Niger	171	TUN	Tunisia
125	NGA	Nigeria	172	TUR	Turkey
126	NIC	Nicaragua	173	TWN	Taiwan
127	NLD	Netherlands	174	TZA	Tanzania
128	NOR	Norway	175	UGA	Uganda
129	NPL	Nepal	176	UKR	Ukraine
130	NZL	New Zealand	177	URY	Uruguay
131	OMN	Oman	178	USA	USA
132	PAK	Pakistan	179	USR	Former USSR
133	PAN	Panama	180	UZB	Uzbekistan
134	PER	Peru	181	VEN	Venezuela
135	PHL	Philippines	182	VGB	British Virgin Islands
136	PNG	Papua New Guinea	183	VNM	Viet Nam
137	POL	Poland	184	VUT	Vanuatu
138	PRK	North Korea	185	WSM	Samoa
139	PRT	Portugal	186	YEM	Yemen
140	PRY	Paraguay	187	ZAF	South Africa
141	PSE	Gaza Strip	188	ZMB	Zambia

Source: Author's composition based on EORA input-output table for 2015

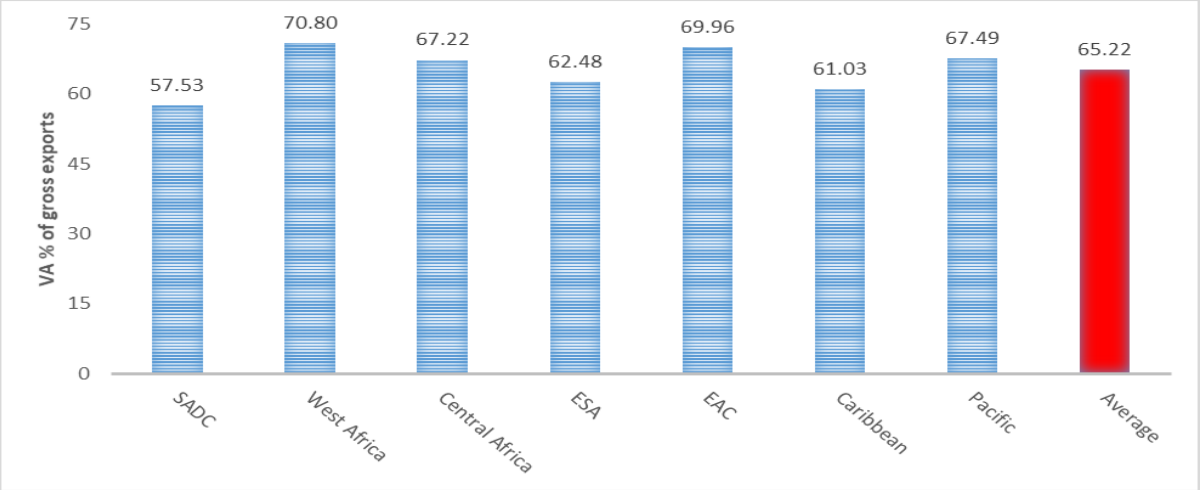
Table 4 shows FD, VA, and sector classification for EORA26 input-output table for the year 2015

No	Eora Final Demand (FD) classification:	No	Eora Primary Inputs (or VA) classification:
1	Household final consumption	1	Compensation of employees
2	Non-profit institutions serving households	2	Taxes on production
3	Government final consumption	3	Subsidies on production
4	Gross fixed capital formation	4	Net operating surplus
5	Changes in inventories	5	Net mixed income
6	Acquisitions less disposals of valuables	6	Consumption of fixed capital
No	**Sector classificaton in Eora26:**	**No**	**Sector classificaton in Eora26:**
1	Agriculture	14	Construction
2	Fishing	15	Maintenance and Repair
3	Mining and Quarrying	16	Wholesale Trade
4	Food & Beverages	17	Retail Trade
5	Textiles and Wearing Apparel	18	Hotels and Restraurants
6	Wood and Paper	19	Transport
7	Petroleum, Chemical and Non-Metallic Mineral Products	20	Post and Telecommunications
8	Metal Products	21	Finacial Intermediation and Business Activities
9	Electrical and Machinery	22	Public Administration
10	Transport Equipment	23	Education, Health and Other Services
11	Other Manufacturing	24	Private Households
12	Recycling	25	Others
13	Electricity, Gas and Water	26	Re-export & Re-import
Source: EORA input-output table for 2015			

Table 6 shows ACP EPA blocs trade to the UK, EU-27, and the Rest of the World (RoW) in 2015

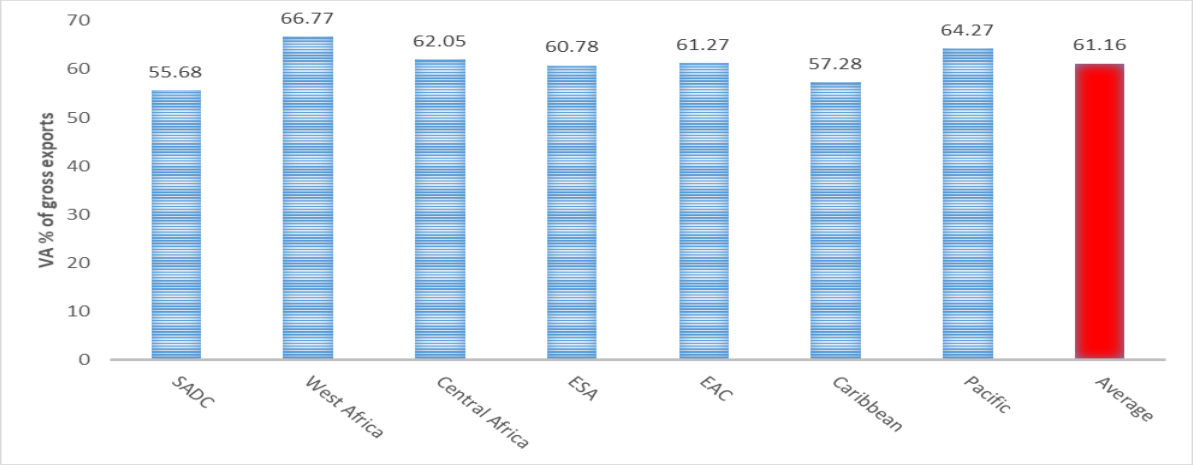
Bloc	ACP exports to the world in $ millions	UK		EU-27		RoW	
		ACP gross exports (GEXP) to UK in $ millions	Share (%) of ACP gross exports to UK	ACP gross exports (GEXP) to EU-27 in $ millions	Share (%) of ACP gross exports to EU-27	ACP gross exports (GEXP) to Row in $ millions	Share (%) of ACP gross exports to RoW
SADC	130,721.93	8,252.00	6.31	30,491.49	23.33	91,978.44	70.36
West Africa	52,978.18	1,206.18	2.28	22,650.56	42.75	29,121.44	54.97
Central Africa	16,545.48	150.70	0.91	5,625.35	34.00	10,769.44	65.09
ESA	14,601.90	1,113.11	7.62	4,426.05	30.31	9,062.74	62.07
EAC	7,563.80	646.43	8.55	2,383.21	31.51	4,534.15	59.95
Caribbean	29,902.13	663.25	2.22	2,704.05	9.04	26,534.83	88.74
Pacific	6,999.51	242.48	3.46	870.33	12.43	5,886.70	84.10
Total	259,312.93	12,274.15	4.73	69,151.04	26.67	177,887.74	68.60
ACP average	37,044.70	1,753.45	4.48	9,878.72	26.20	25,412.53	69.32
African EPA blocs	222,411.29	11,368.42	5.11	65,576.66	29.48	145,466.21	65.40
Caribbean + Pacific	36,901.64	905.73	2.45	3,574.38	9.69	32,421.53	87.86
Source: Author's calculation based on EORA input-output table for 2015							

Figure 4 presents ACP's value-added (share % of bilateral gross exports from ACP to the UK) directly consumed by the UK final demand in 2015



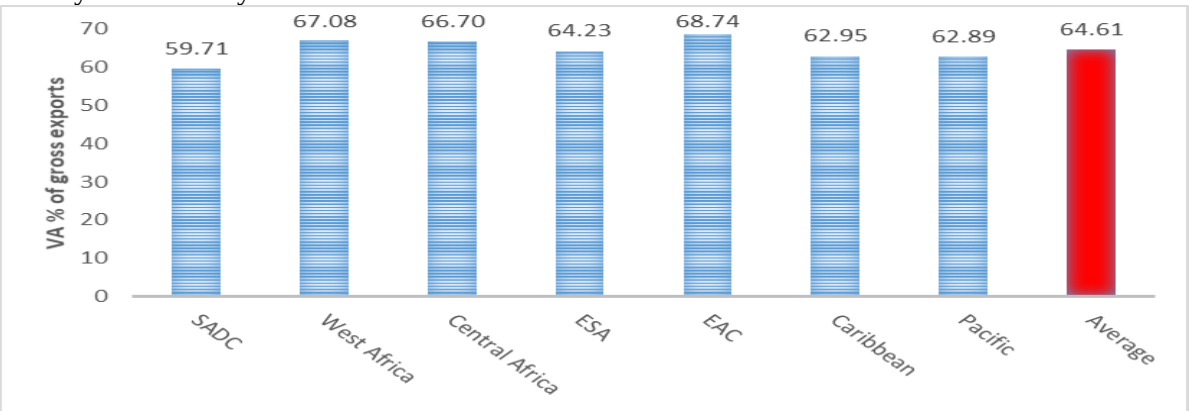
Source: Author's calculation based on EORA input-output table for 2015

Figure 5 presents ACP's value-added (share % of bilateral gross exports from ACP to the EU-27) directly consumed by the EU-27 final demand in 2015



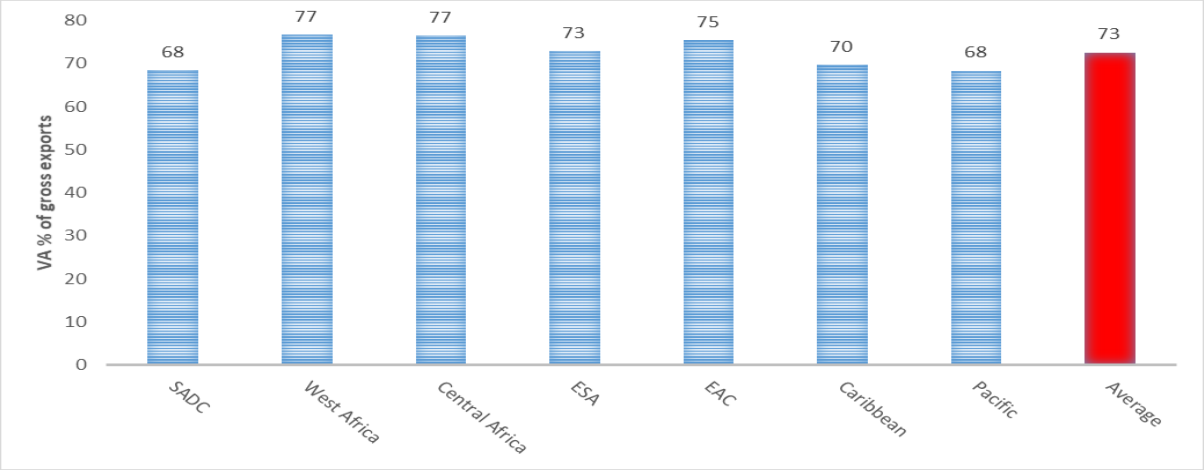
Source: Author's calculation based on EORA input-output table for 2015

Figure 6 presents the UK's value-added (share % of bilateral gross exports from the UK to the ACP) directly consumed by the ACP final demand in 2015



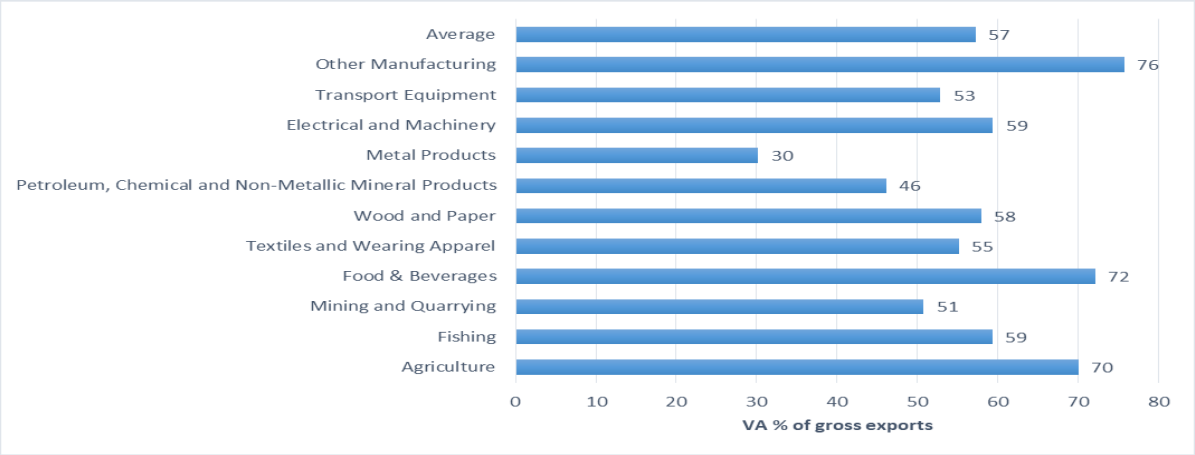
Source: Author's calculation based on EORA input-output table for 2015

Figure 7 presents EU-27 value-added (share % of bilateral gross exports from EU-27 to the ACP) directly consumed by the ACP final demand in 2015



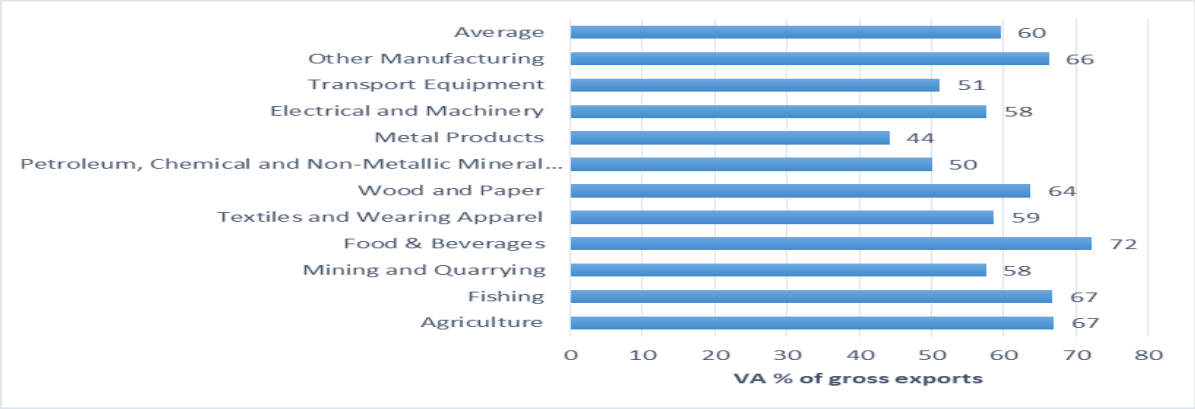
Source: Author's calculation based on EORA input-output table for 2015

Figure 8 presents ACP's value-added (share % of sectoral-bilateral gross exports from ACP to the UK) directly consumed by the UK final demand at sector level in 2015



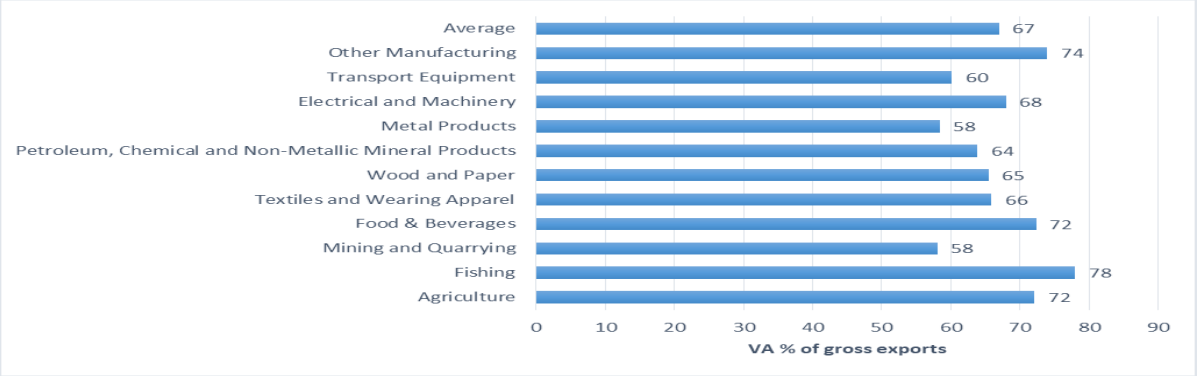
Source: Author's calculation based on EORA input-output table for 2015

Figure 9 presents ACP's value-added (share % of sectoral-bilateral gross exports from ACP to the EU-27) directly consumed by the EU-27 final demand at sector level in 2015



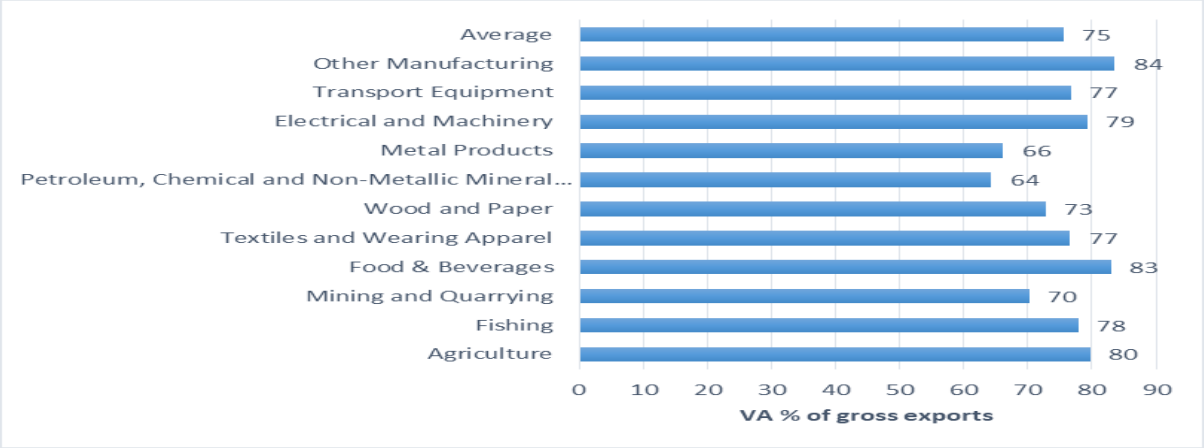
Source: Author's calculation based on EORA input-output table for 2015

Figure 10 presents the UK's value-added (share % of sectoral-bilateral gross exports from the UK to ACP) directly consumed by ACP final demand-by industry in 2015



Source: Author's calculation based on EORA input-output table for 2015

Figure 11 presents EU's-27 value-added (share % of sectoral-bilateral gross exports from the EU-27 to ACP) directly consumed by ACP final demand-by sector in 2015



Source: Author's calculation based on EORA input-output table for 2015

THIRD ESSAY

Impact of trade policy on ACP's food & agricultural sectors' integration into GVCs

ABSTRACT

This essay studies the effect of non-tariff measures (NTMs) associated with shifts in trade regimes on African, Caribbean, and Pacific (ACP) countries with a focus on food & agricultural sector participation in backward and forward Global Value Chains (GVCs). To do so, this study applies a gravity-like of trade in value-added proposed by Balié et al., (2019), the decomposition framework developed by Borin and Mancini (2019), and the NTMs quantity-based approach proposed by Berden et al., (2009).

This study is the first to investigate the impact of NTMs associated with shifts in trade regimes on ACP's trade in value-added and food & agricultural forward and backward participation in GVCs. This study contributes to the literature by applying an empirical gravity model of value-added trade to estimate the effect of trade policy on ACP's food & agricultural backward and forward participation in global network productions.

This study focuses on the agricultural sector and food & beverage sector because ACP's exports are mainly dominated by agricultural products and food and beverage products and NTMs are higher in these two sectors. Policymakers in ACP countries should pay attention to sectors where NTMs are the highest (i.e. where the highest potential gain from trade can be achieved), like the agricultural sector and food & beverage sector.

The results show that the bilateral tariffs and NTMs are not only impeding the trade of goods between two ACP partners but also affect the participation of ACP exporting countries in food and agriculture forward-GVC (GVCF) and backward-GVC (GVCB) (where intermediate inputs cross national borders multiple times). Moreover, ACP countries' participation in GVCF & GVCB does not only rely on the trade protection level they face from all the countries in the world, but also on their own level of protection applied in the same sector. Figures and tables are presented in the appendices section.

Keywords: global value chains, agriculture, food, trade policy, gravity model, ACP

JEL classification: F13, F14, L23, 054, O55, Q17.

TABLE OF CONTENTS

1. INTRODUCTION

The second essay analyzed ACP-UK trade in global value-added and participation in GVCs. This essay investigates the effect of trade policy associated with shifts in trade regimes on ACP countries' food & agricultural sectors backward participation (the use of foreign intermediate goods for the production of goods for exports) and forward participation (the use of domestic inputs in third country exports) in GVCs. This study estimates a gravity model on bilateral flows of trade in value-added to identify the impact of bilateral trade policies on ACP trade in global value-added and integration into global network production. The main source of data is the EORA input-output tables for years from 1995 to 2015.

To produce exports, firms in ACP countries, purchase inputs from national enterprises (value chain) and import intermediates across national borders (GVC). Thus exports from firms rely on value-added from other firms which generate incomes for later firms. But this study focuses on value-added that crosses national borders (GVC). And specifically how NTMs affect ACP trade in global value-added. Hence the research question is:

To what extent are ACP countries' forward and backward participation in agriculture and food GVCs affected by NTMs associated with shifts in trade regimes?

To investigate this question, this study applies a gravity model of trade in value-added proposed by Balié et al., (2019), applying a quantity-based approach proposed by Berden et al., (2009) to quantify trade effects of NTMs, and decomposing the bilateral gross exports with a methodology developed by Borin and Mancini (2019), using the EORA 2015 input-output table. Despite the economic benefits of participation in GVC, only recently the literature on this topic empirically evaluated the integration of developing countries (i.e. ACP countries) in global network production. This is due to the lack of adequate measures and gross trade flows are incapable to reflect the internationalization of industrial products (i.e. product fragmentation)

To compute GVCF and GVCB, this study relies on some assumptions, the so-called proportionality assumptions. This study assumes that every sector uses a mix of imports and domestic supplies exactly the same proportion. For instance, in multilateral input-output tables, there are no observations on the input into German cars of South African steel, but there are inputs on steel. From data, it is known what proportion of the value of German cars is made up of steel. This study also assumes that this is the same for all German produced cars. It is also known how much of the steel is used in Germany and the sourcing country and this study assumes that the use of steel over sources exactly at the same proportion. So the results are all proximate. This is a general issue for all input-output datasets and it is unavoidable.

Given the limitation of standard trade statistics, this work uses Inter-Country Input-Output (ICIO) tables, specifically EORA26 2015 data. ICIO tables combine traditional trade statistics with national Input-Output (IO) tables to form production and consumption linkages within industries and countries. Measures based on ICIO tables suffer from two limitations (Antràs, 2020). First, they base on aggregated Input-Output data and therefore these data sources miss a notable amount of GVC related trade activities taking place among sectors. Second, global Input-Output tables are based on strong assumptions to back out specific bilateral trade flows of intermediate goods that cannot be readily read from either national Input-Output tables or customs data.

This study focuses on trade policy impact on GVC that have been keenly investigated in trade literature (Antràs and Staiger (2012), Antràs (2020), Balié et al., (2019)). Trade policies are linked to vertical specialization (international production fragmentation) through two potential impacts of bilateral protection (Balié et al., 2019) as follows:

1. The first channel is through magnification effect where on the one hand, products incur tariffs and NTMs as many as they cross national borders, while on the other hand, tariffs and are imposed on gross

imports and the value-added by direct importer accounts for a small portion of these imports. This magnification cost affects various countries through various ways of integration into global network production (Yi, 2003).

2. A second channel is through a chain effect that impacts the country's upstream and downstream GVCs related activities and backward and forward participation. In the case of forward participation, domestic tariffs, and NTMs on imports may affect domestic value-added content embodied in exports of partner countries (Balié et al., 2019). While in terms of backward integration, imports tariffs and NTMs pass some of the benefits of protection from the local supplier of final products on to their foreign suppliers of intermediate goods. Most of the bilateral preferences are unilateral, where some of them are a consequence of FTAs or customs unions that can impact the country's integration into global network production in various ways and expand the idea of preferential trade regimes encompassing rules of origins and non-tariff issues (Curran and Nadvi, 2015). At this point, integration into global network chains may encourage deeper bilateral and multilateral trade agreements beyond the traditional terms of trade agreements (Olper, 2016).

This study is the first to investigate the impact of tariffs and NTMs associated with shifts in trade regimes on ACP's food & agricultural sectors' participation in GVCF and GVCB. By decomposing the bilateral gross exports with a methodology developed by Borin and Mancini (2019); hereafter B&M (2019) using the EORA 2015 data, This study contributes to the literature by adopting an empirical gravity model of value-added trade proposed by Balié et al., (2019) to estimate the effect of trade policy on ACP's food & agricultural sectors' backward and forward participation in global network productions applying B&M (2019) approach.

The findings show that the bilateral NTMs imposed by importer country (NTM_{ji}) have a negative impact on the exporter country's agriculture and food integration into GVCF & GVCB of the ACP economies and the world. Therefore; the bilateral NTMs (NTM_{ji}) is not only hindering trade of goods between country *i* and country *j*, but it also impacts the integration of exporting country *i* into GVCF & GVCB.

The bilateral NTMs applied by the exporter country i to its importers (NTM_{ij}) show a significant negative effect on participation in food and agriculture GVCF & GVCB of ACP, and the world. This means that a country's participation in GVCF & GVCB does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

This study concludes that the bilateral tariffs and NTMs are not only impeding the trade of goods between two ACP partners but also affect the participation of ACP exporting countries in food and agriculture forward-GVC (GVCF) and backward-GVC (GVCB) (where intermediate inputs cross national borders multiple times). Moreover, ACP countries' participation in GVCF & GVCB does not only rely on the trade protection level they face from all the countries in the world, but also on their own level of protection applied in the same sector.

The estimated coefficients exhibit a positive and significant effect of FTA, EBA, EPA (for ACP countries only), EU, and RTAs (at the global level). The RTAs, EBA, FTA, and EPA also show an ambiguous relationship with the participation of the agriculture and food sector in GVCF and GVCB. Therefore this study suggests additional research activities on the deep agreements and how different categories (chapters) of NTMs impact ACP countries' integration into GVCs.

The following sections of this study are organized as follows: Part two presents an overview of the related literature. Part three highlights ACP countries' food and agriculture integration into global networks production. Part four provides a methodology and empirical analysis. Part five discusses the results and part six concludes. Part seven lists references.

2. LITERATURE REVIEW

This section first provides an overview of the literature on the most recent studies on countries' participation in GVC and how trade policy influences their integration into global GVC. Then reviews the literature on the trade effect of NTMs; quantity- and price-based approaches.

The gravity model of trade has been the workhorse of trade analysis for more than 60 years (Anderson, 2011; Head and Mayer, 2014). First proposed by Tinbergen (1962) to study the impact of trade policy. Since then, the model has been successful in the analysis of trade flows. Recently the model gained its theoretical micro-foundations (Anderson, 1979; Anderson and van Wincoop, 2003) and the so-called structural gravity (Anderson, 2011; Head and Mayer 2014). Since the 1970s studies have estimated gravity equation on gross trade flows and GDP as a proxy for economic mass, but with new literature on trade in value-added and GVCs, it became possible that to estimate the gravity model on gross trade term or on value-added terms (Baldwin and Taglioni, 2011). Noguera, (2012) was the first to derive a gravity equation incorporating the GVC.

Most literature is devoted to empirical gravity models to evaluate the trade cost elasticity of bilateral trade at an aggregate level (Anderson, 1979, Krugman, 1980), Eaton and Kortum (2002), Melitz (2003), Anderson and van Wincoop (2003). Until only recently with the emergence of global fragmentation of production, a large share of international trade is no longer in final products, but rather in intermediate inputs that cross national borders several times before becoming final and being consumed by final destination markets (Noguera, 2012). Aggregate trade flows don't reflect the origin or destination market of the value-added that is embodied in trade flows. Therefore, the gravity model estimated at the country's aggregate trade level shows the impact of trade costs on aggregate export flow but not the trade cost effect on value-added export flow (Noguera, 2012). The assessment of the trade cost impact on value-added flows requires a gravity model estimated at the value-added trade level.

Hillberry and Hummels (2005) were the first to present a version of the gravity model with intermediate goods. They develop a gravity model of trade in intermediate and final goods that predicts production location, the shipment patterns and provides useful implications for the level and composition of home bias. This model extends Krugman and Venables (1996) model, which in turn is based on the Krugman (1980) model of monopolistic competition and trade in final goods. The main characteristics of this model are: 1) Consumers have identical preferences (that are Cobb-Douglas over commodities and Dixit-Stiglitz over differentiated varieties within a commodity group). 2) Firms incorporate intermediate products, capital, and labor to generate differentiated goods. 3) Based on the input-output framework these goods may be used as final goods, as intermediate inputs, or both. 4) Capital and labor are mobile across industries within a region, but immobile across regions. 5) Firms move across regions in order to maximize profits.

Egger (2010) develops a theoretical model to estimate gravity equations of bilateral final products trade, intermediate products trade, and Foreign Direct Investment (FDI) flows (simultaneously) to show the growth of FDI (multilateral enterprises (MNEs)) relative to trade (national enterprises (NEs)). This model explains the connection between MNEs that invest capital directly in foreign countries, NEs that trade either final goods or intermediate inputs, FDI flows, final goods trade flows, intermediate products trade lows.

This model is a three-country, three-factor, three-goods model of MNEs and NEs with internationally immobile skilled and unskilled labor, internationally mobile capital, and final and intermediate products. The model distinguishes between NEs that generate and export final products for consumers from NEs that produce and export intermediate inputs that can be purchased by other NEs that generate final products or horizontal MNEs (i.e. MNEs with headquarters and a plant in one country and additional plants in either one or two other countries to serve domestic markets) or vertical MNEs (i.e. MNEs with headquarters in one country and a plant in another country). Therefore; a representative

intermediate inputs enterprise in a certain country *i* can sell its output to final products producing NE, horizontal MNEs, or vertical MNEs in country *i* or country *j* or in the rest of the world.

Baldwin and Taglioni (2011) demonstrate that the standard gravity model performs poorly by some measures when it is used in bilateral flows context where parts and components trade is important. They present a simple theoretical underpinning for a modified gravity model that explains trade in global supply networks and how this theoretical model can be used.

The standard gravity model is derived from a consumer expenditure model (Anderson 1979, Bergstrand 1985, 1989, 1990, Anderson and van Wincoop, 2003). In the standard application, the bilateral trade will be regressed on the economic sizes (two GDPs) of the exporter and importer, bilateral distance, and other controlling variables to better explain trade in consumer products. In a situation where consumer trade dominates, the economic size of the importing country is a good proxy for the demand shifter in the consumer expenditure model; the economic size of the importing country is a good proxy of its total supply but when international trade in intermediate inputs dominates, the use of economic sizes (GDPs) for the supply and demand proxies is less appropriate (Baldwin and Taglioni, 2011).

Baldwin and Taglioni (2011) address the misspecification of mass variables. Studies that use estimators to account for the mass variables with fixed effects don't suffer from mass-variable misspecification. While recent studies focus on estimating geographical distance and use GDP as a proxy for the production and demand variables, these studies suffer from mass-variable misspecification. For instance, studies that focus on trade in parts and components such as Athukorala and Yamashita (2006), and Ando and Kimura (2009), these works apply the consumer product gravity model to explain parts and components trade and therefore have misspecified the mass variable (Baldwin and Taglioni, 2011).

Orefice and Rocha (2014) investigate the two-way relationship between deep integration and GVCs trade. A set of indices are constructed in terms of policy areas covered in preferential trade agreements (PTAs) to account for deep integration. This model develops a gravity equation to assess the effect of deep integration on production networks for 200 economies over the period from 1980 to 2007. This study covered a total of 96 PTAs which represent around 90 percent of world trade.

There is a positive relationship between production networks trade and deep integration and this relationship can go in both directions (Orefice and Rocha, 2011). The first direction, Deep PTAs may encourage the creation of production networks through trade facilitation between partners of a supply chain. In the second direction, countries already integrated into GVCs are more likely to sign deeper PTAs. This study investigates both directions of causality.

To investigate the impact of deep integration on production networks trade (i.e. the first direction of causality), this study applies a gravity equation to explore whether the effect of deep integration is heterogeneous across various industries. This kind of estimation potentially suffers from endogeneity due to omitted variables and simultaneity bias but this issue can be controlled by the application of country-time and country-pair fixed effects (Baier and Bergstrand, 2007). To control for selection bias as a result of the existence of zero trade flows, this study uses a two-steps Heckman selection model.

To assess whether participation in network trade increases the probability of signing deeper PTAs (i.e. second direction of causality), this study develops a gravity equation in which the dependent variable is represented by the depth of an agreement based on Baier and Bergstrand (2004). While the share of trade in parts and components over total trade accounts for the explanatory variable of interest. This variable controls for the effect of network trade relative to total trade have on the likelihood of signing deeper PTAs.

This study also investigated whether countries that participated in North-South GVCs are more likely to sign deeper PTAs. The results of this study confirm that the likelihood of signing deeper agreements is higher for country pairs integrated into North-South GVCs or belonging to the Asia region. The results also show that on average, signing deeper PTAs increases production network trade between

member states by almost 35 %, and after considering other PTAs determinants, a 10 % increase in the share of production network trade over total trade increases the depth of an agreement by about 6 %.

Caliendo and Parro (2012) develop a gravity model that relies on bilateral flows of trade in value-added to investigate the trade and welfare impacts of tariff reductions from the North American Free Trade Agreement (NAFTA) between Canada, Mexico, and the U.S. This model is built on a multi-country, multi-sector Ricardian model of the interaction across tradable and non-tradable industries represented in the input-output (I-O) tables. The model is estimated at a sectoral level using data from 1993, the year before NAFTA entered into force. The model also calibrates 31 countries 40 industries and then, using the estimated parameters and combining the shift in tariffs from 1993 to 2005, both between NAFTA member states and with the rest of the world to assess the welfare impacts and quantify the shifts in exports and imports in gross and at the sectoral level.

This study suggests that Mexico's welfare raises by 1.31%, the U.S.'s welfare increases by 0.08%, and Canada's welfare decreases by 0.06%. Moreover, intra-bloc trade boosts by 118% for Mexico, 11% for Canada, and 41% for the U.S. This study also finds out that welfare impacts from tariff reductions are decreased in a situation where the production structure doesn't consider intermediate products (input-output linkages).

In contrast to these studies that focus on aggregate trade flows in a framework that combines trade in intermediate inputs in different settings such as (Hillberry and Hummels (2005), Baldwin and Taglioni (2011), Orefice and Rocha (2014), Caliendo and Parro (2012), Noguera (2012), and Balié et al., (2019) focus on value-added trade and GVCs.

Noguera (2012) was the first to propose a gravity model of trade incorporating the global value chain. This study focused on the determinants of trade in value-added which incorporates the global input-output framework into an international trade model to derive a gravity model for bilateral value-added flows. He quantifies the impacts of trade costs by applying the dataset constructed by Johnson and Noguera (2012) which includes 42 economies for the period 1970-2009. He concluded that the bilateral trade cost elasticity of value-added exports is about two-thirds of that for aggregate exports. Also, the bilateral value-added exports rely not only on bilateral trade costs between exporter and importer but also on trade costs with third countries.

Noguera (2012) first derive an international trade model that accounts for the global input-output structure for aggregate exports. This model extends Anderson and van Wincoop (2003) that considers a one-good endowment economy, to include production using intermediate inputs and trade in these intermediate products. Then the model applies the methodology developed by Johnson and Noguera (2012) to break down gross value-added into bilateral value-added trade flows. Lastly, the model integrates this decomposition with the aggregate trade gravity model to get a model that relates bilateral value-added exports to gravity variables. So this approach reflects the intuition that value-added is not only directly traded between exporter and importer but also a consequence of how product trade flows are combined and used across economies through the global input-output framework (Noguera, 2012).

Balié et al., (2019) apply a gravity model of trade on EORA input-output tables for the year 2013 to study the impact of bilateral import tariffs and shifts in trade regimes associated with regional trade agreements on the backward participation and forward participation of agriculture and food GVCs in Sub-Saharan Africa (SSA). This model applies a methodology developed by Wang, Wei, and Zhu (2013) to decompose gross value-added trade flows and compute the measures of GVC participation. This study suggests that SSA economies' world trade shares are low but their GVC participation is increasing over time particularly upstream as suppliers of unprocessed intermediate goods. The main destinations of the value-added demand of SSA agricultural products are the EU and emerging countries' markets rather than regional markets. Also, the bilateral trade protection remarkably impacts the GVC backward and forward participation of the agriculture and food sectors of SSA countries.

Ghodsi et al., (2017) focus on how different types of NTMs impact global trade over the period of 1995-2014. To differentiate between various NTM types, they use the information on NTMs notified to the WTO from the integrated Trade Intelligence Portal (I-TIP). They amend the I-TIP database to suit econometric analysis and the estimation of trade impacts of NTMs at the HS 6-digit product level for more than 100 countries with a gravity model. Their results show that about 60% of all estimates point towards a trade-impeding effect of NTMs. The positive effect on the demand side compensates for the negative impact on the surging costs of the supply side for sanitary and phytosanitary (SPS) measures. The overall technical barriers to trade (TBTs) impede trade in high-income countries in Europe and Central Asia.

Fusacchia et al., (2021) define a new measure of trade protection based on the value-added in trade, to assess the impact of the tariff on exporting firms that depend on imported intermediate inputs. Fusacchia et al., (2021) provide an index, defined in a general equilibrium framework, to measure protection in the context of GVCs. Fusacchia et al., (2021) assess trade protection by calculating protection indexes at the bilateral level on both gross imports and imports to exports using the Global Trade Analysis Project (GTAP) computable general equilibrium model. Fusacchia et al., (2021) use these indexes to investigate the relationship between the EU tariffs and the integration of the Italian GVCs. Fusacchia et al., (2021) show that in the case of Italy, imports to exports are overall less protected than gross imports with significant differences at the industry level. They also show that the EU tariffs mostly affect Italian exporting firms in the case of chemical products, wearing apparel, and leather products.

The main differences between this study and Ghodsi et al., (2017) are: 1) Ghodsi et al., (2017) studies trade impacts of different types of NTMs while this study focuses on overall trade effects of NTMs. 2) they focus on global trade for more than 100 economies and this stud focuses mainly on agriculture and food products for ACP countries (developing and least developed countries).

NTMs quantification approaches: In the last two decades, we have witnessed an increase in trade literature on quantifying the trade effect of NTMs. Generally, there are two main approaches to quantify the trade effect of NTMs: Price-based and quantity-based methodologies.

Price-based approach: this approach compares the prices in the importing economy with prices of comparable goods in free markets (Berden and Francois, 2015). Among those applied price-based approaches are Bradford (2005), Ferrantino (2006), and Dean et al. (2009).

Dean et al.,'s (2009) NTMs price-based approach takes the advantage of retail price data at the city level to study how much of NTMs affect prices. For the presence of NTM, they based their analysis on Kee et al.,'s (2009) data and Bradford's (2003, 2005) for price data at the product level. Generally, Dean et al.,'s (2009) approach is based on the following steps: 1) Price gap: they use a differentiated product approach that accounts for various varieties (i.e. imported and domestic varieties). 2) Presence of NTM and retail price data (NTMs across countries and products). 3) Variable coefficients: to assess the NTM effect at the country and sector level, they regress the retail price gap on local distribution margins, transport costs, and tariffs. Then the variable coefficient of the NTM impact is interpreted into tariff equivalents. 4) Finally, the move from variable coefficients to country and sector-level tariff equivalents: the variable coefficient of the NTM effect can be changed into trade cost estimates (tariff equivalents)

Quantity-based approach: this approach uses gravity models to assess how much the presence of NTMs decreases trade flows compared to potential trade (Berden and Francois, 2015). Among those developed quantity-based approaches are Leamer (1988), Berden et al., (2009), Fontagné et al., (2013), Francois et al., (2013), and Egger et al., (2015).

Berden et al., (2009) use NTMs quantity-based methodology to quantify the potential impacts of the Transatlantic Trade and Investment Partnership (TTIP). To do so, they apply the following steps: 1) Business survey to collect NTM survey numbers at the bilateral level: the aim of the survey is to collect data on market restrictions (the presence of NTMs) at the bilateral level where businesses were

asked to indicate the level of market restrictions based on points from zero to 100. They collected 5,500 data points at the bilateral level. 2) From NTM survey numbers to NTM index: the presence of NTMs (NTM survey numbers) at the bilateral level will be transformed into NTM index on the log scale. From NTM index to gravity equation variable coefficient: they apply gravity model to assess the potential impact of the TTIP agreement by using dummies variables (EU, NAFTA, TTIP) to interact with the NTM index. Finally, they apply their model to18 different sectors but the agriculture sector was not included in their study.

Cadot and Gourdon (2016) combine for the first time dataset of NTMs in 65 economies with the CEPII's unit values database to assess average ad-valorem equivalents (AVEs) for sanitary and phytosanitary, technical-barriers-to trade and other measures by section of the Harmonized System of product classification. They show that deep-integration clauses in regional trade agreements, specifically the mutual recognition of conformity assessment procedures, significantly decrease the price-raising impact of NTMs, possibly reflecting lower compliance costs.

Orefice (2017) studies the determinants of the recent proliferation of Specific Trade Concerns (STCs) raised at the WTO on NTMs, with a focus on SPS and TBTs. Orefice (2017) examines whether STCs are raised by exporting countries as a consequence of tariff reductions in importing countries, that is when NTMs become barriers to trade. Orefice (2017) shows that SPS and TBT concerns are raised by exporting countries as a result of the importer's tariff cut.

Cheong et al., (2018) isolate the impacts of tariff and non-tariff changes under PTAs. They construct a new dataset of bilateral tariff rates for 90 importing and 149 exporting countries for the year 1996-2010, covering the Harmonized System 2-digit level of product varieties. Cheong et al., (2018) allow for heterogeneity across three different types of PTAs, specifically CUs, FTAs, and partial scope agreements (PSAs). Cheong et al., (2018) show that: 1) non-tariff changes under PTAs on average increase both the intensive and extensive margins of trade. 2) Unlike FTAs and CUs, PSAs do not have discernible trade effects. 3) CUs have a stronger trade effect than FTAs. 4) (v) non-tariff changes associated with CUs have a stronger impact on trade than those associated with FTAs and PSAs. 5) the effect of CUs due to the non-tariff changes, while that of FTAs due to both tariff and non-tariff changes. 6) changes on non-tariff take a longer time than tariff changes to have an impact on the intensive margin. 7) there is significant heterogeneity across industries in their response to trade liberalization.

Gunessee et al., (2018) study the evolution of the incidence and intensity of NTMs. Gunessee et al., (2018) build on Kee et al., (2009) to estimate the ad valorem equivalents of NTMs for 97 countries at the product level over the period 1997–2015. Gunessee et al., (2018) show that: 1) the incidence and the intensity of NTMs were both increasing over this period. 2) The evolution of overall protection derived jointly from tariffs and NTMs. 3) The overall protection level, for most products and countries, has not reduced although the fall in tariffs associated with multilateral, regional, and bilateral trade agreements in recent decades.

Herghelegiu (2018) examines the extent to which NTMs are set for protectionist purposes with special attention to developing countries. Herghelegiu (2018) shows that NTMs reflect protectionist forces, mainly for those that have been subject to trade concerns at the WTO. With regards to the other measures, there is no evidence that protectionism is the driving force behind their adoption. Herghelegiu (2018) also shows that transnational lobbying is positively associated with the probability of adopting NTMs.

Bekkers and Romagosa (2019) show that recently many countries enter into deep and comprehensive FTAs that contain provisions on NTMs. This is in contrast with the traditional shallow trade agreements that focused mainly on the reduction of tariffs. Bekkers and Romagosa (2019) also reveal that to predict the welfare effects of deep FTAs is to translate the NTM provisions into overall welfare effects which can be achieved through 1) the particular NTM provisions need to be translated into trade cost reductions. 2) Welfare effects of the trade cost reductions are computed with a general equilibrium model.

Kinzius et al., (2019) apply the structural gravity model on Global Trade Alert data, to study the impact of NTBs on imports. Kinzius et al., (2019) also show that: 1) the implementation of NTBs decreases imports of affected products by up to 12%. 2) Different categories of NTBs impact trade to a different extent. 3) Behind-the-border measures lower the importer's market access.
Santeramo and Lamonaca (2019) review the existing literature on the impact of NTMs on agri-food trade and conduct a meta-analysis to extricate potential determinants of heterogeneity in estimates.

Santeramo and Lamonaca (2019) show that: 1) some studies reveal positive significant estimates and others negative significant estimates. 2) the impacts of NTMs vary across categories of NTM, proxies used for NTMs, and levels of detail of studies. 3) the estimated impacts are also affected by methodological issues and publication processes.

This study is the first to investigate the impact of tariffs and NTMs associated with shifts in trade regimes on ACP's food & agricultural sectors' participation in GVCF and GVCB. By decomposing the bilateral gross exports with a methodology developed by B&M (2019) using the EORA 2015 data, This study contributes to the literature by adopting an empirical gravity model of *value-added trade* proposed by Balié et al., (2019) to estimate the effect of trade policy on ACP's food & agricultural sectors' backward and forward participation in global network productions applying B&M (2019) approach.

3. ACP COUNTRIES' FOOD AND AGRICULTURE INTEGRATION INTO GVC

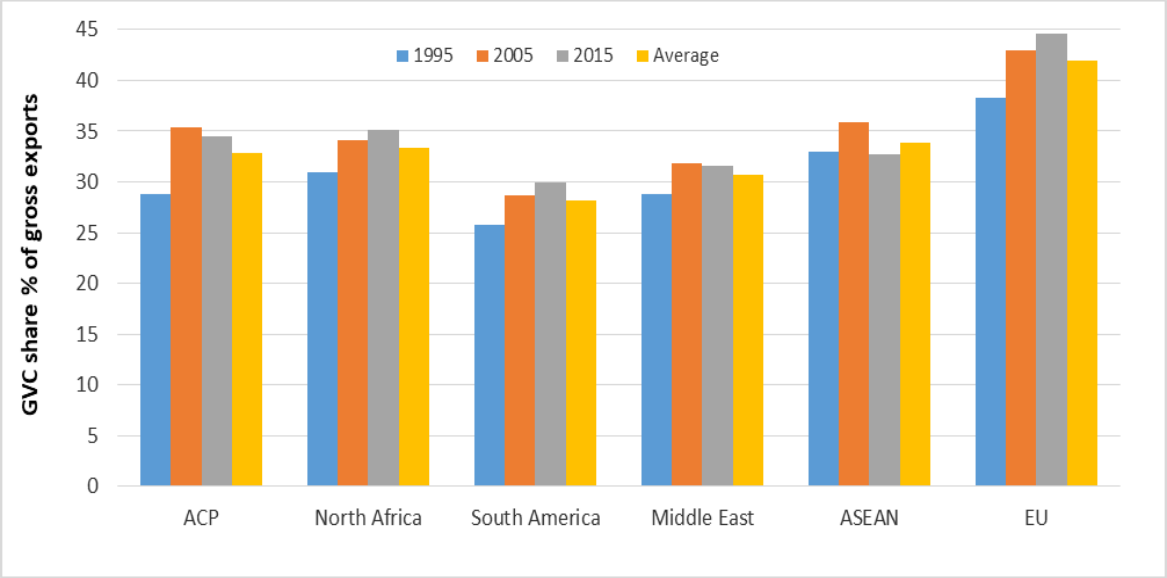
3.1. Some stylized facts

This section presents the food and agriculture sector integration into GVCs in ACP countries, applying B&M (2019) decomposition methodology on EORA Input-Output (IO) tables from 1995 to 2015, and then focuses on bilateral trade policy (tariffs, NTMs, RTAs) in ACP countries. EORA IO tables provide information about demand and supply linkages among 188 economies and 26 sectors including ACP countries from 1990 to 2015. EORA tables allow us to compute GVCs indicators (i.e. forward-GVC index & backward-GVC index) based on gross exports and value-added trade relations between these countries. To do this, this study applies B&M's (2019) decomposition methodology (presented in appendix 2) on EORA tables (1995 to 2015).

Figure (1) presents the overall level of GVC (forward-GVC plus backward-GVC) participation of the agricultural sector (as exporting sector) in 1995, 2005, 2015 and averages (averages are taken for these three years) across regions. On average, the EU28 and ASEAN economies are the most integrated over these three years. Figures exhibit that on average, the ACP economies integration index is very high (33%), equal to the index of North Africa (33%) and higher than indices of the Middle East (31%) and South America (28%). This shows that more than one-third of all agriculture trade activities in ACP countries are GVC-related.

Similarly, Figure (2) presents the overall GVC participation of the food & beverages sector in 1995, 2005, 2015 and averages (averages are taken for these three years) across regions. On average, the EU28 and ASEAN economies are the most integrated over these three years. The ACP economies' integration level also is very high (on average 28%) and higher than the level of the Middle East. This means that almost one-third of all food trade activities in ACP countries are GVC-related.

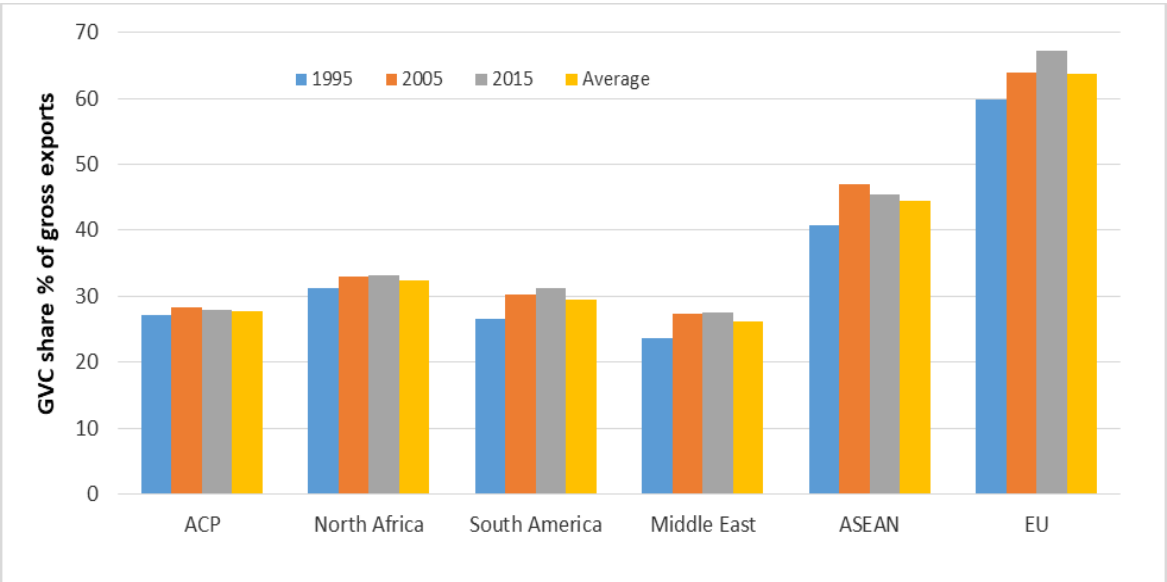
Figure 1 shows the overall-GVC participation of the agricultural sector by region in 1995, 2005, 2015, and average



Source: Author's calculation based on EORA data, 1995, 2005, 2015

These two figures (1) and (2) show that GVC participation is increasing over time worldwide. These figures also give us a bigger picture of the overall GVC participation (i.e. forward-GVC plus backward-GVC as one indicator) in the agriculture and food sector but this study mainly focuses on forward-GVC-related trade activities and backward-GVC-related trade activities separately to analyze the upstream and downstream activities of ACP economies in these two sectors. Therefore; the following paragraphs focus on forward and backward GVC participation across regions and ACP countries.

Figure 2 shows the overall-GVC participation of the food & beverages sector by region in 1995, 2005, and 2015

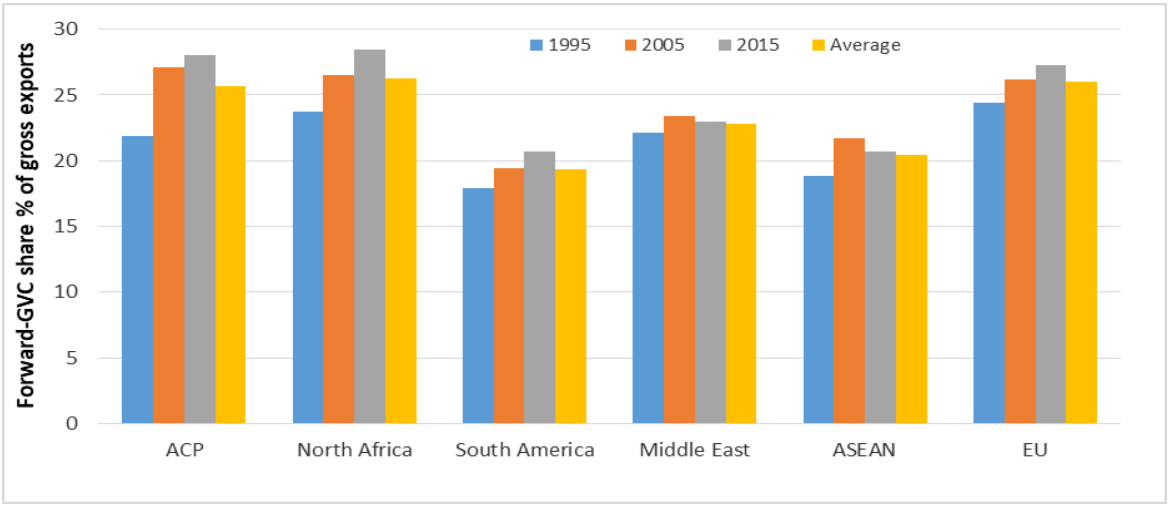


Source: Author's calculation based on EORA data, 1995, 2005, 2015

Figure (3) shows forward-GVC (GVCF) participation of the agriculture sector in 1995, 2005, 2015, and averages across regions. The ACP, EU28, and the ASEAN economies are the best performers in supplying value-added to other economies in the world. This means that these regions are highly involved in upstream activities (i.e. early stages of the production process). Figure (3) shows that ACP

countries' agriculture sector is more involved in forward-GVC (26%) than South America (19%), ASEAN (20%), and the Middle East (23%) countries.

Figure 3 shows forward-GVC participation of the agricultural sector by region in 1995, 2005, and 2015

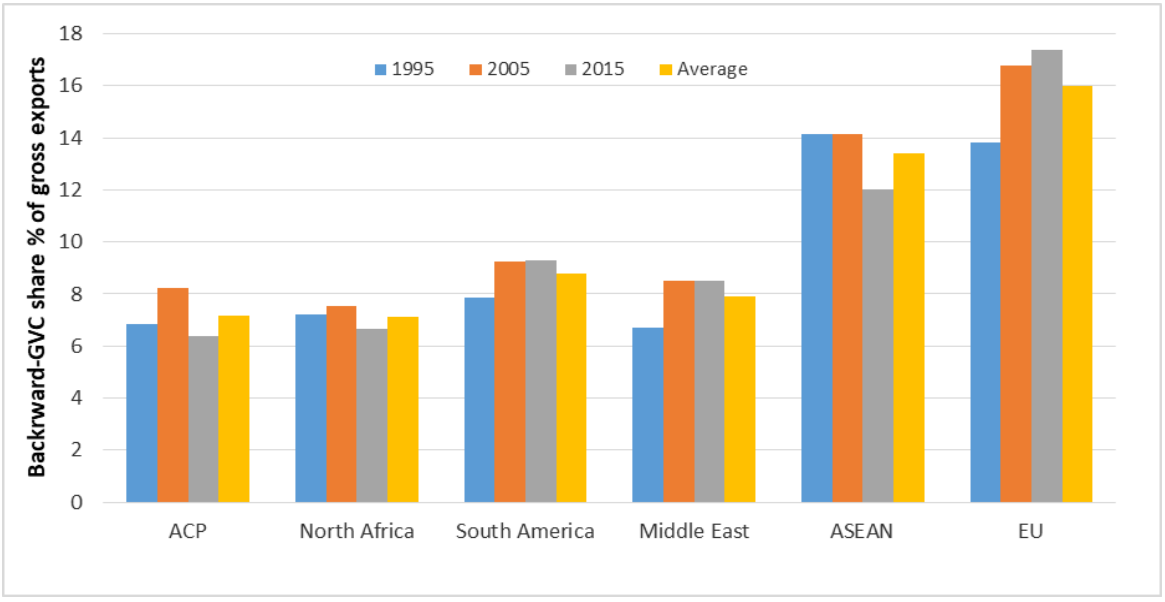


Source: Author's calculation based on EORA data, 1995, 2005, 2015

On the other hand, the EU28 and ASEAN countries are the most integrated into agriculture GVCB (figure 4). This means that these regions are highly involved in downstream activities. Figure (4) shows that on average, ACP (7%) and North African (7%) economies are less involved in agriculture GVCB-related trade activities (i.e. downstream activities).

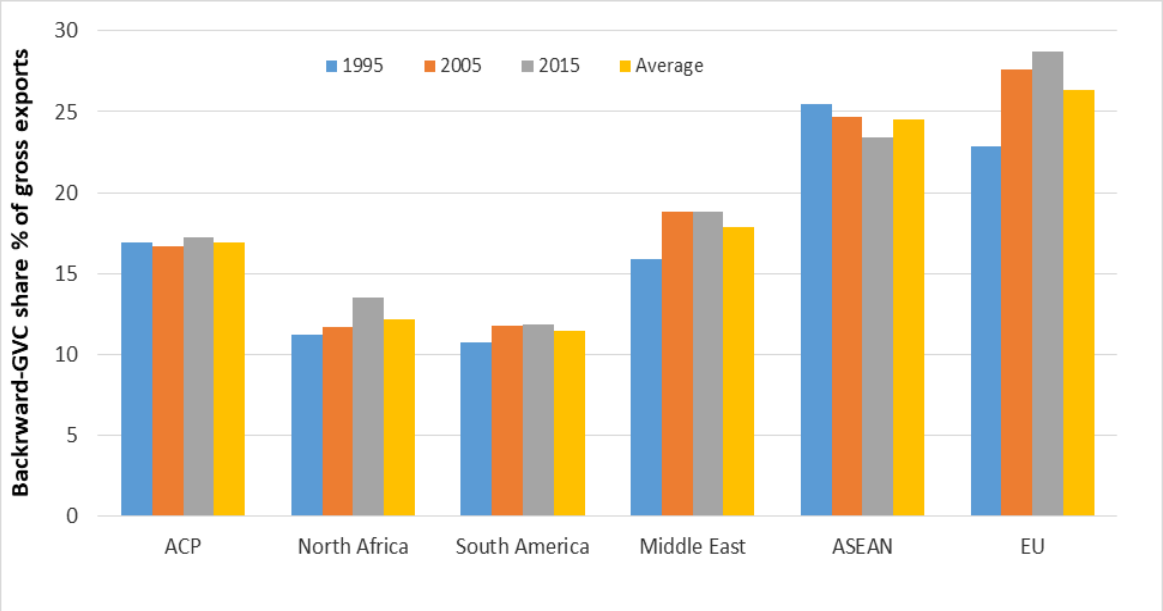
For the food & beverages sector, figure (5) exhibits that the EU28 and ASEAN countries are also the most involved in downstream activities (i.e. GVCB). But on average, the ACP participation level (17%) in GVCB is higher than in North Africa (12%) and South America (11%). This means that the ACP countries are involved in food & beverages downstream activities more than North Africa and South America. The EU28, North Africa, and ASEAN countries are the most integrated into food & beverages GVCF (i.e. upstream activities), and ACP and the Middle East are less integrated (figure 6).

Figure 4 shows backward-GVC participation of the agricultural sector by region in 1995, 2005, and 2015



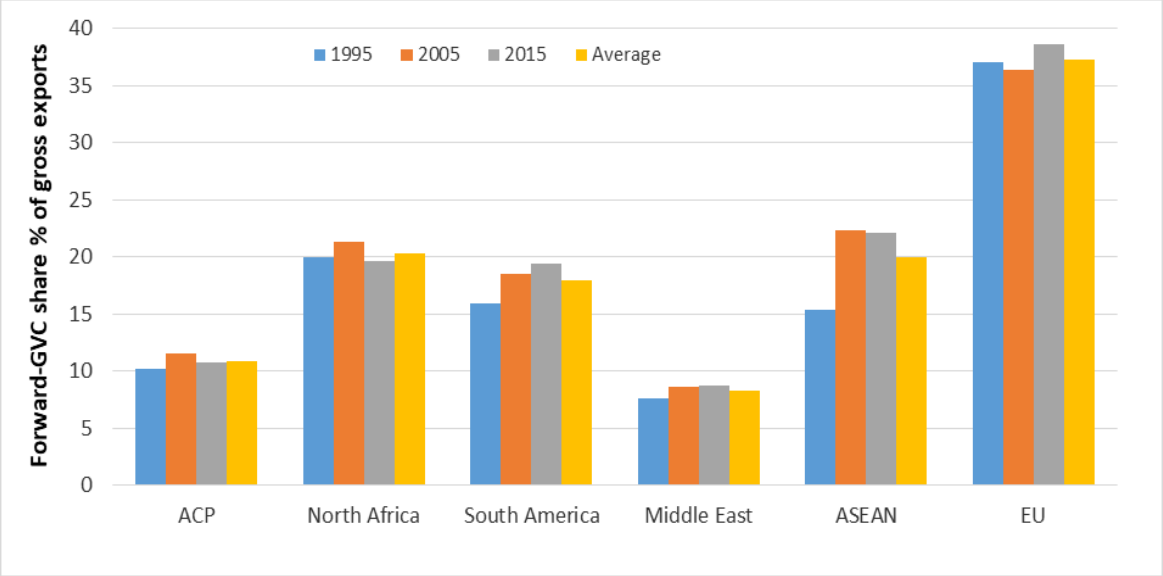
Source: Author's calculation based on EORA data, 1995, 2005, 2015

Figure 5 shows backward-GVC participation of the food & beverages sector by region in 1995, 2005, and 2015



Source: Author's calculation based on EORA data, 1995, 2005, 2015

Figure 6 shows forward-GVC participation of the food & beverages sector by region in 1995, 2005, and 2015



Source: Author's calculation based on EORA data, 1995, 2005, 2015

At the country level, ACP countries are highly integrated into food & beverages GVCB and GVCF. Figure (7) shows that ACP economies are highly involved in food & beverages upstream and downstream activities. The countries with the highest GVCB (downstream activities) indicators are Tanzania (38%), Botswana (38%), Antigua and Barbuda (37%), Swaziland (36%), the Bahamas (31%), São Tomé and Príncipe (29%), Guyana (28%), Mauritius (27%), Namibia (27%), Barbados (25%), Ethiopia (24%), Jamaica (24%), and Cape Verde (22%). The countries with the highest GVCF (upstream activities) indicators are Suriname (39%), DR Congo (33%), Gambia (30%), Nigeria (28), Eritrea (28%), Tchad (26%), Burundi (25%), Seychelles (25%), Liberia (22%), Rwanda (22%), and Senegal (21%).

In the agriculture sector, figure (8) shows that the ACP countries are mainly involved in upstream activities. The countries with the highest GVCF (upstream activities) indicators are Suriname (67%), DR Congo (52%), Ghana (41%), Rwanda (40%), Swaziland (40%), Burundi (38%), Congo (38%), Guinea (37%), Kenya (35%), Senegal (35%), Sierra Leone (35%), Central African Republic (33%), Guyana (33%), Cameroon (32%), São Tomé and Príncipe (31%), and Cape Verde (30%).

The EU27 and the UK are the main destination markets for agricultural exports from ACP countries. Table (1) shows 51.6% of the ACP agricultural exports went to the EU28 (UK 4.2% + EU27 47.4%). 54.95 % of ACP's agricultural value-added directly (DAVAX) consumed by the EU28 final demand (EU27 50.25% + the UK 4.70%). The ACP countries' GVC-related agricultural trade activities in bilateral exports to the EU28 are mainly driven by upstream linkages (GVCF).

The EU28 is also the main destination market for ACP's food & beverage exports. Table (1) shows 56.44% of the ACP food & beverages exports went to the EU28 (UK 9.04% + EU27 47.39%). 58.45 % of ACP's agricultural value-added directly (DAVAX) consumed by the EU28 final demand (EU27 49.08% + the UK 9.38%). The ACP countries' GVC-related food & beverages trade activities in bilateral exports to the EU28 are mainly driven by upstream linkages (GVCF).

To sum up, Agriculture and food & beverages GVCB and GVCF are increasing over time worldwide. The ACP, EU28, and the ASEAN economies are the best performers in supplying agricultural value-added to other economies in the world since they are involved in upstream activities (GVCF). The EU28 and ASEAN countries are the most integrated into agriculture GVCB. This means that these regions are highly involved in downstream activities. The ACP and North African economies are less involved in agriculture GVCB-related trade activities.

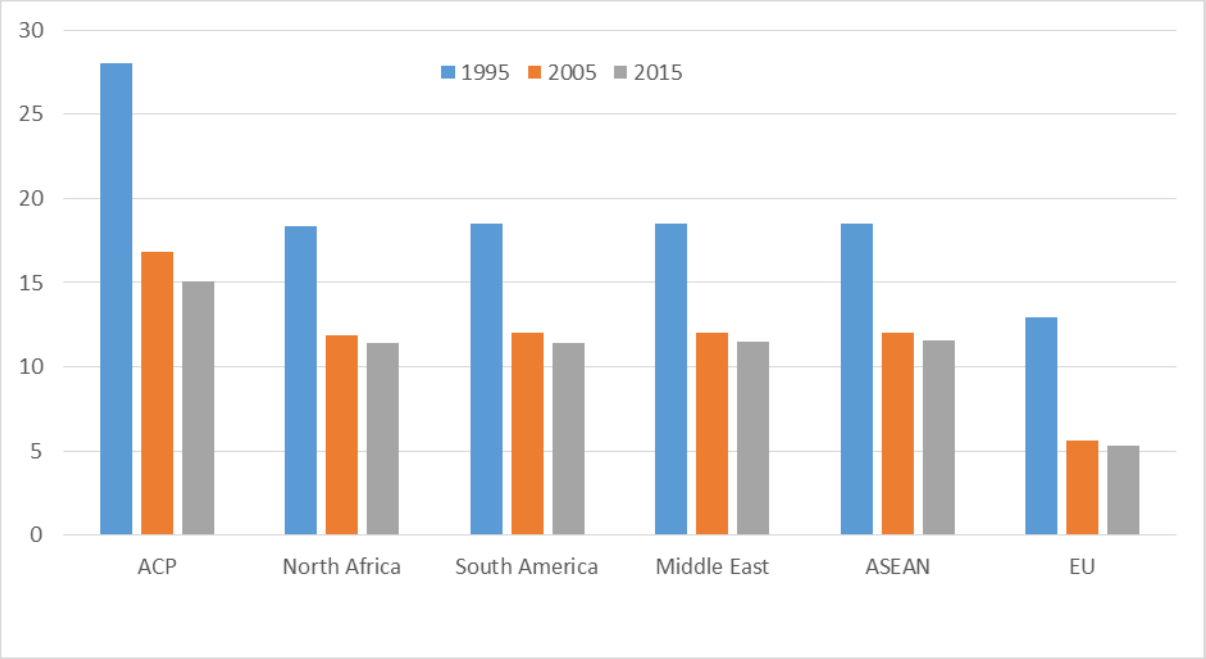
The EU28 and ASEAN countries are also the most involved in food & beverages downstream activities (i.e. GVCB). The ACP participation level in food & beverages GVCB is also considerable and higher than in North Africa and South America. The EU28, North Africa, and ASEAN countries are the most integrated into food & beverages GVCF, and ACP and the Middle East are less integrated. The EU28 is interested in importing unprocessed intermediate inputs from ACP countries to be processed domestically and then to be involved in downstream activities. The EU28 is less interested in importing final products or processed inputs from the ACP economies.

At the country level, there is heterogeneity among ACP countries' involvement in the international fragmentation of production. Also, most of ACP countries participation in agriculture and food & beverages GVCB and GVCF are mainly driven by the supply of inputs for other economies, only a few of them are importers of foreign inputs for the production of their exports such as Tanzania, Botswana, Antigua, and Barbuda, Swaziland, the Bahamas, São Tomé and Príncipe, Guyana, Mauritius, Namibia, Barbados, Ethiopia, Jamaica, and Cape Verde.

3.1.1. Tariffs and Regional Trade Agreements (RTAs)

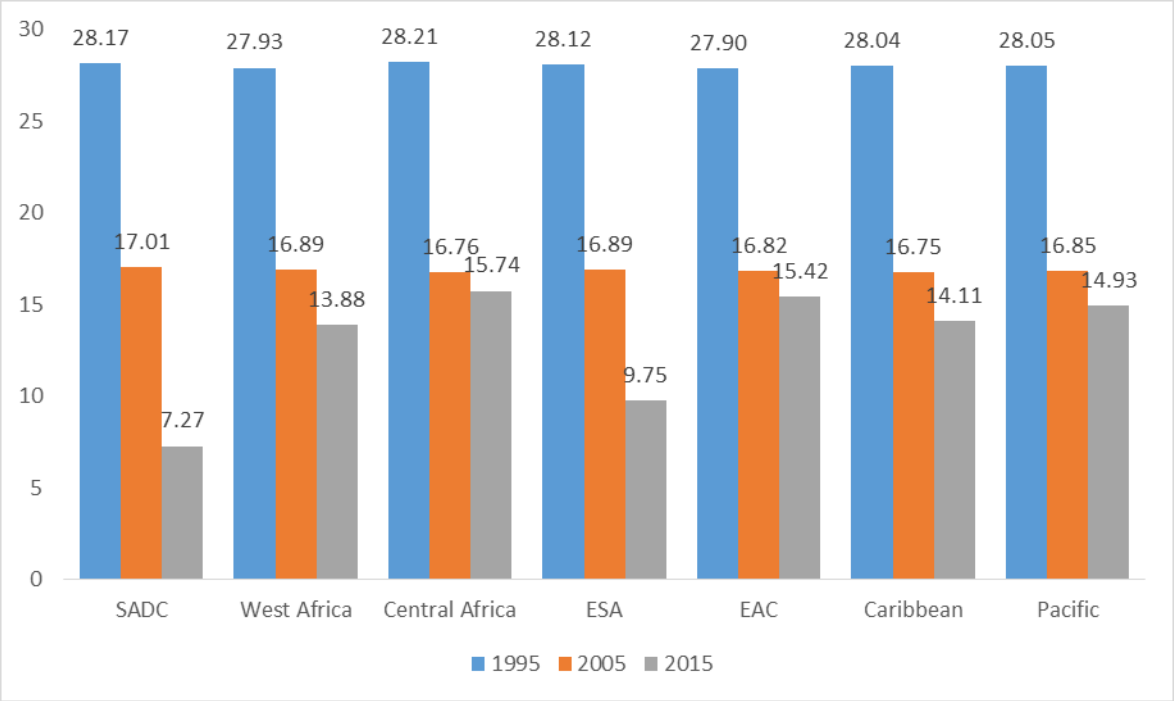
Quantifying trade policy impact on agriculture and food GVCB and GVCF participation requires detailed information on tariffs, RTAs, and NTMs at the sectoral-bilateral country level. To this end, the main source of the sectoral-bilateral tariff schedules is the World Integrated Trade Solution (WITS) WTO IDB/CTS databases. Although agriculture average tariffs rates are declining over time worldwide, still very high, particularly in ACP countries (figure 9). In 2015, the agriculture average tariff rates were still significant at 15% (figure 9). With exception of the Southern African Development Community (SADC) (7%), the agriculture average import protection rates are still considerable at ACP bloc levels in 2015 (figure 10).

Figure 9 shows agriculture average tariff rates, by region, in 1995, 2005 and 2015



Source: Author's calculation based WITS WTO IDB/CTS databases

Figure 10 shows agriculture average tariff rates, for ACP blocs, in 1995, 2005 and 2015

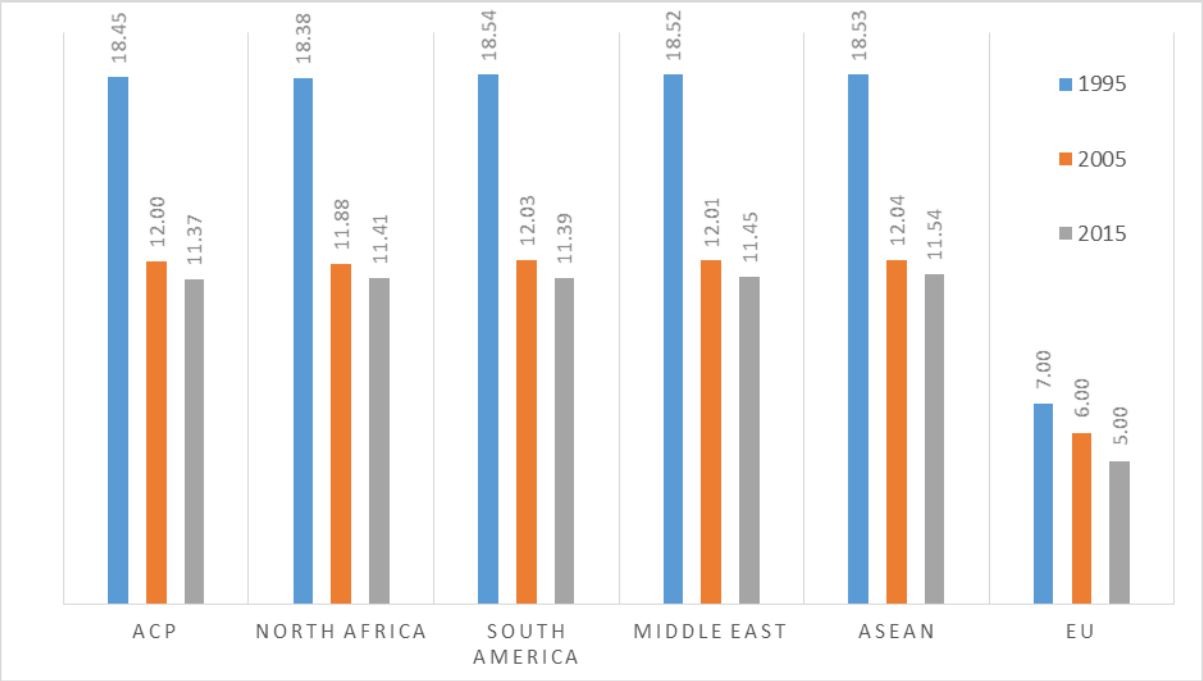


Source: Author's calculation based WITS WTO IDB/CTS databases
Notes: SADC: Southern African Development Community. ESA: Eastern and Southern Africa. EAC: East African Community. Caribbean: Caribbean Forum (Cariforum).

Although food & beverages average tariff rates are declining over time worldwide, still significant in all regions except EU28 (figure 11). In 2015, food & beverages average tariff rates were still high at 11% (figure 11). Food & beverages' average import protection levels are still significant at all ACP bloc levels at 11% in 2015 (figure 12). RTAs data are obtained from the WTO RTAs database and De Sousa (2012) dataset that covers 199 countries from 1958 to 2015 which excludes partial scope agreements in force and notified to the WTO up to 2015. Figure (13) shows that, despite an increasing number of

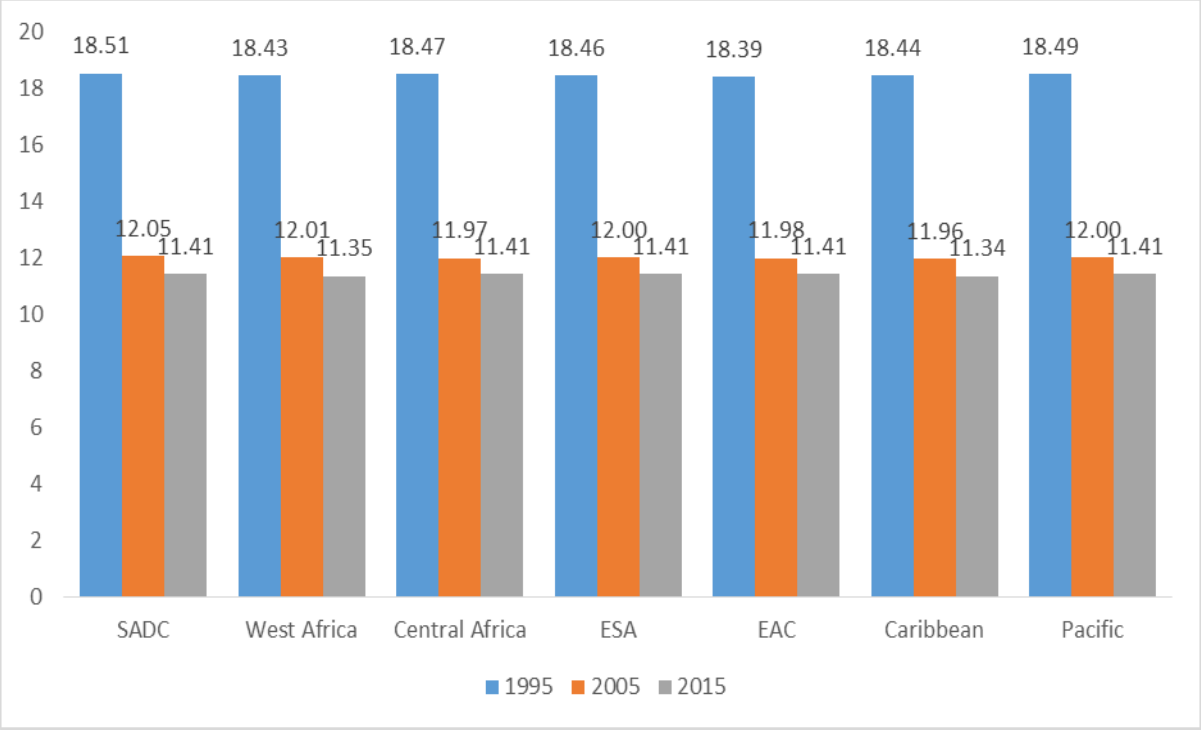
signed RTAs in all regions, the average number of RTAs signed by each ACP country is still very low (about 7).

Figure 11 shows food & beverages average tariff rates, by region, in 1995, 2005 and 2015



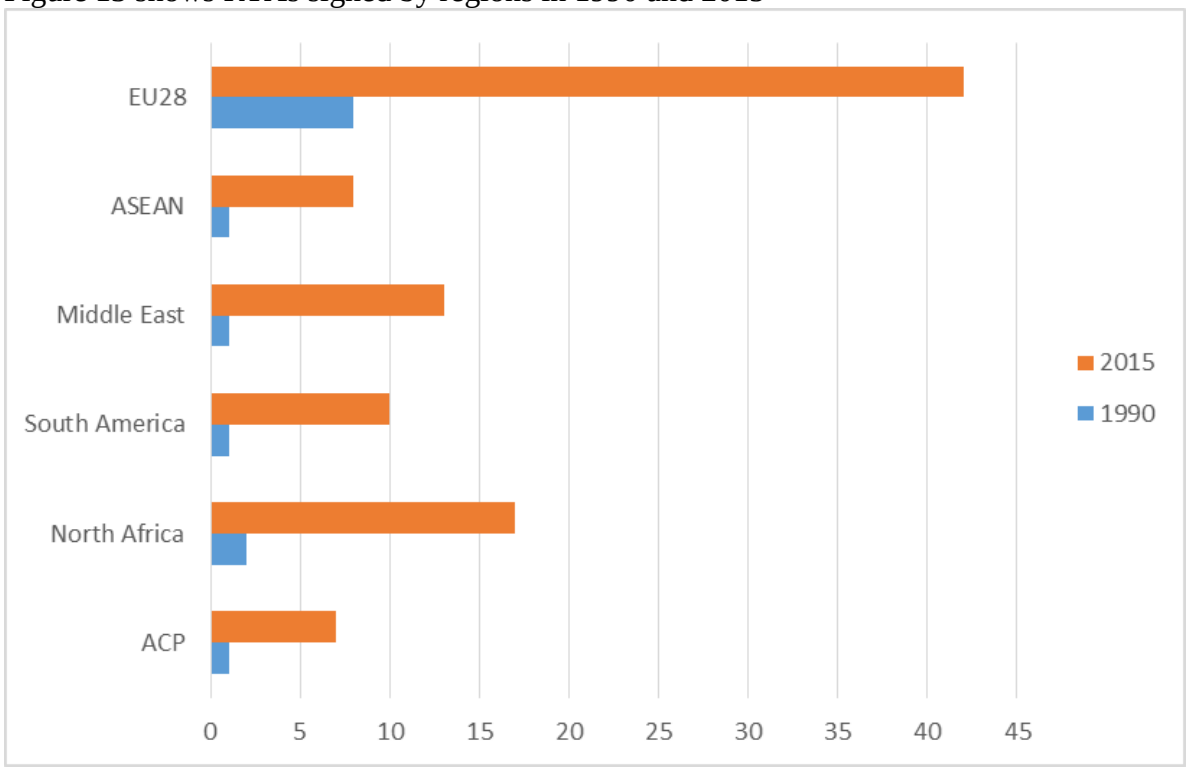
Source: Author's calculation based WITS WTO IDB/CTS databases

Figure 12 shows food & beverages average tariff rates, for ACP blocs, in 1995, 2005 and 2015



Source: Author's calculation based WITS WTO IDB/CTS databases
Notes: SADC: Southern African Development Community. ESA: Eastern and Southern Africa. EAC: East African Community. Caribbean: Caribbean Forum (Cariforum).

Figure 13 shows RTAs signed by regions in 1990 and 2015



Source: Author's calculation based on WTO RTAs database

4. METHODOLOGY AND EMPIRICAL ANALYSIS

The main goal of this section is to present the empirical gravity model on bilateral flows of trade in value-added to identify the impact of tariffs and NTMs (associated with shifts in trade regimes) on ACP's food & agricultural sectors forward and backward participation in GVCs.

This empirical analysis makes use of a panel specification with fixed effects and a various identification strategy that relies on bilateral flows of trade in value-added. To do this, this study applies the well-specified gravity equation and inputs from the most recent theoretical and applied literature to quantify whether tariffs and NTMs associated with shifts in trade regimes influence the ACP's food & agricultural sectors forward and backward participation in GVCs. This study adopts the gravity model for value-added trade developed by Balié et al., (2019) and the decomposition methodology of aggregate value-added into bilateral value-added trade proposed by B&M (2019) presented in appendix (2). As a result of that, the well-specified gravity model is given by the following equation:

$$GVC_{ijt} = \beta_0 + \beta_1 t_{ijt} + \varphi_{it} + \tau_{jt} + \varphi\tau_{ij} + \varepsilon_{it} \quad (1)$$

Where all non-dummy variables are in natural logs. *i* denotes the exporter country, *j* the importer country, and *t* indicates time. GVC (in values $) accounts for the bilateral exports of value-added derived from B&M (2019) decomposition (appendix 2). This study uses two alternative response (dependent) variables as following: 1) Backward participation (the use of foreign intermediate goods for the production of goods for exports) in GVCs (see appendix 1). 2) Forward participation (the use of domestic inputs in third country exports) in GVCs (see appendix 1).

Country's Participation in GVCs involves both upstream and downstream activities. An upstream supplier (i.e. forward participation) exports intermediate inputs to a downstream producer (i.e. backward participation), who then processes and adds value to these intermediate products for further export to another country. A country's high involvement in global supply networks can be determined

by one of the following: 1) A country's exports contain a high import content (downstream producer). 2) country supplies intermediate inputs for further export by other countries (an upstream producer).

Forward participation measures the exporting country's involvement in upstream activities relative to the importing countries. Backward participation measures the degree of the exporting country's involvement in downstream activities relative to the importing countries. Therefore; a country's position in a supply chain is determined by making a comparison between its upstream and downstream activities.

β_0 is the intercept, φ_{it} denotes time-variant exporter fixed effect for country *i*, and τ_{jt} indicates time-variant importer fixed effect for country *j*, $\varphi\tau_{ij}$ denotes country-pair fixed effect (exporter-importer interactions) and ε_{it} is the error term. The panel specification controls for unobserved heterogeneity in trade data, the exporter-time, and importer-time fixed effects allow us to control for all time-variant unobservable country characteristics. While the country-pair fixed effects control for any time-invariant country pair that could affect bilateral trade flows between *i* and *j*. The full set of country-time fixed effects control for time-varying Multilateral Resistance Terms (Anderson and van Wincoop, 2003).

t_{ijt} is trade cost (i.e. the trade policy variable). Commonly, proxy variables can be used to measure t_{ij}, such as the bilateral distance between country *i* and country *j* is denoted by DST_{ij}, whether there is an international border ADJ_{ij}, whether they share a common official language LNG_{ij}, whether they have a common colonial relationship after the colonial era COR_{ij}, whether they impose tariffs ($Tariff_{ij}$) and NTMs (NTM_{ij}), and whether they have a Regional Trade Agreement RTA_{ij} to measure the effect of the trade policy on backward and forward participation as follows:

$$t_{ijt} = \beta_1 DST_{ij} + \beta_2 ADJ_{ij} + \beta_3 LNG_{ij} + \beta_4 COR_{ij} + \beta_5 Tariff_{ijt} + \beta_6 NTM_{ijt} + \beta_7 RTA_{ijt} \quad (2)$$

Where all non-dummy variables are in natural logs.

Recent RTAs focus on addressing NTMs. Cadot & Gourdon (2016) show that in RTAs with deep-integration clauses, harmonization, mutual recognition of standards or conformity assessment and enhanced transparency significantly reduce trade costs generated by different national standards. Trivedi et al., (2019) analyze 58 RTAs signed or/and in force from 2009 to 2018 to investigate the extent to which RTAs in Asia and the Pacific address three types of Non-Tariff Measures (NTMs) namely technical barriers to trade (TBT), sanitary and phytosanitary (SPS) and government procurement (GP). Their findings show that RTAs signed on or after 2014 feature extensive provisions on SPS and TBT. The number of RTAs featuring provisions on GP has increased remarkably before and after 2014. This study mainly focuses on the quantification of trade policy variables ($Tariff_{ijt}$, NTM_{ijt} , EPA_{ijt}, EBA_{ijt}, FTA_{ijt}, RTA_{ijt}) therefore, substituting (2) into (1) produces the estimated gravity model as follows:

$$\begin{aligned} GVC_{ijt} = {} & \beta_0 + \beta_1 Tariff_{ijt} + \beta_2 NTM_{ijt} + \beta_3 FTA_{ijt} + \beta_4 EPA_{ijt} + \beta_5 EBA_{ijt} \\ & + \beta_6 RTA_{ijt} + \beta_7 Interaction\ terms_{ijt} + \varphi_{it} + \tau_{jt} + \varphi\tau_{ij} + \varepsilon_{it} \end{aligned} \quad (3)$$

Where all non-dummy variables are in natural logs. $Tarif_{ijt}$ accounts for tariffs imposed by importing country *j* on exported goods from exporting country *i*. NTM_{ijt} accounts for NTMs imposed by importing country *j* on exported goods from exporting country *i*. FTA_{ijt} is a dummy variable that takes the value of one when exporting country *i* and importing country *j* have an FTA at time *t*, and zero otherwise. EPA_{ijt} is a dummy variable that takes the value of one when exporting country *i* and importing country *j* have an EPA at time *t*, and zero otherwise. EBA_{ijt} is a dummy variable that takes the value of one when exporting country *i* and importing country *j* have an EBA at time *t*, and zero otherwise. RTA_{ijt} is a dummy variable that takes the value of one when exporting country *i* and importing country *j* have RTA at time *t*, and zero otherwise. Interaction terms are 1)

$Interaction(\text{NTM} * \text{low} - \text{income countries})_{\_ijt}$ captures the trade effect of NTMs on low-income countries only. $Interaction(\text{EBA} * \text{EPA})_{\_ijt}$ captures the trade effect of tariffs and NTMs on ACP countries that enjoy both EBA and EPA EU market access.

This study estimates the coefficients by using the Poisson Maximum-Likelihood Estimator (PPML) approach to deal with the well-known econometric problems resulting from zero bilateral trade flows and heteroskedastic residuals in log-linear gravity equations (Silva and Tenreyro 2006) as follows:

$$GVC_{ijt} = exp\,(\,\beta_1 Tariff_{ijt} + \beta_2 NTM_{ijt} + \beta_3 FTA_{ijt} + \beta_4 EPA_{ijt} + \beta_5 EBA_{ijt} + \beta_6 RTA_{ijt} + \beta_7 Interaction\ terms_{ijt} + \varphi_{it} + \tau_{jt} + \varphi\tau_{ij}\,) + \varepsilon_{it} \quad (4)$$

In the following section, this study provides the methods used to classify NTMs, aggregate NTMs applied at products (HS6 digits) level to NTMs at food sector and agriculture sector level by using BEC classifications. Then uses the NTMs Frequency Index (FI) and Coverage Ratio (CR) to quantify NTMs at the food and agriculture sectors level. After that, this study shows how to move from NTMs FI to gravity model dummy-variable coefficients. This study adopts a quantity-based approach proposed by Berden et al., (2009).

4.1.Non-tariff Measures (NTMs) from concepts to measurements

4.1.1. Definition and Classification of Non-tariff Measures

NTMs are policy measures, other than customs tariffs, that can potentially have an economic impact on international trade of goods, changing quantities traded, or prices, or both (UNCTD, 2009). The NTMs are divided into 16 chapters (A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, and P) according to the UNCTD classification of 2012 (table 2).

Classification of NTMs: The classification of NTMs developed by Multi-Agency Support Team (MAST) from different international organizations (FAO, IMF, ITC, OECD, UNCTD, UNIDO, WB, and WTO), to assist the group of eminent persons on non-tariff barriers founded by the secretary-general of UNCTD in 2006 (UNCTD 2012). Chapter A, on Sanitary and Phytosanitary (SPS) measures, refers to measures such as restriction for substances, food safety measures, measures for preventing the dissemination of disease or pests, and all conformity-assessment measures related to food safety (certification, testing and inspection, and quarantine). Chapter B, on technical measures such as labeling, standards on technical specifications and quality requirements, measures protecting the environment, all conformity-assessment measures related to technical requirements (certification, testing, and inspection). Chapter C classifies measures related to pre-shipment inspections and customs formalities.

Chapter D refers to contingent measures implemented to counteract particular adverse effects of imports in the market of the importing country, measures aimed at unfair foreign trade practices, antidumping, countervailing, and safeguard measures. Chapter E, on licensing, quotas, other quantity control measures, and tariff-rate quotas. Chapter F refers to price-control measures that affect the prices of imported goods. Such as support to the domestic price of certain products when the import prices of these goods are lower. This chapter also includes para-tariff measures. Chapter G, on finance measures, refers to measures restricting the payments of imports and measures imposing restrictions on the terms of payment. Chapter H, on anti-competitive measures. It refers mainly to monopolistic measures, such as State trading, sole importing agencies, compulsory national insurance, and transport. Chapter I refers to trade-related investment measures that restrict investment such as requesting local content.

Chapter J, on distribution restrictions, refers to restrictive measures related to the internal distribution of imported products. Chapter K is on restrictions on post-sales services such as the provision of accessory services. Chapter L, on measures related to subsidies that affect trade. Chapter M is on government procurement restriction measures, which refers to the restrictions bidders may find when

trying to sell their products to a foreign government. Chapter N, on restrictions related to intellectual property measures and intellectual property rights. Chapter O, on rules of origin, refers to measures that restrict the origin of goods or their inputs. Chapter P, on export measures such as export taxes, export quotas, and export prohibitions.

The main source of NTMs data for this study is the Integrated Trade Intelligence Portal (I-TIP) of the WTO. I-TIP NTMs data contains 12 types of non-tariff measures (notified to the WTO) at the product (HS 6-digit) level for all sectors. These 12 types are Antidumping (ADP), Countervailing duties (CVD), Export subsidies (EXS), Quantitative Restrictions (QRS), Safeguards (SFG), Sanitary and Phytosanitary Measures (SPS), Special Safeguards (SSG), State trading enterprises (STE), Technical barriers to trade (TBT), Tariff-rate quotas, (TRQ), Specific trade concern raised against an SPS (SPS_STC), and Specific trade concern raised against a TBT (TBT_STC). I-TIP NTMs data covers more than 5,000 products for all sectors over the period from 1995 to 2015 for more than 150 countries including the EU (table 3) and 50 ACP countries (table 3.1). Table (26) shows ACP countries by region. This study focuses on NTMs imposed on intermediate and final goods (i.e. HS 6-digit products).

4.1.2. ACP versus EU28 NTMs

ACP countries impose 7 types (ADP, QRS, SPS, SSG, STE, TBT, and TRQ) of NTMs on imports from foreign countries (table 4). In the agriculture and food sector, ACP mainly imposes the following categories: 1) SPS measures represent 29% (in terms of number of NTMs by chapter) of ACP's total NTMs in the food sector and 17% of ACP's total NTMs in the agriculture sector (table 4). 2) TBT measures account for 68% of ACP's total NTMs in the food sector and 81% of ACP's total NTMs in the agriculture sector (table 4).

EU28 applies 3 types (SPS, SSG, and TBT) of NTMs on imports from foreign countries (table 5). In the agriculture and food sector, the EU28 mainly imposes the following categories: 1) SPS measures represent 15% of the EU's total NTMs in the food sector and 12% of the EU's total NTMs in the agriculture sector (table 5). 2) TBT measures account for more than 80% of the EU's total NTMs in both sectors (table 5). Generally, the EU28 applies fewer NTMs than ACP countries in both sectors. Even at the world level, countries impose mainly SPS and TBT measures (tables 6 and 7).

4.1.3. Quantifying Non-tariff Measures (NTMs): quantity-based approach

Computation of NTMs: This study uses the quantity-based approach proposed by Berden et al., (2009). Berden et al., (2009) used NTM survey numbers to compute the NTM index but this study uses the WTO I-TIP NTMs dataset which provides NTMs imposed on each HS6-digits product at the bilateral level. Then aggregates them to the sector level (*HS-2 digits*) to calculate the bilateral NTM FI and NTM CR. There are various NTMs databases but this study uses I-TIP of the WTO dataset because I-TIP NTMs data covers more than 5,000 products for all sectors over the period from 1995 to 2015 for more than 150 countries including the EU (table 3) and 50 ACP countries (table 3.1).

The shift from NTMs at the product (HS-6 digits) level to NTMs at sector level (EORA-2 digits): The NTMs applied to each product at the HS-6 digits level have been classified according to the end-use of each product, final or intermediate goods, by using BEC classification of goods (this study focuses on intermediate and final goods). Then by combining these NTMs data with EORA data on intermediate and final goods (GVCF and GVCB), this study calculates the NTM FI and NTM CR for intermediate and final goods in the agricultural sector and food sector for each reporter (at bilateral level).

To assess trade restrictiveness induced by NTMs, this study applies the following trade frequency index

$$NTM\_FI_{ijkt} = \left[\frac{\sum D_{ijkt} M_{ijkt}}{\sum M_{Wkt}}\right].100 \quad (5)$$

Where D is a dummy variable taking the value of one if there are NTMs and zero otherwise; M is also a dummy variable that takes the value of one if there are imports in j from i of good k; t stands for the year of measurement of the NTM (Bora et al., 2002).

A refinement of this trade frequency index can be derived by substituting the dummy variable M with the actual value of bilateral trade flow for each product k (V) to derive a trade coverage index as follows:

$$C_{ijkt} = \left[\frac{\sum D_{ijkt} V_{WkT}}{\sum V_{WkT}}\right] * 100 \quad (6)$$

In this case, T is the year of import weights (with a time lag to soften endogeneity).

The shift from NTM FI to gravity equation. After quantifying NTMs for the food sector and agriculture sector for each reporter (at bilateral level) using NTM FI and NTM CR, this study regresses value-added on NTM FI and NTM CR by applying gravity equations (4). The coefficients on the policy dummy variables can be changed into trade cost estimates as follows: $[e^{\widehat{\beta}_{dummy}}-1]*100$ (Baier & Bergstrand, 2007). Where the beta hat dummy is the estimate of the effects of policy variables in the gravity model (4).

4.2. Summary statistics of continuous and dummy variables:

Tables (8) and (9) show the descriptive statistics of continuous and dummy variables of food and agriculture panel data respectively. Here the focus will be on within and between variations of independent variables (regressors). Dependent variables (GVCF & GVCB) and regressors (the rest) can potentially vary over both time and countries. Variation over time is called within variation, and variation across countries is called between variation. This distinction is very important because controlling for fixed effects (FE) allows for identifying only the within variation (over time). Generally speaking, for regressors with more variation across countries (between variation) than over time (within variation), within estimation models (such as the FE model) may lead to considerable efficiency loss (Cameron & Trivedi, 2009).

The uppercase N denotes the total number of observations of the variable over a period of time (i.e. 21 years). The lowercase n denotes the number of observations for country pairs over a period of time (ONE year only). T denotes time (years). The min and max columns give the minimums and maximums of the variable. For example, table (8) shows $NTMs\ (Frequency\ idex)_{ij}$ variable has N = 283,728 (for 11 years) observations, n = 24,784 observations (for one year only), and T = 11(11.448) years. Minimum = 29.89164, Maximum = 100 (between variation). Therefore, 24,784 x11=283,728 observations.

Time-invariant regressors are contiguity, common official language, common colonizer, and distance (in both tables 8 and 9). All these bilateral time-invariant regressors will be captured by country-pair (exporter-importer interactions) fixed effect (Baier & Bergstrand, 2007). To note that in the case of Tariff rate (applied weighted mean), NTM FI, EPA, there is more variation over time (within variation) than across countries (between variation) in both tables (8) and (9). Whereas for the rest of the independent variables, there is more cross-country variation than overtime (in both tables 8 and 9).

5. RESULTS

This section presents the outcomes of gravity model estimates. Tables from (10) to (25) show the results of the gravity model (4) estimates for the period from 1995-2015 for the agriculture sector and the food & beverages sector. Tables (10) to (17) report gravity output for the agriculture sector and tables (18) to (25) report gravity output for the food & beverages sector. Tables (10) to (13) show the coefficients for NTMs FI in the agriculture sector, tables (14) to (17) present the coefficients for NTMs CR in the

agriculture sector. Tables (18) to (21) show the coefficients for NTMs FI in the food sector, tables (22) to (25) present the coefficients for NTMs CR in the food sector.

Tables (10), (11), (14), and (15) present the coefficients for the world (151 countries) in the agriculture sector. Tables (18), (19), (22), and (23) show the coefficients for the world (151 countries) in the food sector. Tables (12), (13), (16), and (17) report the coefficients for 50 ACP countries in the agriculture sector. Tables (20), (21), (24), and (25) show the coefficients for 50 ACP countries in the food sector.

Tables (10), (12), (14), (16), (18), (20), (22), and (24), column A1 and column A3 are estimated on the same variables and the only difference is that A3 is estimated without tariff rate (applied mean)_ij. Similarly, column A2 and column A4 are estimated on the same variables and the only difference is that A4 is estimated without tariff rate (applied mean)_ji. Column B1 and column B3 are estimated on the same variables and the only difference is that B3 is estimated without tariff rate (applied mean)_ij. Similarly, column B2 and column B4 are estimated on the same variables and the only difference is that B4 is estimated without tariff rate (applied mean)_ji.

Tables (11), (13), (15), (17), (19), (21), (23), and (25), Column A1 and column A3 are estimated on the same variables and the only difference is that A3 is estimated without tariff rate (applied weighted mean)_ij. Similarly, column A2 and column A4 are estimated on the same variables and the only difference is that A4 is estimated without tariff rate (applied weighted mean)_ji. Column B1 and column B3 are estimated on the same variables and the only difference is that B3 is estimated without tariff rate (applied weighted mean)_ij. Similarly, column B2 and column B4 are estimated on the same variables and the only difference is that B4 is estimated without tariff rate (applied weighted mean)_ji.

Agriculture sector: Frequency Index (FI)

At the ACP and global level, the coefficients of bilateral agricultural tariffs applied (mean) by the exporter country to its importers ($tariff_{ij}$) exhibit a significant negative impact on integration into GVCF (table 10 and 12; column A1). Similarly, the coefficients of bilateral agricultural tariffs applied (weighted mean) by the exporter country to its importers ($tariff_{ij}$) show a negative impact on integration into GVCF (table 11 and 13; column A1). This means that a country's GVCF performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector.

Tables (10) to (13) show the significant negative impact of the importer country bilateral protection ($tariff_{ji}$) on the exporter country's agriculture integration into GVCF (in tables 10 to 13; column A2). Thus, bilateral trade protection ($tariff_{ji}$) is not only impeding trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCF (where intermediate inputs cross national borders multiple times).

The coefficients of bilateral agricultural NTMs applied by the exporter country i to its importers ($NTM\ FI_{ij}$) show a significant negative effect on participation in GVCF of ACP countries (columns A1 and A3; in tables 12 and 13) and the world (columns A1 and A3; in tables 10 and 11). This means that a country's participation in GVCF does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

Table 10 NTMs frequency index & tariff rate applied mean: gravity output for the worlds' agriculture GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied mean)_ij	-0.00558***				-0.00348**			
	(0.00170)				(0.00142)			
Tariff rate (applied mean)_ji		-0.00465***				-0.00658***		
		(0.00148)				(0.00162)		
NTM (frequency index)_ij	-1.004***		-1.002***		-0.999***		-0.998***	
	(0.00260)		(0.00221)		(0.00200)		(0.00176)	
Interaction term (frequency index*low income countries)_ij	-0.00159		-0.00140		0.00382		0.00758**	
	(0.00452)		(0.00431)		(0.00334)		(0.00384)	
NTM (frequency index)_ji		-0.998***		-1.002***		-0.991***		-0.998***
		(0.00293)		(0.00220)		(0.00270)		(0.00176)
Interaction term (frequency index*low income countries)_ji		0.00231		-0.00140		0.00697		0.00758**
		(0.00446)		(0.00431)		(0.00442)		(0.00384)
RTA	0.0455***	0.0433***	0.0573***	0.0573***	-0.0123**	-0.0132*	-0.00643	-0.00643
	(0.00796)	(0.00827)	(0.00700)	(0.00700)	(0.00618)	(0.00758)	(0.00618)	(0.00618)
Constant	18.23***	18.27***	18.41***	18.41***	17.86***	17.74***	18.10***	18.10***
	(0.0107)	(0.0122)	(0.00963)	(0.00959)	(0.00840)	(0.0112)	(0.00786)	(0.00782)
Observations	121,069	120,567	199,531	199,531	121,488	121,118	200,258	200,258
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM frequency index, and interaction term variables are lagged (5 years).

Table 11 NTMs frequency index & weighted tariffs: gravity output for the worlds' agriculture GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied weighted mean)_ij	-0.00155				-0.00153			
	(0.00117)				(0.00105)			
Tariff rate (applied weighted mean)_ji		-0.00190*				-0.00205*		
		(0.00107)				(0.00112)		
NTM (frequency index)_ij	-1.003***		-1.002***		-0.999***		-0.998***	
	(0.00263)		(0.00221)		(0.00201)		(0.00176)	
Interaction term (frequency index*low income countries)_ij	-0.00157		-0.00140		0.00368		0.00758**	
	(0.00453)		(0.00431)		(0.00336)		(0.00384)	
NTM (frequency index)_ji		-1.000***		-1.002***		-0.998***		-0.998***
		(0.00325)		(0.00220)		(0.00289)		(0.00176)
Interaction term (frequency index*low income countries)_ji		0.00184		-0.00140		0.00757*		0.00758**
		(0.00450)		(0.00431)		(0.00444)		(0.00384)
RTA	0.0449***	0.0437***	0.0573***	0.0573***	-0.0134**	-0.0138*	-0.00643	-0.00643
	(0.00808)	(0.00837)	(0.00700)	(0.00700)	(0.00612)	(0.00767)	(0.00618)	(0.00618)
Constant	18.22***	18.28***	18.41***	18.41***	17.85***	17.74***	18.10***	18.10***
	(0.0109)	(0.0135)	(0.00963)	(0.00959)	(0.00837)	(0.0120)	(0.00786)	(0.00782)
Observations	119,660	119,167	199,531	199,531	120,079	119,709	200,258	200,258
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM frequency index, and interaction term variables are lagged (5 years).

Tables (10) to (13) also show that the agricultural bilateral NTMs imposed by importer country ($NTM\ FI_{ji}$), negatively affect the exporter country's agriculture integration into GVCF of ACP economies (columns A2 and A4; in tables 12 and 13) and the world (columns A2 and A4; in tables 10 and 11). Therefore; the bilateral NTMs ($NTM\ FI_{ji}$) is not only hindering trade of goods between country *i* and country *j*, but it also impacts the integration of exporting country *i* into GVCF.

Tables (10) to (13) show the negative impact of the importer country bilateral protection ($tariff_{ji}$) on the exporter country's agriculture integration into GVCB (column B2; in tables 10 to 13). Thus, bilateral trade protection ($tariff_{ji}$) is not only impeding trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCB (where intermediate inputs cross national borders multiple times).

Table 12 NTMs frequency index & tariff rate applied mean: gravity output for the EU & ACP agriculture GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied mean)_ij	-0.00547***				-0.00327**			
	(0.00170)				(0.00142)			
Tariff rate (applied mean)_ji		-0.00455***				-0.00636***		
		(0.00148)				(0.00161)		
NTM (frequency index)_ij	-1.004***		-1.002***		-0.999***		-0.998***	
	(0.00260)		(0.00219)		(0.00201)		(0.00175)	
NTM (frequency index)_ji		-0.998***		-1.002***		-0.991***		-0.998***
		(0.00293)		(0.00218)		(0.00271)		(0.00174)
FTA	0.0428***	0.0410***	0.0542***	0.0542***	-0.0138**	-0.0194**	-0.0119*	-0.0119*
	(0.00795)	(0.00829)	(0.00706)	(0.00706)	(0.00615)	(0.00754)	(0.00615)	(0.00615)
EBA	-0.314***	-0.189	0.0529	0.0529	-0.0543	0.342*	0.344*	0.344*
	(0.0784)	(0.134)	(0.132)	(0.132)	(0.117)	(0.200)	(0.201)	(0.201)
EPA (for ACP countries only)	0.0233	0.0711*	0.0184	0.0184	0.146***	0.156***	0.123***	0.123***
	(0.0670)	(0.0388)	(0.0282)	(0.0282)	(0.0504)	(0.0447)	(0.0284)	(0.0284)
Interaction term (EBA*EPA)	0.202	0.519***	-0.145	-0.145	-0.103	-0.0982	-0.471**	-0.471**
	(0.161)	(0.178)	(0.146)	(0.146)	(0.158)	(0.225)	(0.208)	(0.208)
EU	0.192***	0.253***	0.142***	0.142***	0.216***	0.354***	0.230***	0.230***
	(0.0206)	(0.0294)	(0.0135)	(0.0135)	(0.0277)	(0.0442)	(0.0242)	(0.0242)
Constant	18.23***	18.27***	18.39***	18.39***	17.86***	17.74***	18.07***	18.07***
	(0.0107)	(0.0122)	(0.00978)	(0.00975)	(0.00842)	(0.0112)	(0.00844)	(0.00840)
Observations	121,302	120,791	200,277	200,277	121,723	121,345	201,006	201,006
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate and NTM frequency index are lagged (5 years).

The coefficients of bilateral agricultural tariffs applied by the exporter country to its importers ($tariff_{ij}$) exhibit a negative impact on integration into GVCB (column B1; in tables 10 to 13). This means that a country's GVCB performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector.

Tables (10) to (13) also show that the agricultural bilateral NTMs imposed by importer country ($NTM\ FI_{ji}$), negatively affect the exporter country's agriculture integration into GVCB of ACP economies (column B2 and B4; in table 12 and 13) and the world (column B2 and B4; in tables 10 and 11). Therefore; the bilateral NTMs ($NTM\ FI_{ji}$) is not only hindering trade of goods between country *i* and country *j* but it also impacts the integration of exporting country *i* into GVCB.

The coefficients of bilateral agricultural NTMs applied by the exporter country *i* to its importers ($NTM\ FI_{ij}$) show a significant negative effect on participation in GVCB of ACP countries (column B1 and B3; in table 12 and 13) and the world (column B1 and B3; in tables 10 and 11). This means that a country's participation in GVCB does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

Table 13 NTMs frequency index & weighted tariffs: gravity output for the EU & ACP agriculture GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied weighted mean)_ij	-0.00153				-0.00139			
	(0.00117)				(0.00105)			
Tariff rate (applied weighted mean)_ji		-0.00186*				-0.00208*		
		(0.00107)				(0.00111)		
NTM (frequency index)_ij	-1.004***		-1.002***		-0.999***		-0.998***	
	(0.00263)		(0.00219)		(0.00202)		(0.00175)	
NTM (frequency index)_ji		-1.000***		-1.002***		-0.999***		-0.998***
		(0.00324)		(0.00218)		(0.00288)		(0.00174)
FTA	0.0421***	0.0414***	0.0542***	0.0542***	-0.0150**	-0.0202***	-0.0119*	-0.0119*
	(0.00806)	(0.00838)	(0.00706)	(0.00706)	(0.00610)	(0.00764)	(0.00615)	(0.00615)
EBA	-0.312***	-0.191	0.0529	0.0529	-0.0699	0.342*	0.344*	0.344*
	(0.0780)	(0.136)	(0.132)	(0.132)	(0.116)	(0.199)	(0.201)	(0.201)
EPA (for ACP countries only)	0.0236	0.0545	0.0184	0.0184	0.143***	0.170***	0.123***	0.123***
	(0.0675)	(0.0392)	(0.0282)	(0.0282)	(0.0508)	(0.0463)	(0.0284)	(0.0284)
Interaction term (EBA*EPA)	0.200	0.574***	-0.145	-0.145	-0.0892	-0.0858	-0.471**	-0.471**
	(0.161)	(0.184)	(0.146)	(0.146)	(0.159)	(0.226)	(0.208)	(0.208)
EU	0.191***	0.251***	0.142***	0.142***	0.216***	0.360***	0.230***	0.230***
	(0.0203)	(0.0296)	(0.0135)	(0.0135)	(0.0278)	(0.0442)	(0.0242)	(0.0242)
Constant	18.21***	18.28***	18.39***	18.39***	17.85***	17.74***	18.07***	18.07***
	(0.0109)	(0.0135)	(0.00978)	(0.00975)	(0.00840)	(0.0120)	(0.00844)	(0.00840)
Observations	119,892	119,381	200,277	200,277	120,313	119,925	201,006	201,006
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate and NTM frequency index are lagged (5 years).

Tables (10) to (13) also show the impacts of the existing preferential trade regimes FTA, EBA, EPA (for ACP countries only), EU, and RTAs on GVCF and GVCB participation in the agriculture sector. The estimated coefficients exhibit a positive and significant effect of FTA, EBA, EPA (for ACP countries only), EU, and RTAs (at the global level). The RTAs, EBA, and EPA also show an ambiguous relationship with the participation of the agriculture sector in GVCF and GVCB.

For instance, the positive sign of the FTA dummy measures the increase in ACP's participation in forward-GVC under FTA by 4. percent ([$e^{0.0428}$-1]*100) in the case of decrease by -63.36 percent in the NTM chapters ($NTM\ FI_{ij}$) and decrease by -1 percent in tariffs ($Tariff\ rate\ (applied\ mean)_{ij}$) of the exporting countries to their importers (table 12 column A1). Also, the positive sign of the FTA dummy measures the increase in ACP's participation in forward-GVC under FTA by 4 percent in the case of a decrease by -63.14 percent in the NTM chapters ($NTM\ FI_{ji}$) and decrease by -0.5 percent in tariffs ($Tariff\ rate\ (applied\ mean)_{ji}$) of the importing countries on their exporters (table 12 column A2). This suggests that the preferential trade regime (FTA) is focusing on enhancing member states' export capacity of domestic value-added.

The positive sign of the EPA dummy measures the increase in ACP's participation in backward-GVC under EPA by 16 percent in the case of decrease by -63.18 percent in the NTM chapters ($NTM\ FI_{ij}$) and decrease by -0.3 percent in tariffs ($Tariff\ rate\ (applied\ mean)_{ij}$) of the exporting countries to

their importers (table 12 column B1). Also, the positive sign of the EPA dummy measures the increase in ACP's participation in backward-GVC under EPA by 17 percent in the case of decrease by -62.88 percent in the NTM chapters ($NTM\ FI_{ji}$) and decrease by -1 percent in tariffs ($Tariff\ rate\ (applied\ mean)_{ji}$) of the importing countries on their exporters (table 12 column B2).

The positive sign of the RTA dummy measures the increase in countries' participation in forward-GVC under RTA in the case of a decrease in the NTM chapters ($NTM\ FI_{ij}$) and decrease in tariffs ($Tariff\ rate_{ij}$) of the exporting countries to their importers (tables 10 and 11 column A1). Also, the positive sign of the RTA dummy measures the increase in countries' participation in forward-GVC under RTA in the case of a decrease in the NTM chapters ($NTM\ FI_{ji}$) and decrease in tariffs ($Tariff\ rate_{ji}$) of the importing countries on their exporters (tables 10 and 11 column A2). This suggests that the RTA is focusing on enhancing member states' export capacity of domestic value-added.

Agriculture sector: Coverage Ratio (CR)

At the ACP and global level, the coefficients of bilateral agricultural tariffs applied (mean) by the exporter country to its importers ($tariff_{ij}$) show a negative impact on integration into GVCF (table 14 and 16; column A1). Similarly, the coefficients of bilateral agricultural tariffs applied (weighted mean) by the exporter country to its importers ($tariff_{ij}$) show a negative impact on integration into GVCF (table 15 and 17; column A1). This means that a country's GVCF performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector.

Tables (15) and (17) show the significant negative impact of the importer country bilateral protection ($tariff_{ji}$) on the exporter country's agriculture integration into GVCF (in tables 15 and 17; column A2). Tables (14) and (16) show positive signs but they are nonsignificant. Thus, bilateral trade protection ($tariff_{ji}$) is not only impeding trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCF (where intermediate inputs cross national borders multiple times).

Table 14 NTMs coverage ratio & tariff rate applied mean: gravity output for the worlds' agriculture GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied mean)_ij	-0.00245				-0.00343**			
	(0.00164)				(0.00134)			
Tariff rate (applied mean)_ji		0.000612				-0.000121		
		(0.00225)				(0.00234)		
NTM (coverage ratio)_ij	-0.998***		-0.995***		-1.001***		-0.995***	
	(0.00621)		(0.00459)		(0.00536)		(0.00572)	
Interaction term (coverage ratio*low income countries)_ij	-0.00154		-0.00107		0.00812		-0.00216	
	(0.00343)		(0.00441)		(0.00820)		(0.00812)	
NTM (coverage ratio)_ji		-0.967***		-0.989***		-0.988***		-0.991***
		(0.00990)		(0.00677)		(0.0111)		(0.00745)
Interaction term (coverage ratio*low income countries)_ji		0.00750		0.00910		0.0175**		0.0190**
		(0.00821)		(0.0105)		(0.00794)		(0.00916)
RTA	0.0380***	0.0196**	0.0498***	0.0305***	0.000316	-0.0284***	-0.00191	-0.0271***
	(0.00829)	(0.00984)	(0.00717)	(0.00893)	(0.00593)	(0.00903)	(0.00594)	(0.00761)
Constant	18.41***	17.87***	18.58***	18.45***	18.07***	17.93***	18.30***	18.37***
	(0.0276)	(0.0422)	(0.0207)	(0.0294)	(0.0197)	(0.0435)	(0.0217)	(0.0299)
Observations	90,207	89,882	147,286	146,365	90,514	90,936	147,775	148,398
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).

Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM coverage ratio, and interaction term variables are lagged (5 years).

The coefficients of bilateral agricultural NTMs applied by the exporter country *i* to its importers ($NTM\ CR_{ij}$) show a significant negative effect on participation in GVCF of ACP countries (columns A1 and A3; in tables 16 and 17) and the world (columns A1 and A3; in tables 14 and 15). This means that a country's participation in GVCF does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

Table 15 NTMs coverage ratio & weighted tariffs: gravity output for the worlds' agriculture GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied weighted mean)_ij	-0.000590				-0.000603			
	(0.00106)				(0.000944)			
Tariff rate (applied weighted mean)_ji		-0.00148				-0.00257*		
		(0.00152)				(0.00145)		
NTM (coverage ratio)_ij	-0.997***		-0.995***		-1.000***		-0.995***	
	(0.00628)		(0.00459)		(0.00546)		(0.00572)	
Interaction term (coverage ratio*low income countries)_ij	-0.00143		-0.00107		0.00976		-0.00216	
	(0.00342)		(0.00441)		(0.00823)		(0.00812)	
NTM (coverage ratio)_ji		-0.965***		-0.989***		-0.986***		-0.991***
		(0.0101)		(0.00677)		(0.0112)		(0.00745)
Interaction term (coverage ratio*low income countries)_ji		0.00375		0.00910		0.0170**		0.0190**
		(0.00780)		(0.0105)		(0.00788)		(0.00916)
RTA	0.0380***	0.0209**	0.0498***	0.0305***	0.000261	-0.0274***	-0.00191	-0.0271***
	(0.00848)	(0.00990)	(0.00717)	(0.00893)	(0.00596)	(0.00921)	(0.00594)	(0.00761)
Constant	18.40***	17.87***	18.58***	18.45***	18.06***	17.89***	18.30***	18.37***
	(0.0279)	(0.0427)	(0.0207)	(0.0294)	(0.0200)	(0.0441)	(0.0217)	(0.0299)
Observations	89,445	89,069	147,286	146,365	89,752	90,115	147,775	148,398
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM coverage ratio, and interaction term variables are lagged (5 years).

Tables (14) to (17) also show that the agricultural bilateral NTMs imposed by importer country ($NTM\ CR_{ji}$), negatively affect the exporter country's agriculture integration into GVCF of ACP economies (columns A2 and A4; in tables 16 and 17) and the world (columns A2 and A4; in tables 14 and 15). Therefore; the bilateral NTMs ($NTM\ CR_{ji}$) is not only hindering trade of goods between country *i* and country *j*, but it also impacts the integration of exporting country *i* into GVCF.

Tables (14) to (17) show the negative impact of the importer country bilateral protection ($tariff_{ji}$) on the exporter country's agriculture integration into GVCB (column B2; in tables 14 to 17) except table (16) shows positive sign but nonsignificant. Thus, bilateral trade protection ($tariff_{ji}$) is not only impeding trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCB (where intermediate inputs cross national borders multiple times).

Table 16 NTMs coverage ratio & tariff rate applied mean: gravity output for the EU & ACP agriculture GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied mean)_ij	-0.00243				-0.00331**			
	(0.00164)				(0.00133)			
Tariff rate (applied mean)_ji		0.000832				0.000155		
		(0.00225)				(0.00233)		
NTM (coverage ratio)_ij	-0.998***		-0.995***		-1.002***		-0.996***	
	(0.00621)		(0.00459)		(0.00537)		(0.00572)	
NTM (coverage ratio)_ji		-0.967***		-0.989***		-0.988***		-0.991***
		(0.00992)		(0.00678)		(0.0110)		(0.00746)
FTA	0.0355***	0.0183*	0.0489***	0.0284***	-0.000813	-0.0343***	-0.00233	-0.0318***
	(0.00827)	(0.00982)	(0.00725)	(0.00888)	(0.00592)	(0.00901)	(0.00598)	(0.00757)
EBA	0.0904**	-0.248*	-0.00711	-0.235***	0.0888*	0.217	0.00441	0.0417
	(0.0424)	(0.135)	(0.0291)	(0.0873)	(0.0484)	(0.202)	(0.0359)	(0.104)
EPA (for ACP countries only)	0.0118	0.104*	-0.0726	0.0232	0.137	0.150***	0.0751*	0.158***
	(0.104)	(0.0534)	(0.0521)	(0.0292)	(0.0879)	(0.0583)	(0.0447)	(0.0424)
Interaction term (EBA*EPA)	-0.526*	0.597***	0.00138	0.213**	-0.266*	-0.0229	-0.0408	-0.230*
	(0.292)	(0.181)	(0.109)	(0.105)	(0.151)	(0.234)	(0.0627)	(0.123)
EU	0.146***	0.260***	0.0902***	0.0861***	0.210***	0.308***	0.142***	0.148***
	(0.0251)	(0.0396)	(0.0148)	(0.0214)	(0.0429)	(0.0339)	(0.0243)	(0.0329)
Constant	18.41***	17.87***	18.57***	18.43***	18.07***	17.93***	18.28***	18.35***
	(0.0277)	(0.0422)	(0.0207)	(0.0303)	(0.0197)	(0.0433)	(0.0220)	(0.0313)
Observations	90,207	89,882	147,286	146,365	90,514	90,936	147,775	148,398
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM coverage ratio, and interaction term variables are lagged (5 years).

The coefficients of bilateral agricultural tariffs applied by the exporter country to its importers ($tariff_{ij}$) exhibit a negative impact on integration into GVCB (column B1; in tables 14 to 17). This means that a country's GVCB performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector.

Tables (14) to (17) also show that the agricultural bilateral NTMs imposed by importer country ($NTM\ CR_{ji}$), negatively affect the exporter country's agriculture integration into GVCB of ACP economies (column B2 and B4; in table 16 and 17) and the world (column B2 and B4; in tables 14 and 15). Therefore; the bilateral NTMs ($NTM\ CR_{ji}$) is not only hindering trade of goods between country *i* and country *j* but it also impacts the integration of exporting country *i* into GVCB.

The coefficients of bilateral agricultural NTMs applied by the exporter country *i* to its importers ($NTM\ CR_{ij}$) show a significant negative effect on participation in GVCB of ACP countries (column B1 and B3; in table 16 and 17) and the world (column B1 and B3; in tables 14 and 15). This means that a country's participation in GVCB does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

Tables (14) to (17) also show the impacts of the existing preferential trade regimes FTA, EBA, EPA (for ACP countries only), EU, and RTAs on GVCF and GVCB participation in the agriculture sector. The estimated coefficients exhibit a positive and significant effect of FTA, EBA, EPA (for ACP countries only), EU, and RTAs (at the global level). The RTAs, FTA, EBA, and EPA also show an ambiguous relationship with the participation of the agriculture sector in GVCF and GVCB.

Table 17 NTMs coverage ratio & weighted tariff: gravity output for the EU & ACP agriculture GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied weighted mean)_ij	-0.000565				-0.000407			
	(0.00106)				(0.000934)			
Tariff rate (applied weighted mean)_ji		-0.00145				-0.00256*		
		(0.00152)				(0.00145)		
NTM (coverage ratio)_ij	-0.997***		-0.995***		-1.001***		-0.996***	
	(0.00629)		(0.00459)		(0.00547)		(0.00572)	
NTM (coverage ratio)_ji		-0.965***		-0.989***		-0.987***		-0.991***
		(0.0101)		(0.00678)		(0.0112)		(0.00746)
FTA	0.0352***	0.0196**	0.0489***	0.0284***	-0.00102	-0.0333***	-0.00233	-0.0318***
	(0.00846)	(0.00987)	(0.00725)	(0.00888)	(0.00595)	(0.00920)	(0.00598)	(0.00757)
EBA	0.104**	-0.246*	-0.00711	-0.235***	0.110**	0.250	0.00441	0.0417
	(0.0427)	(0.145)	(0.0291)	(0.0873)	(0.0452)	(0.201)	(0.0359)	(0.104)
EPA (for ACP countries only)	0.0108	0.102*	-0.0726	0.0232	0.136	0.173***	0.0751*	0.158***
	(0.105)	(0.0568)	(0.0521)	(0.0292)	(0.0888)	(0.0613)	(0.0447)	(0.0424)
Interaction term (EBA*EPA)	-0.540*	0.644***	0.00138	0.213**	-0.289*	-0.0443	-0.0408	-0.230*
	(0.292)	(0.194)	(0.109)	(0.105)	(0.151)	(0.235)	(0.0627)	(0.123)
EU	0.147***	0.257***	0.0902***	0.0861***	0.214***	0.309***	0.142***	0.148***
	(0.0250)	(0.0398)	(0.0148)	(0.0214)	(0.0429)	(0.0339)	(0.0243)	(0.0329)
Constant	18.40***	17.87***	18.57***	18.43***	18.07***	17.90***	18.28***	18.35***
	(0.0280)	(0.0427)	(0.0207)	(0.0303)	(0.0200)	(0.0439)	(0.0220)	(0.0313)
Observations	89,445	89,069	147,286	146,365	89,752	90,115	147,775	148,398
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM coverage ratio, and interaction term variables are lagged (5 years).

For instance, the positive sign of the FTA dummy measures the increase in ACP's participation in forward-GVC under FTA in the case of a decrease in the NTM chapters ($NTM\ CR_{ij}$) and decrease in tariffs ($Tariff\ rate\ (applied\ weighted\ mean)_{ij}$) of the exporting countries to their importers (table 17 column A1). Also, the positive sign of the FTA dummy measures the increase in ACP's participation in forward-GVC under FTA in the case of a decrease in the NTM chapters ($NTM\ CR_{ji}$) and decrease in tariffs ($Tariff\ rate\ (applied\ weighted\ mean)_{ji}$) of the importing countries on their exporters (table 17 column A2). This suggests that the preferential trade regime (FTA) is focusing on enhancing member states' export capacity of domestic value-added.

Food & beverages sector: Frequency Index (FI)

At the ACP and global level, the coefficients of bilateral food tariffs applied (mean) by the exporter country to its importers ($tariff_{ij}$) exhibit a negative impact on integration into GVCF (tables 18 and 20; column A1). Similarly, the coefficients of bilateral food tariffs applied (weighted mean) by the exporter country to its importers ($tariff_{ij}$) show a negative impact on integration into GVCF (table 19 and 21; column A1). This means that a country's GVCF performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector.

Tables (18) to (21) show the significant negative impact of the importer country bilateral protection ($tariff_{ji}$) on the exporter country's food integration into GVCF (tables 18 to 21; column A2). Thus, bilateral trade protection ($tariff_{ji}$) is not only impeding trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCF (where intermediate inputs cross national borders multiple times).

Table 18 NTMs frequency index & tariff rate applied mean: gravity output for the worlds' food GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied mean)_ij	-0.00586***				-0.00388***			
	(0.00159)				(0.00139)			
Tariff rate (applied mean)_ji		-0.00523***				-0.00790***		
		(0.00139)				(0.00165)		
NTM (frequency index)_ij	-1.003***		-1.001***		-1.003***		-1.002***	
	(0.00163)		(0.00143)		(0.00150)		(0.00127)	
Interaction term (frequency index*low income countries)_ij	-0.00469		0.00756		-0.00132		0.00860**	
	(0.00477)		(0.00555)		(0.00312)		(0.00423)	
NTM (frequency index)_ji		-1.002***		-1.001***		-1.004***		-1.002***
		(0.00187)		(0.00142)		(0.00181)		(0.00124)
Interaction term (frequency index*low income countries)_ji		-0.00261		0.00756		0.00183		0.00861**
		(0.00484)		(0.00555)		(0.00427)		(0.00423)
RTA	0.0534***	0.0500***	0.0666***	0.0666***	-0.00984	-0.0128*	-0.00328	-0.00325
	(0.00783)	(0.00813)	(0.00691)	(0.00691)	(0.00622)	(0.00739)	(0.00609)	(0.00609)
Constant	18.17***	18.23***	18.43***	18.44***	17.77***	17.69***	18.05***	18.05***
	(0.00712)	(0.00798)	(0.00661)	(0.00659)	(0.00626)	(0.00762)	(0.00596)	(0.00588)
Observations	150,630	149,805	259,567	259,563	151,125	150,595	260,709	260,705
R-squared	0.999	0.999	0.999	0.999	0.999	0.998	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM frequency index, and interaction term variables are lagged (5 years).

The coefficients of bilateral food NTMs applied by the exporter country *i* to its importers ($NTM\ FI_{ij}$) show a significant negative effect on participation in GVCF of ACP countries (columns A1 and A3; in tables 20 and 21) and the world (columns A1 and A3; in tables 18 and 19). This means that a country's participation in GVCF does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

Tables (18) to (21) also show that the food bilateral NTMs imposed by importer country ($NTM\ FI_{ji}$), negatively affect the exporter country's food integration into GVCF of ACP economies (columns A2 and A4; in tables 20 and 21) and the world (columns A2 and A4; in tables 18 and 19). Therefore; the bilateral NTMs ($NTM\ FI_{ji}$) is not only hindering trade of goods between country *i* and country *j*, but it also impacts the integration of exporting country *i* into GVCF.

Tables (18) to (21) show the negative impact of the importer country bilateral protection ($tariff_{ji}$) on the exporter country's food integration into GVCB (column B2; in tables 18 to 21). Thus, bilateral trade protection ($tariff_{ji}$) is not only impeding trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCB (where intermediate inputs cross national borders multiple times).

Table 19 NTMs frequency index & weighted tariffs: gravity output for the worlds' food GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied weighted mean)_ij	-0.00168				-0.00192**			
	(0.00107)				(0.000959)			
Tariff rate (applied weighted mean)_ji		-0.00240**				-0.00305***		
		(0.00102)				(0.00111)		
NTM (frequency index)_ij	-1.004***		-1.001***		-1.003***		-1.002***	
	(0.00164)		(0.00143)		(0.00149)		(0.00127)	
Interaction term (frequency index*low income countries)_ij	-0.00471		0.00756		-0.00154		0.00860**	
	(0.00480)		(0.00555)		(0.00315)		(0.00423)	
NTM (frequency index)_ji		-1.002***		-1.001***		-1.004***		-1.002***
		(0.00189)		(0.00142)		(0.00183)		(0.00124)
Interaction term (frequency index*low income countries)_ji		-0.00364		0.00756		0.00202		0.00861**
		(0.00499)		(0.00555)		(0.00436)		(0.00423)
RTA	0.0519***	0.0500***	0.0666***	0.0666***	-0.0116*	-0.0148**	-0.00328	-0.00325
	(0.00790)	(0.00826)	(0.00691)	(0.00691)	(0.00612)	(0.00753)	(0.00609)	(0.00609)
Constant	18.16***	18.23***	18.43***	18.44***	17.76***	17.66***	18.05***	18.05***
	(0.00699)	(0.00797)	(0.00661)	(0.00659)	(0.00608)	(0.00760)	(0.00596)	(0.00588)
Observations	148,800	147,943	259,567	259,563	149,295	148,729	260,709	260,705
R-squared	0.999	0.999	0.999	0.999	0.999	0.998	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM frequency index, and interaction term variables are lagged (5 years).

Table 20 NTMs frequency index & tariff rate applied mean: gravity output for the EU & ACP food GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied mean)_ij	-0.00558***				-0.00350**			
	(0.00159)				(0.00139)			
Tariff rate (applied mean)_ji		-0.00493***				-0.00710***		
		(0.00139)				(0.00163)		
NTM (frequency index)_ij	-1.003***		-1.001***		-1.003***		-1.001***	
	(0.00163)		(0.00142)		(0.00151)		(0.00125)	
NTM (frequency index)_ji		-1.002***		-1.001***		-1.004***		-1.001***
		(0.00186)		(0.00142)		(0.00176)		(0.00123)
FTA	0.0480***	0.0455***	0.0619***	0.0619***	-0.0137**	-0.0207***	-0.0100*	-0.0100*
	(0.00774)	(0.00807)	(0.00692)	(0.00692)	(0.00614)	(0.00731)	(0.00603)	(0.00603)
EBA	-0.210**	-0.193**	-0.122**	-0.122**	0.0557	0.189	-0.0237	-0.0239
	(0.0973)	(0.0855)	(0.0620)	(0.0620)	(0.0852)	(0.141)	(0.0798)	(0.0798)
EPA (for ACP countries only)	-0.0343	0.0120	-0.0238	-0.0240	0.173***	0.183***	0.147***	0.147***
	(0.0355)	(0.0292)	(0.0177)	(0.0177)	(0.0459)	(0.0364)	(0.0221)	(0.0221)
Interaction term (EBA*EPA)	-0.0150	0.278**	0.0773	0.0775	-0.424***	-0.189	-0.188**	-0.188**
	(0.133)	(0.111)	(0.0761)	(0.0761)	(0.120)	(0.157)	(0.0896)	(0.0896)
EU	0.165***	0.210***	0.0992***	0.0990***	0.194***	0.333***	0.187***	0.187***
	(0.0164)	(0.0231)	(0.00929)	(0.00929)	(0.0191)	(0.0290)	(0.0166)	(0.0166)
Constant	18.17***	18.22***	18.41***	18.42***	17.76***	17.68***	18.01***	18.01***
	(0.00711)	(0.00793)	(0.00688)	(0.00686)	(0.00626)	(0.00741)	(0.00660)	(0.00654)
Observations	150,981	150,051	260,350	260,346	151,480	150,847	261,499	261,495
R-squared	0.999	0.999	0.999	0.999	0.999	0.998	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017)

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate and NTM frequency index are lagged (5 years).

The coefficients of bilateral food tariffs applied by the exporter country to its importers ($tariff_{ij}$) exhibit a significant negative impact on integration into GVCB (column B1; in tables 18 to 21). This means that a country's GVCB performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector.

Tables (18) to (21) also show that the food bilateral NTMs imposed by importer country ($NTM\ FI_{ji}$), negatively affect the exporter country's food integration into GVCB of ACP economies (column B2 and B4; in table 20 and 21) and the world (column B2 and B4; in tables 18 and 19). Therefore; the bilateral NTMs ($NTM\ FI_{ji}$) is not only hindering trade of goods between country *i* and country *j* but it also impacts the integration of exporting country *i* into GVCB.

The coefficients of bilateral food NTMs applied by the exporter country *i* to its importers ($NTM\ FI_{ij}$) show a significant negative effect on participation in GVCB of ACP countries (column B1 and B3; in table 20 and 21) and the world (column B1 and B3; in tables 18 and 19). This means that a country's participation in GVCB does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

Table 21 NTMs frequency index & weighted tariffs: gravity output for the EU & ACP food GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied weighted mean)_ij	-0.00159				-0.00175*			
	(0.00106)				(0.000952)			
Tariff rate (applied weighted mean)_ji		-0.00231**				-0.00280**		
		(0.00102)				(0.00110)		
NTM (frequency index)_ij	-1.003***		-1.001***		-1.003***		-1.001***	
	(0.00164)		(0.00142)		(0.00149)		(0.00125)	
NTM (frequency index)_ji		-1.002***		-1.001***		-1.004***		-1.001***
		(0.00188)		(0.00142)		(0.00177)		(0.00123)
FTA	0.0465***	0.0454***	0.0619***	0.0619***	-0.0156***	-0.0230***	-0.0100*	-0.0100*
	(0.00780)	(0.00819)	(0.00692)	(0.00692)	(0.00605)	(0.00746)	(0.00603)	(0.00603)
EBA	-0.209**	-0.193**	-0.122**	-0.122**	0.0497	0.194	-0.0237	-0.0239
	(0.0973)	(0.0862)	(0.0620)	(0.0620)	(0.0869)	(0.140)	(0.0798)	(0.0798)
EPA (for ACP countries only)	-0.0341	0.0388	-0.0238	-0.0240	0.170***	0.226***	0.147***	0.147***
	(0.0355)	(0.0307)	(0.0177)	(0.0177)	(0.0459)	(0.0375)	(0.0221)	(0.0221)
Interaction term (EBA*EPA)	-0.0158	0.283**	0.0773	0.0775	-0.419***	-0.223	-0.188**	-0.188**
	(0.134)	(0.115)	(0.0761)	(0.0761)	(0.122)	(0.159)	(0.0896)	(0.0896)
EU	0.163***	0.213***	0.0992***	0.0990***	0.192***	0.343***	0.187***	0.187***
	(0.0160)	(0.0232)	(0.00929)	(0.00929)	(0.0189)	(0.0291)	(0.0166)	(0.0166)
Constant	18.16***	18.23***	18.41***	18.42***	17.75***	17.65***	18.01***	18.01***
	(0.00696)	(0.00790)	(0.00688)	(0.00686)	(0.00607)	(0.00738)	(0.00660)	(0.00654)
Observations	149,147	148,181	260,350	260,346	149,646	148,973	261,499	261,495
R-squared	0.999	0.999	0.999	0.999	0.999	0.998	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate and NTM frequency index are lagged (5 years).

Tables (18) to (21) also show the impacts of the existing preferential trade regimes FTA, EBA, EPA (for ACP countries only), EU, and RTAs on GVCF and GVCB participation in the food sector. The

estimated coefficients exhibit a positive and significant effect of FTA, EBA, EPA (for ACP countries only), EU, and RTAs (at the global level). The RTAs, EBA, FTA, and EPA also show an ambiguous relationship with the participation of the food sector in GVCF and GVCB.

For example, the positive sign of the FTA dummy measures the increase in ACP's participation in forward-GVC under FTA in the case of a decrease in the NTM chapters ($NTM\ FI_{ij}$) and decrease in tariffs ($Tariff\ rate_{ij}$) of the exporting countries to their importers (tables 20 and 21 column A1). Also, the positive sign of the FTA dummy measures the increase in ACP's participation in forward-GVC under FTA in the case of a decrease in the NTM chapters ($NTM\ FI_{ji}$) and decrease in tariffs ($Tariff\ rate_{ji}$) of the importing countries on their exporters (tables 20 and 21 column A2). This suggests that the preferential trade regime (FTA) is focusing on enhancing member states' export capacity of domestic value-added.

The positive sign of the EPA dummy measures the increase in ACP's participation in backward-GVC under EPA in the case of a decrease in the NTM chapters ($NTM\ FI_{ij}$) and decrease in tariffs ($Tariff\ rate_{ij}$) of the exporting countries to their importers (tables 20 and 21 column B1). Also, the positive sign of the EPA dummy measures the increase in ACP's participation in backward-GVC under EPA in the case of a decrease in the NTM chapters ($NTM\ FI_{ji}$) and decrease in tariffs ($Tariff\ rate_{ji}$) of the importing countries on their exporters (tables 20 and 21 column B2).

The positive sign of the RTA dummy measures the increase in countries' participation in forward-GVC under RTA in the case of a decrease in the NTM chapters ($NTM\ FI_{ij}$) and decrease in tariffs ($Tariff\ rate_{ij}$) of the exporting countries to their importers (tables 18 and 19 column A1). Also, the positive sign of the RTA dummy measures the increase in countries' participation in forward-GVC under RTA in the case of a decrease in the NTM chapters ($NTM\ FI_{ji}$) and decrease in tariffs ($Tariff\ rate_{ji}$) of the importing countries on their exporters (tables 18 and 19 column A2). This suggests that the RTA is focusing on enhancing member states' export capacity of domestic value-added.

Food & beverages sector: Coverage Ratio (CR)

At the ACP and global level, the coefficients of bilateral food tariffs applied (mean) by the exporter country to its importers ($tariff_{ij}$) show a negative impact on integration into GVCF (table 22 and 24; column A1). Similarly, the coefficients of bilateral food tariffs applied (weighted mean) by the exporter country to its importers ($tariff_{ij}$) show a negative impact on integration into GVCF (table 23 and 25; column A1). This means that a country's GVCF performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector.

Tables (22) to (25) show the significant negative impact of the importer country bilateral protection ($tariff_{ji}$) on the exporter country's food integration into GVCF (in tables 22 to 25; column A2). Thus, bilateral trade protection ($tariff_{ji}$) is not only impeding trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCF (where intermediate inputs cross national borders multiple times).

The coefficients of bilateral food NTMs applied by the exporter country *i* to its importers ($NTM\ CR_{ij}$) show a significant negative effect on participation in GVCF of ACP countries (columns A1 and A3; in tables 24 and 25) and the world (columns A1 and A3; in tables 22 and 23). This means that a country's participation in GVCF does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

Table 22 NTMs coverage ratio & tariff rate applied mean: gravity output for the worlds' food GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied mean)_ij	-0.00513***				-0.00466***			
	(0.00177)				(0.00145)			
Tariff rate (applied mean)_ji		-0.00565***				-0.00712***		
		(0.00186)				(0.00208)		
NTM (coverage ratio)_ij	-0.988***		-1.008***		-1.002***		-1.005***	
	(0.00784)		(0.00514)		(0.00977)		(0.00569)	
Interaction term (coverage ratio*low income countries)_ij	0.00184		0.00301		0.0185*		0.0125	
	(0.00363)		(0.00879)		(0.0110)		(0.0137)	
NTM (coverage ratio)_ji		-0.955***		-0.987***		-0.969***		-0.989***
		(0.00911)		(0.00560)		(0.00923)		(0.00701)
Interaction term (coverage ratio*low income countries)_ji		-0.000128		0.0122		0.00640		0.0160*
		(0.00877)		(0.00938)		(0.00746)		(0.00898)
RTA	0.0402***	0.0339***	0.0588***	0.0460***	-0.00681	-0.0191**	-0.00245	-0.0134**
	(0.00870)	(0.00937)	(0.00768)	(0.00809)	(0.00682)	(0.00808)	(0.00645)	(0.00681)
Constant	18.27***	18.01***	18.61***	18.55***	17.97***	17.78***	18.27***	18.24***
	(0.0351)	(0.0403)	(0.0230)	(0.0253)	(0.0362)	(0.0361)	(0.0218)	(0.0279)
Observations	109,192	109,588	182,700	182,006	109,714	110,914	183,528	184,349
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM coverage ratio, and interaction term variables are lagged (5 years).

Table 23 NTMs coverage ratio & weighted tariffs: gravity output for the worlds' food GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied weighted mean)_ij	-0.00103				-0.00152			
	(0.00114)				(0.00104)			
Tariff rate (applied weighted mean)_ji		-0.00339**				-0.00426***		
		(0.00134)				(0.00130)		
NTM (coverage ratio)_ij	-0.989***		-1.008***		-1.003***		-1.005***	
	(0.00796)		(0.00514)		(0.00987)		(0.00569)	
Interaction term (coverage ratio*low income countries)_ij	0.00144		0.00301		0.0180*		0.0125	
	(0.00362)		(0.00879)		(0.0108)		(0.0137)	
NTM (coverage ratio)_ji		-0.953***		-0.987***		-0.970***		-0.989***
		(0.00921)		(0.00560)		(0.00932)		(0.00701)
Interaction term (coverage ratio*low income countries)_ji		-0.00225		0.0122		0.00693		0.0160*
		(0.00853)		(0.00938)		(0.00765)		(0.00898)
RTA	0.0361***	0.0336***	0.0588***	0.0460***	-0.0107	-0.0209**	-0.00245	-0.0134**
	(0.00867)	(0.00953)	(0.00768)	(0.00809)	(0.00676)	(0.00824)	(0.00645)	(0.00681)
Constant	18.27***	18.01***	18.61***	18.55***	17.97***	17.75***	18.27***	18.24***
	(0.0355)	(0.0407)	(0.0230)	(0.0253)	(0.0366)	(0.0364)	(0.0218)	(0.0279)
Observations	108,216	108,500	182,700	182,006	108,738	109,822	183,528	184,349
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM coverage ratio, and interaction term variables are lagged (5 years).

Tables (22) to (25) also show that the food bilateral NTMs imposed by importer country ($NTM\ CR_{ji}$), negatively affect the exporter country's food integration into GVCF of ACP economies (columns A2 and A4; in tables 24 and 25) and the world (columns A2 and A4; in tables 22 and 23). Therefore; the bilateral NTMs ($NTM\ CR_{ji}$) is not only hindering trade of goods between country *i* and country *j*, but it also impacts the integration of exporting country *i* into GVCF.

Tables (22) to (25) show the negative impact of the importer country bilateral protection ($tariff_{ji}$) on the exporter country's food integration into GVCB (column B2; in tables 22 to 25). Thus, bilateral trade protection ($tariff_{ji}$) is not only impeding trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCB (where intermediate inputs cross national borders multiple times).

Table 24 NTMs coverage ratio & tariff rate applied mean: gravity output for the EU & ACP food GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied mean)_ij	-0.00494***				-0.00429***			
	(0.00177)				(0.00146)			
Tariff rate (applied mean)_ji		-0.00525***				-0.00640***		
		(0.00185)				(0.00206)		
NTM (coverage ratio)_ij	-0.987***		-1.008***		-1.001***		-1.005***	
	(0.00782)		(0.00513)		(0.00981)		(0.00566)	
NTM (coverage ratio)_ji		-0.955***		-0.987***		-0.970***		-0.990***
		(0.00910)		(0.00561)		(0.00905)		(0.00701)
FTA	0.0363***	0.0315***	0.0569***	0.0428***	-0.00852	-0.0246***	-0.00479	-0.0184***
	(0.00862)	(0.00932)	(0.00773)	(0.00805)	(0.00679)	(0.00802)	(0.00646)	(0.00675)
EBA	0.124***	-0.198**	-0.0135	-0.220***	0.146***	0.161	-0.0391	-0.149
	(0.0339)	(0.0939)	(0.0397)	(0.0707)	(0.0329)	(0.162)	(0.0683)	(0.128)
EPA (for ACP countries only)	-0.0619	0.0680*	-0.112***	-0.000146	0.166***	0.176***	0.169***	0.122***
	(0.0601)	(0.0380)	(0.0390)	(0.0195)	(0.0522)	(0.0410)	(0.0367)	(0.0245)
Interaction term (EBA*EPA)	-0.0327	0.241*	0.0302	0.167*	-0.188***	-0.184	-0.0371	-0.0945
	(0.0693)	(0.123)	(0.0874)	(0.0856)	(0.0607)	(0.178)	(0.0785)	(0.137)
EU	0.217***	0.201***	0.120***	0.0692***	0.217***	0.281***	0.226***	0.141***
	(0.0222)	(0.0262)	(0.0136)	(0.0128)	(0.0251)	(0.0284)	(0.0243)	(0.0187)
Constant	18.26***	18.01***	18.59***	18.54***	17.96***	17.77***	18.22***	18.22***
	(0.0350)	(0.0402)	(0.0227)	(0.0255)	(0.0364)	(0.0353)	(0.0225)	(0.0281)
Observations	109,192	109,588	182,700	182,006	109,714	110,914	183,528	184,349
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM coverage ratio, and interaction term variables are lagged (5 years).

The coefficients of bilateral food tariffs applied by the exporter country to its importers ($tariff_{ij}$) exhibit a negative impact on integration into GVCB (column B1; in tables 22 to 25). This means that a country's GVCB performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector.

Tables (22) to (25) also show that the food bilateral NTMs imposed by importer country ($NTM\ CR_{ji}$), negatively affect the exporter country's food integration into GVCB of ACP economies (column B2 and B4; in table 24 and 25) and the world (column B2 and B4; in tables 22 and 23). Therefore; the bilateral NTMs ($NTM\ CR_{ji}$) is not only hindering trade of goods between country *i* and country *j* but it also impacts the integration of exporting country *i* into GVCB.

The coefficients of bilateral food NTMs applied by the exporter country i to its importers ($NTM\ CR_{ij}$) show a significant negative effect on participation in GVCB of ACP countries (column B1 and B3; in table 24 and 25) and the world (column B1 and B3; in tables 22 and 23). This means that a country's participation in GVCB does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

Table 25 NTMs coverage ratio & weighted tariff: gravity output for the EU & ACP food GVCF & GVCB participation, PPML with FE

Variables	A				B			
	A1	A2	A3	A4	B1	B2	B3	B4
	GVCF	GVCF	GVCF	GVCF	GVCB	GVCB	GVCB	GVCB
Tariff rate (applied weighted mean)_ij	-0.000960				-0.00128			
	(0.00114)				(0.00103)			
Tariff rate (applied weighted mean)_ji		-0.00331**				-0.00404***		
		(0.00133)				(0.00129)		
NTM (coverage ratio)_ij	-0.987***		-1.008***		-1.002***		-1.005***	
	(0.00794)		(0.00513)		(0.00990)		(0.00566)	
NTM (coverage ratio)_ji		-0.954***		-0.987***		-0.971***		-0.990***
		(0.00919)		(0.00561)		(0.00912)		(0.00701)
FTA	0.0322***	0.0310***	0.0569***	0.0428***	-0.0124*	-0.0266***	-0.00479	-0.0184***
	(0.00859)	(0.00948)	(0.00773)	(0.00805)	(0.00672)	(0.00821)	(0.00646)	(0.00675)
EBA	0.128***	-0.192**	-0.0135	-0.220***	0.156***	0.160	-0.0391	-0.149
	(0.0347)	(0.0945)	(0.0397)	(0.0707)	(0.0332)	(0.159)	(0.0683)	(0.128)
EPA (for ACP countries only)	-0.0659	0.0891**	-0.112***	-0.000146	0.162***	0.210***	0.169***	0.122***
	(0.0607)	(0.0397)	(0.0390)	(0.0195)	(0.0525)	(0.0418)	(0.0367)	(0.0245)
Interaction term (EBA*EPA)	-0.0406	0.259**	0.0302	0.167*	-0.201***	-0.187	-0.0371	-0.0945
	(0.0699)	(0.127)	(0.0874)	(0.0856)	(0.0610)	(0.176)	(0.0785)	(0.137)
EU	0.213***	0.204***	0.120***	0.0692***	0.215***	0.293***	0.226***	0.141***
	(0.0215)	(0.0263)	(0.0136)	(0.0128)	(0.0250)	(0.0285)	(0.0243)	(0.0187)
Constant	18.26***	18.01***	18.59***	18.54***	17.96***	17.75***	18.22***	18.22***
	(0.0355)	(0.0405)	(0.0227)	(0.0255)	(0.0367)	(0.0356)	(0.0225)	(0.0281)
Observations	108,216	108,500	182,700	182,006	108,738	109,822	183,528	184,349
R-squared	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999
Importer_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter_time_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country_pair_FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).
Notes: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. Tariff rate, NTM coverage ratio, and interaction term variables are lagged (5 years).

Tables (22) to (25) also show the impacts of the existing preferential trade regimes FTA, EBA, EPA (for ACP countries only), EU, and RTAs on GVCF and GVCB participation in the food sector. The estimated coefficients exhibit a positive and significant effect of FTA, EBA, EPA (for ACP countries only), EU, and RTAs (at the global level). The RTAs, FTA, EBA, and EPA also show an ambiguous relationship with the participation of the food sector in GVCF and GVCB.

For instance, the positive sign of the FTA dummy measures the increase in ACP's participation in forward-GVC under FTA in the case of a decrease in the NTM chapters ($NTM\ CR_{ij}$) and decrease in tariffs ($Tariff\ rate\ (applied\ weighted\ mean)_{ij}$) of the exporting countries to their importers (table 25 column A1). Also, the positive sign of the FTA dummy measures the increase in ACP's participation in forward-GVC under FTA in the case of a decrease in the NTM chapters ($NTM\ CR_{ji}$) and decrease in tariffs ($Tariff\ rate\ (applied\ weighted\ mean)_{ji}$) of the importing countries on their exporters (table 25 column A2). This suggests that the preferential trade regime (FTA) is focusing on enhancing member countries' export capacity of domestic value-added.

The positive sign of the RTA dummy measures the increase in countries' participation in forward-GVC under RTA in the case of a decrease in the NTM chapters ($NTM\ CR_{ij}$) and decrease in tariffs ($Tariff\ rate_{ij}$) of the exporting countries to their importers (tables 22 and 23 column A1). Also, the

positive sign of the RTA dummy measures the increase in countries' participation in forward-GVC under RTA in the case of a decrease in the NTM chapters ($NTM\ CR_{ji}$) and decrease in tariffs ($Tariff\ rate_{ji}$) of the importing countries on their exporters (tables 22 and 23 column A2). This suggests that the RTA is focusing on enhancing member states' export capacity of domestic value-added.

The positive sign of the EPA dummy measures the increase in ACP's participation in backward-GVC under EPA in the case of a decrease in the NTM chapters ($NTM\ CR_{ij}$) and decrease in tariffs ($Tariff\ rate_{ij}$) of the exporting countries to their importers (tables 24 and 25 column B1). Also, the positive sign of the EPA dummy measures the increase in ACP's participation in backward-GVC under EPA in the case of a decrease in the NTM chapters ($NTM\ CR_{ji}$) and decrease in tariffs ($Tariff\ rate_{ji}$) of the importing countries on their exporters (tables 24 and 25 column B2).

To sum up, these results answer the research question as follows: 1) The bilateral tariffs and NTMs are not only impeding the trade of goods between two ACP partners but also affects the participation of ACP exporting countries in food and agriculture GVCF & GVCB (where intermediate inputs cross national borders multiple times). 2) ACP countries' participation in GVCF & GVCB does not only rely on the trade protection level they face from all the countries in the world, but also on their own level of protection applied in the same sector.

The estimated coefficients exhibit a positive and significant effect of FTA, EBA, EPA (for ACP countries only), EU, and RTAs (at the global level). The RTAs, EBA, FTA, and EPA also show an ambiguous relationship with the participation of the agriculture and food sector in GVCF and GVCB. The interaction term (NTMs* low-income countries) also shows an ambiguous relationship with the participation of the agriculture and food sector in GVCF and GVCB.

6. CONCLUSION

The importer country bilateral protection ($tarif_{ji}$) negatively affect the exporter country's food and agriculture integration into GVCF and GVCB, for ACP economies, and the world. Therefore; bilateral trade protection ($tarif_{ji}$) is not only impeding the trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCF (where intermediate inputs cross national borders multiple times).

The bilateral tariffs applied by the exporter country to its importers ($tariff_{ij}$) have a negative impact on exporter countries' food and agriculture integration into GVCF and GVCB of ACP economies and all the countries in the world. This means that a country's GVCF and GVCB performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector (e.g. agriculture).

The bilateral NTMs imposed by importer country (NTM_{ji}) have a negative impact on the exporter country's agriculture and food integration into GVCF & GVCB of the ACP economies and the world. Therefore; the bilateral NTMs (NTM_{ji}) is not only hindering trade of goods between country *i* and country *j*, but it also impacts the integration of exporting country *i* into GVCF & GVCB.

The bilateral NTMs applied by the exporter country *i* to its importers (NTM_{ij}) show a significant negative effect on participation in food and agriculture GVCF & GVCB of ACP, and the world. This means that a country's participation in GVCF & GVCB does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

This study concludes that the bilateral tariffs and NTMs are not only impeding the trade of goods between two ACP partners but also affect the participation of ACP exporting countries in food and agriculture forward-GVC (GVCF) and backward-GVC (GVCB) (where intermediate inputs cross

national borders multiple times). Moreover, ACP countries' participation in GVCF & GVCB does not only rely on the trade protection level they face from all the countries in the world, but also on their own level of protection applied in the same sector.

The estimated coefficients exhibit a positive and significant effect of FTA, EBA, EPA (for ACP countries only), EU, and RTAs (at the global level). The RTAs, EBA, FTA, and EPA also show an ambiguous relationship with the participation of the agriculture and food sector in GVCF and GVCB. Therefore this study suggests additional research activities on the deep agreements and how different categories (chapters) of NTMs impact ACP countries' integration into GVCs.

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8. APPENDICES

8.1.Appendix (1): Borin and Mancini (2019) GVC indicators

Accounting of GVC indicators are based on ICIO framework with *G* countries and *N* sectors where $\mathbf{X}_s$ is the *N×1* vector of gross output produced in country *s*, **A** is the *GN×GN* global input coefficients matrix, **B** is the global Leontief inverse matrix, $\mathbf{V}_s$ is the *1×N* vector of the value-added shares embedded in each gross output unit produced in country *s* and $\mathbf{E}_{sr}$ is the *N×1* vector of exports of country *s* to country *r*, $\mathbf{u}_N$ is the *1×N* unit row vector and $(\mathrm{I}-\mathbf{A}_{ss})^{-1}$ account for the domestic inverse Leontief matrix (for more details see appendix B in the second essay). Based on the bilateral source-based framework, B&M (2019) propose a precise indicator of the share of exports related to forward supply linkages ($\mathbf{GVC}forward$) and the $\mathbf{GVC}backward$ indicator as following:

$$The\ overall\ \mathbf{GVC}_{sr} = \mathbf{GVC}backward_{sr} + \mathbf{GVC}forward_{sr} \tag{1.1}$$

$$\text{Where } \mathbf{GVC}backward_{sr}\ (\mathbf{VS}_{sr}) = \frac{\mathbf{V}_s(\mathrm{I}-\mathbf{A}_{ss})^{-1}\sum_{j\neq s}^{G}\mathbf{A}_{sj}\mathbf{B}_{js}\mathbf{E}_{sr}+\sum_{t\neq s}^{G}\mathbf{V}_t\mathbf{B}_{ts}\mathbf{E}_{sr}}{\mathbf{u}_N\mathbf{E}_{sr}} \tag{1.2}$$

$$\mathbf{GVC}forward_{sr}\ (\mathbf{VS1}_{sr}) = \frac{\mathbf{V}_s(\mathrm{I}-\mathbf{A}_{ss})^{-1}\mathbf{A}_{sr}(\mathrm{I}-\mathbf{A}_{rr})^{-1}\left(\sum_{j\neq r}^{G}\mathbf{Y}_{rj}+\sum_{j\neq r}^{G}\mathbf{A}_{rj}\sum_{k}^{G}\sum_{l\neq s}^{G}\mathbf{B}_{jk}\mathbf{Y}_{kl}\right)}{\mathbf{u}_N\mathbf{E}_{sr}} \tag{1.3}$$

8.2.Appendix (2): Tables and figures

Table 1 shows the decomposition of agriculture and food & beverages exports in ACP countries for the year 2015

Region	Sector code	Gross exports (GEXP)	Domestic content (DC)	Domestic Value-Added (DVA)	DAVAX	Reflection	Foreign Value-Added (FVA)	GVC-related trade (GVC)	GVC-backward (GVCB)	GVC-forward (GVCF)
ACP exports to the world	1	19893.27	18448	18439.69	12618.92	132.43	1444.17	7274.35	1453.59	5820.77
ACP exports to the UK	1	842.11	798.05	797.79	592.54	10.37	44.02	249.56	44.32	205.24
ACP exports to the EU27	1	9431.55	8755.09	8751.15	6341.41	92.47	675.95	3090.14	680.4	2409.73
ACP exports to the world	4	14121.04	12206.91	12196.6	9938.12	59.95	1912.83	4182.92	1924.44	2258.47
ACP exports to the EU27	4	6692.62	5849.59	5844.92	4877.21	40.1	842.43	1815.41	847.7	967.71
ACP exports to the UK	4	1277.03	1095.66	1094.73	932.06	8.8	181.25	344.97	182.3	162.67
		Share (%) of gross exports								
ACP exports to EU28	1	51.64	51.78	51.78	54.95	77.66	49.85	45.91	49.86	44.92
ACP exports to EU27	1	47.41	47.46	47.46	50.25	69.83	46.81	42.48	46.81	41.40
ACP exports to UK	1	4.23	4.33	4.33	4.70	7.83	3.05	3.43	3.05	3.53
ACP exports to EU28	4	56.44	56.90	56.90	58.45	81.57	53.52	51.65	53.52	50.05
ACP exports to EU27	4	47.39	47.92	47.92	49.08	66.89	44.04	43.40	44.05	42.85
ACP exports to UK	4	9.04	8.98	8.98	9.38	14.68	9.48	8.25	9.47	7.20

Source: Author's calculation based on EORA data 2015
Notes: 1: denotes agriculture sector. 4: denotes food & beverages sector
DAVAX: Value-Added directly absorbed by the importer

Table 2 presents NTM chapters

Imports	Technical measures	**A** SANITARY AND PHYTOSANITARY MEASURES (SPS) **B** TECHNICAL BARRIERS TO TRADE (TBT) **C** PRE-SHIPMENT INSPECTION AND OTHER FORMALITIES
	Non technical measures	**D** CONTINGENT TRADE-PROTECTIVE MEASURES **E** NON-AUTOMATIC LICENSING, QUOTAS, PROHIBITIONS AND QUANTITY-CONTROL MEASURES OTHER THAN FOR SPS OR TBT REASONS **F** PRICE-CONTROL MEASURES, INCLUDING ADDITIONAL TAXES AND CHARGES **G** FINANCE MEASURES **H** MEASURES AFFECTING COMPETITION **I** TRADE-RELATED INVESTMENT MEASURES **J** DISTRIBUTION RESTRICTIONS **K** RESTRICTIONS ON POST-SALES SERVICES **L** SUBSIDIES (EXCLUDING EXPORT SUBSIDIES UNDR P7 **M** GOVERNMENT PROCUREMENT RESTRICTIONS **N** INTELLECTUAL PROPERTY **O** RULES OF ORIGIN
	Exports	**P** EXPORT-RELATED MEASURES

Source: Classification of NTMs, UNCTD (2012)

Table 3 presents countries included in the WTO I-TIP NTMs database for 1995 to 2015

No	Country	Country code	No	Country	Country code	No	Country	Country code
1	Afghanistan	AFG	27	China	CHN	53	Germany	DEU
2	Albania	ALB	28	Colombia	COL	54	Ghana	GHA
3	Antigua and Barbuda	ATG	29	Congo	COG	55	Greece	GRC
4	Argentina	ARG	30	Costa Rica	CRI	56	Grenada	GRD
5	Armenia	ARM	31	Cote d'Ivoire	CIV	57	Guatemala	GTM
6	Australia	AUS	32	Croatia	HRV	58	Guinea	GIN
7	Austria	AUT	33	Cuba	CUB	59	Guyana	GUY
8	Bahrain	BHR	34	Cyprus	CYP	60	Haiti	HTI
9	Bangladesh	BGD	35	Czech Republic	CZE	61	Honduras	HND
10	Barbados	BRB	36	Democratic Republic of the Congo	COD	62	Hong Kong	HKG
11	Belgium	BEL	37	Denmark	DNK	63	Hungary	HUN
12	Belize	BLZ	38	Dominica	DMA	64	Iceland	ISL
13	Benin	BEN	39	Dominican Republic	DOM	65	India	IND
14	Bolivia	BOL	40	Ecuador	ECU	66	Indonesia	IDN
15	Botswana	BWA	41	Egypt	EGY	67	Ireland	IRL
16	Brazil	BRA	42	El Salvador	SLV	68	Israel	ISR
17	Brunei Darussalam	BRN	43	Estonia	EST	69	Italy	ITA
18	Bulgaria	BGR	44	Eswatini	SWZ	70	Jamaica	JAM
19	Burkina Faso	BFA	45	European Union	EUN	71	Japan	JPN
20	Burundi	BDI	46	European Union	EU	72	Jordan	JOR
21	Cabo Verde	CPV	47	Fiji	FJI	73	Kazakhstan	KAZ
22	Cambodia	KHM	48	Finland	FIN	74	Kenya	KEN
23	Cameroon	CMR	49	France	FRA			
24	Canada	CAN	50	Gabon	GAB	75	Kuwait	KWT
25	Central African Republic	CAF	51	Gambia	GMB	76	Kyrgyzstan	KGZ
26	Chile	CHL	52	Georgia	GEO	77	Laos	LAO

Source: Integrated Trade Intelligence Portal (I-TIP) of the WTO.

Table 3 continues

78	Latvia	LVA	103	Pakistan	PAK	128	Suriname	SUR
79	Liberia	LBR	104	Panama	PAN	129	Sweden	SWE
80	Lithuania	LTU	105	Papua New Guinea	PNG	130	Switzerland	CHE
81	Macao	MAC	106	Paraguay	PRY	131	Taiwan	TWN
82	Madagascar	MDG	107	Peru	PER	132	Tajikistan	TJK
83	Malawi	MWI	108	Philippines	PHL	133	Tanzania	TZA
84	Malaysia	MYS	109	Poland	POL	134	Thailand	THA
85	Mali	MLI	110	Portugal	PRT	135	Togo	TGO
86	Malta	MLT	111	Qatar	QAT	136	Trinidad and Tobago	TTO
87	Mauritius	MUS	112	Romania	ROU	137	Tunisia	TUN
88	Mexico	MEX	113	Russia	RUS	138	Turkey	TUR
89	Moldova	MDA	114	Rwanda	RWA	139	Uganda	UGA
90	Mongolia	MNG	115	Saint Lucia	LCA	140	Ukraine	UKR
91	Montenegro	MNE	116	Saint Vincent and the Grenadines	VCT	141	United Arab Emirates	ARE
92	Morocco	MAR	117	Samoa	WSM	142	United Kingdom	GBR
93	Mozambique	MOZ	118	Saudi Arabia	SAU	143	United States	USA
94	Namibia	NAM	119	Senegal	SEN	144	Unspecified	UNS
95	Nepal	NPL	120	Seychelles	SYC	145	Uruguay	URY
96	Netherlands	NLD	121	Singapore	SGP	146	Vanuatu	VUT
97	New Zealand	NZL	122	Slovakia	SVK	147	Venezuela	VEN
98	Nicaragua	NIC	123	Slovenia	SVN	148	Vietnam	VNM
99	Nigeria	NGA	124	South Africa	ZAF	149	Yemen	YEM
100	North Macedonia	MKD	125	South Korea	KOR	150	Zambia	ZMB
101	Norway	NOR	126	Spain	ESP	151	Zimbabwe	ZWE
102	Oman	OMN	127	Sri Lanka	LKA			

Source: Integrated Trade Intelligence Portal (I-TIP) of the WTO.

Table 3.1 presents the 50 countries included in the WTO I-TIP database from 1995 to 2015

No	Country code	ACP bloc	No	Country code	ACP bloc	No	Country code	ACP bloc	No	Country code	ACP bloc
1	CAF	CA	14	JAM	Cariforum	27	SYC	ESA	40	BFA	WA
2	CMR	CA	15	LCA	Cariforum	28	ZMB	ESA	41	CIV	WA
3	COD	CA	16	SUR	Cariforum	29	ZWE	ESA	42	CPV	WA
4	COG	CA	17	TTO	Cariforum	30	FJI	Pacific	43	GHA	WA
5	GAB	CA	18	VCT	Cariforum	31	PNG	Pacific	44	GIN	WA
6	ATG	Cariforum	19	BDI	EAC	32	VUT	Pacific	45	GMB	WA
7	BLZ	Cariforum	20	KEN	EAC	33	WSM	Pacific	46	LBR	WA
8	BRB	Cariforum	21	RWA	EAC	34	BWA	SADC	47	MLI	WA
9	DMA	Cariforum	22	TZA	EAC	35	MOZ	SADC	48	NGA	WA
10	DOM	Cariforum	23	UGA	EAC	36	NAM	SADC	49	SEN	WA
11	GRD	Cariforum	24	MDG	ESA	37	SWZ	SADC	50	TGO	WA
12	GUY	Cariforum	25	MUS	ESA	38	ZAF	SADC			
13	HTI	Cariforum	26	MWI	ESA	39	BEN	WA			

Source: Integrated Trade Intelligence Portal (I-TIP) of the WTO.
Notes: SADC: Southern African Development Community. WA: West Africa. CA: Central Africa. ESA: Eastern and Southern Africa. EAC: East African Community. Cariforum: Caribbean Forum.

Table 4 shows ACP NTMs imposed on intermediate and final goods in food and agriculture sectors over the period from 1995 to 2015

Year	Agriculture sector								Food sector						
	ADP	QRS	SPS	SSG	STE	TBT	TRQ	Total	QRS	SPS	SSG	STE	TBT	TRQ	Total
1995	0	0	132	741	342	0	1767	2982	0	0	1311	1425	0	7809	10545
1996	0	114	2736	0	0	0	0	2850	513	114	0	0	0	0	627
1997	0	0	114	0	0	4446	0	4560	0	18411	0	0	3078	0	21489
1998	0	0	0	0	0	23883	0	23883	0	18183	0	0	37791	0	55974
1999	0	0	171	0	0	0	0	171	0	2109	0	0	3819	0	5928
2000	0	0	627	0	0	0	0	627	0	228	0	0	171	0	399
2001	0	0	0	0	0	0	0	0	0	20406	0	0	0	0	20406
2002	5	0	0	1710	0	1710	0	3425	0	1140	5757	0	228	0	7125
2003	0	0	7524	3591	0	48507	0	59622	0	6555	5073	0	97869	0	109497
2004	0	0	0	285	0	3306	0	3591	0	14364	228	0	11001	0	25593
2005	0	0	50787	399	0	2223	0	53409	0	45543	3078	0	45429	0	94050
2006	0	0	0	0	0	53979	0	53979	0	29070	1425	0	175902	0	206397
2007	0	0	21489	0	0	106590	0	128079	0	11685	342	0	227316	0	239343
2008	0	0	0	114	0	38931	0	39045	0	7296	969	0	56487	0	64752
2009	0	0	77577	228	0	117705	0	195510	0	162450	513	0	167409	0	330372
2010	0	0	90744	0	0	500631	0	591375	0	174477	0	0	583338	0	757815
2011	0	0	15048	0	0	162849	0	177897	0	134007	1140	0	244359	0	379506
2012	0	0	0	0	0	220875	0	220875	0	1254	0	0	269724	0	270978
2013	0	37050	55461	0	0	425163	0	517674	83334	211185	0	0	245670	0	540189
2014	0	0	39558	57	0	24054	0	63669	0	81339	57	0	88806	0	170202
2015	0	0	35112	0	0	153501	0	188613	0	92454	0	0	146946	0	239400
Total	5	37164	397080	7125	342	1888353	1767	2331836	83847	1032270	19893	1425	2405343	7809	3550587
%	0	2	17	0	0	81	0		2	29	1	0	68	0	

Source: Integrated Trade Intelligence Portal (I-TIP) of the WTO.
Notes: ADP: Antidumping. QRS: Quantitative Restrictions. SPS: Sanitary and Phytosanitary Measures. SSG: Special Safeguards. STE: State trading enterprise. TBT: Technical barriers to trade. TRQ: Tariff-rate quotas.

Table 5 presents EU28 NTMs imposed on intermediate and final goods in food and agriculture sectors over the period from 1995 to 2015

Year	Agriculture sector				Food sector			
	SPS	SSG	TBT	Total	SPS	SSG	TBT	Total
1995	12138	0	28	12166	24724	0	364	25088
1996	28	0	22218	22246	742	0	36442	37184
1997	3836	0	24682	28518	9842	0	44688	54530
1998	7672	0	28350	36022	15442	0	53116	68558
1999	0	0	55972	55972	1708	0	99050	100758
2000	3836	0	14	3850	8092	0	2534	10626
2001	0	0	0	0	364	0	2674	3038
2002	56	0	14	70	3640	0	196	3836
2003	784	0	4858	5642	5166	0	8624	13790
2004	0	408	8160	8568	12624	3384	19032	35040
2005	264	0	6840	7104	2256	24	22896	25176
2006	24	0	6576	6600	0	0	3384	3384
2007	0	0	2990	2990	0	78	15002	15080
2008	0	0	22490	22490	806	0	66716	67522
2009	0	0	16016	16016	0	78	31616	31694
2010	0	52	7722	7774	0	650	17810	18460
2011	0	0	10712	10712	0	0	15990	15990
2012	0	0	0	0	0	0	10946	10946
2013	0	0	0	0	0	0	130	130
2014	0	0	0	0	0	0	5103	5103
2015	2511	0	7398	9909	1053	0	15120	16173
Total	31149	460	225040	256649	86459	4214	471433	562106
%	12	0	88		15	1	84	

Source: Integrated Trade Intelligence Portal (I-TIP) of the WTO.

Notes: SPS: Sanitary and Phytosanitary Measures. SSG: Special Safeguards. TBT: Technical barriers to trade.

Table 6 presents world NTMs imposed on intermediate and final goods in the agriculture sector over the period from 1995 to 2015

Year	ADP	CVD	EXS	QRS	SFG	SPS	SPS_STC	SSG	STE	TBT	TBT_STC	TRQ	Total
1995	3	0	269555	14973	483	699999	0	22886	64561	35742	0	272476	1380678
1996	10	0	0	322	322	762450	9	40587	644	766211	4	0	1570559
1997	3	0	3059	0	0	1033905	527	31077	0	1335548	71	0	2404190
1998	649	1	0	1288	322	1062643	179	7889	0	1111023	288	0	2184282
1999	23	0	0	58443	0	1146691	5	30613	161	1834256	0	0	3070192
2000	18	6	0	805	3864	1184058	106	3703	2093	79162	10	0	1273825
2001	36	7	0	2576	322	1741188	645	6764	0	766826	1515	0	2519879
2002	41	0	0	5957	2093	1579971	833	26899	0	1077734	399	0	2693927
2003	2	0	0	322	966	3580314	851	32850	0	2572730	576	0	6188611
2004	3	1	0	0	0	3644341	752	11753	0	937457	0	0	4594307
2005	9	7	0	8855	1612	2405384	987	14329	0	1121759	319	0	3553261
2006	6	1	0	3220	0	3880655	306	5314	0	1899935	25	0	5789462
2007	5	0	0	0	0	4527941	133	1610	0	2102577	1100	0	6633366
2008	4	0	0	16	0	4987586	506	2256	0	3353435	1639	0	8345442
2009	5	1	0	18033	322	4676837	826	4030	0	4604202	5194	0	9309450
2010	4	0	0	129122	322	9848744	268	2579	0	4858103	299	0	14839441
2011	2	1	0	0	0	8670805	132	1128	0	5246255	2672	0	13920995
2012	3	0	0	578004	322	5442297	0	3220	0	4213363	2783	0	10239992
2013	3	0	0	112057	161	7969545	0	1128	483	5481307	6714	0	13571398
2014	4	0	0	131216	1771	7754186	462	1127	0	5678589	553	0	13567908
2015	12	0	0	66976	805	9538107	71	0	0	4380148	2010	0	13988129
Total	845	25	272614	1132185	13687	86137647	7598	251742	67942	53456362	26171	272476	141639294

Source: Integrated Trade Intelligence Portal (I-TIP) of the WTO.
Notes: ADP: Antidumping. CVD: Countervailing duties. EXS: Export subsidies. QRS: Quantitative Restrictions. SFG: Safeguards. SPS: Sanitary and Phytosanitary Measures. SSG: Special Safeguards (agriculture). STE: State trading enterprise. TBT: Technical barriers to trade. TRQ: Tariff-rate quotas. SPS_STC: specific trade concern raised against an SPS. TBT_STC: specific trade concern raised against a TBT.

Table 7 presents world NTMs imposed on intermediate and final goods in the food sector over the period from 1995 to 2015

Year	ADP	CVD	EXS	QRS	SFG	SPS	SPS_STC	SSG	STE	TBT	TBT_STC	TRQ	Total
1995	34	25	534682	10787	161	1197314	39	89735	47029	80339	84	653456	2613685
1996	12	4	0	1449	0	1487480	2553	101632	0	1427957	0	0	3021087
1997	13	6	13363	0	483	1931882	496	87968	322	2565930	80	0	4600543
1998	1538	5	0	23023	2254	1721640	871	18354	2737	2110078	205	0	3880705
1999	28	69	0	179998	3703	2163076	321	200099	0	3787015	0	0	6334309
2000	23	8	0	0	12558	2161179	117	22076	9338	118681	368	0	2324348
2001	48	36	0	1288	4669	3462136	2175	37878	322	1578048	3068	0	5089668
2002	30	2	0	2254	4669	3064307	2155	113885	0	1914618	920	0	5102840
2003	26	12	0	644	4029	4931282	619	84618	0	5094432	656	0	10116318
2004	24	8	0	11270	1934	4922264	1300	62156	322	1589611	312	161	6589362
2005	18	0	0	18354	483	4102548	431	57960	644	2618390	702	0	6799530
2006	35	0	0	5796	4508	7413691	277	14336	0	3444871	37	0	10883551
2007	24	13	0	161	322	7245726	794	7084	0	3927119	2288	0	11183531
2008	3	0	0	0	0	7700145	641	10953	0	6221690	1056	0	13934488
2009	43	8	0	22379	2093	7745349	1936	57335	0	7967617	8234	2415	15807409
2010	1	8	0	217189	0	13316099	935	15164	322	7633348	2685	0	21185751
2011	17	5	0	161	0	13802067	574	11916	0	9298001	6448	0	23119189
2012	4	4	0	1673258	644	9239102	14	7572	0	7587083	4472	966	18513119
2013	49	148	0	240695	1610	13521599	101	1613	0	8763064	16419	7406	22552704
2014	17	18	0	282925	322	13581426	545	322	3703	10389752	3593	0	24262623
2015	6	10	0	126868	644	17242137	463	0	0	8554408	3997	0	25928533
Total	1993	389	548045	2818499	45086	141952449	17357	1002656	64739	96672052	55624	664404	243843293

Source: Integrated Trade Intelligence Portal (I-TIP) of the WTO.
Notes: ADP: Antidumping. CVD: Countervailing duties. EXS: Export subsidies. QRS: Quantitative Restrictions. SFG: Safeguards. SPS: Sanitary and Phytosanitary Measures. SSG: Special Safeguards (agriculture). STE: State trading enterprise. TBT: Technical barriers to trade. TRQ: Tariff-rate quotas. SPS_STC: specific trade concern raised against an SPS. TBT_STC: specific trade concern raised against a TBT.

Table 8 shows descriptive statistics of continuous and dummy variables in food panel data

Variable		Mean	Std. Dev.	Min	Max	Observations
Tariff rate (applied mean)_ij	overall	8.685606	10.00769	0	630	N = 460732
	between		7.682169	0	99.33667	n = 31820
	within		6.572629	-81.1761	586.5463	T = 14.4793
Tariff rate (applied weighted mean)_ij	overall	7.939292	11.21859	0	630	N = 460732
	between		7.864801	0	130.6245	n = 31820
	within		8.24107	-113.28	573.8502	T = 14.4793
Tariff rate (applied mean)_ji	overall	8.685407	10.00982	0	747	N = 460710
	between		7.635511	0	105.114	n = 31820
	within		6.613307	-64.3186	688.5028	T = 14.4786
Tariff rate (applied weighted mean)_ji	overall	7.927544	11.16997	0	747	N = 460710
	between		7.825177	0	135.607	n = 31820
	within		8.240598	-90.3008	700.9437	T = 14.4786
NTMs (frequency index)_ij	overall	74.27605	34.06006	0.023521	100	N = 283728
	between		17.3691	29.89164	100	n = 24784
	within		30.01016	-19.5349	143.4143	T-bar = 11.448
NTMs (frequency index)_ji	overall	74.25155	34.06006	-0.00098	99.9755	N = 283728
	between		17.3691	29.86714	99.9755	n = 24784
	within		30.01016	-19.5594	143.3898	T-bar = 11.448
NTMs (coverage ratio_GVCF)_ij	overall	70.89508	61.21514	-543.717	955.8694	N = 215806
	between		54.712	-354.936	752.6058	n = 24932
	within		36.3783	-323.445	792.7976	T-bar = 8.65578
NTMs (coverage ratio_GVCF)_ji	overall	77.25979	100.7002	-10611.7	789.3901	N = 215806
	between		85.13928	-3759.62	490.245	n = 24932
	within		76.18206	-9353.42	2498.902	T-bar = 8.65578
NTMs (coverage ratio_GVCB)_ij	overall	45.98557	56.15382	0.312828	905.2888	N = 215806
	between		73.46899	4.135869	905.2888	n = 24932
	within		30.98193	-460.783	540.1681	T-bar = 8.65578
NTMs (coverage ratio_GVCB)_ji	overall	47.79536	211.1626	0.03183	21760.33	N = 215806
	between		193.8245	0.156414	17408.26	n = 24932
	within		172.2772	-5371.98	18033.26	T-bar = 8.65578

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).

Table 8 continues

FTA	overall	0.060871	0.239094	0	1	N = 825840
	between		0.183025	0	1	n = 34410
	within		0.153847	-0.89746	1.019205	T = 24
EPA	overall	0.007561	0.086623	0	1	N = 1622082
	between		0.040029	0	0.269231	n = 62501
	within		0.076801	-0.26167	0.969099	T-bar = 25.9529
RTA	overall	0.048027	0.213822	0	1	N = 1622082
	between		0.17266	0	1	n = 62501
	within		0.126744	-0.91351	1.009565	T-bar = 25.9529
GDP_PC	overall	12529.35	18896.89	115.4357	145221.2	N = 732045
	between		22342.31	236.3643	145221.2	n = 31820
	within		3222.293	-12262.3	52738.57	T = 23.0058
Contiguity	overall	0.01676	0.12837	0	1	N = 773280
	between		0.128372	0	1	n = 32220
	within		0	0.01676	0.01676	T = 24
Common official language	overall	0.137679	0.344562	0	1	N = 773280
	between		0.344568	0	1	n = 32220
	within		0	0.137679	0.137679	T = 24
Common colonizer post 1945	overall	0.096276	0.294969	0	1	N = 773280
	between		0.294973	0	1	n = 32220
	within		0	0.096276	0.096276	T = 24
Weighted distance (pop-wt,km)	overall	7791.673	4418.897	60.77057	19781.39	N = 773280
	between		4418.963	60.77057	19781.39	n = 32220
	within		0	7791.673	7791.673	T = 24
Low income countries	overall	0.019058	0.13673	0	1	N = 1622082
	between		0.115323	0	0.923077	n = 62501
	within		0.073296	-0.90402	0.980597	T-bar = 25.9529

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).

Table 9 shows descriptive statistics of continuous and dummy variables in agriculture panel data

Variable		Mean	Std. Dev.	Min	Max	Observations
Tariff rate (applied mean)_ij	overall	8.685606	10.00769	0	630	N = 460732
	between		7.682169	0	99.33667	n = 31820
	within		6.572629	-81.1761	586.5463	T = 14.4793
Tariff rate (applied weighted mean)_ij	overall	7.939292	11.21859	0	630	N = 460732
	between		7.864801	0	130.6245	n = 31820
	within		8.24107	-113.28	573.8502	T = 14.4793
Tariff rate (applied mean)_ji	overall	8.685407	10.00982	0	747	N = 460710
	between		7.635511	0	105.114	n = 31820
	within		6.613307	-64.3186	688.5028	T = 14.4786
Tariff rate (applied weighted mean)_ji	overall	7.927544	11.16997	0	747	N = 460710
	between		7.825177	0	135.607	n = 31820
	within		8.240598	-90.3008	700.9437	T = 14.4786
NTMs (frequency index)_ij	overall	75.93859	31.84061	0.093052	100	N = 220870
	between		17.08785	16.26761	100	n = 23864
	within		27.48795	-12.5196	154.7014	T-bar = 9.25536
NTMs (frequency index)_ji	overall	75.91409	31.84061	0.068552	99.9755	N = 220870
	between		17.08785	16.24311	99.9755	n = 23864
	within		27.48795	-12.5441	154.6769	T-bar = 9.25536
NTMs (coverage ratio_GVCF)_ij	overall	73.62986	64.3496	-543.717	955.8694	N = 182518
	between		56.54337	-298.596	752.6058	n = 24664
	within		38.01328	-320.711	811.2338	T-bar = 7.40018
NTMs (coverage ratio_GVCF)_ji	overall	77.78919	109.5727	-10611.7	789.3901	N = 182518
	between		89.81003	-3759.62	490.245	n = 24664
	within		82.83823	-9352.89	2499.431	T-bar = 7.40018
NTMs (coverage ratio_GVCB)_ij	overall	45.72793	57.00249	0.312828	905.2888	N = 182518
	between		65.37971	4.135869	905.2888	n = 24664
	within		32.26084	-448.255	539.9104	T-bar = 7.40018
NTMs (coverage ratio_GVCB)_ji	overall	51.43235	233.7551	0.03183	21760.33	N = 182518
	between		199.0498	0.156414	17408.26	n = 24664
	within		190.314	-5368.34	18036.89	T-bar = 7.40018

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).

Table 9 continues

FTA	overall	0.060871	0.239094	0	1	N = 825840
	between		0.183025	0	1	n = 34410
	within		0.153847	-0.89746	1.019205	T = 24
EPA	overall	0.007561	0.086623	0	1	N = 1622082
	between		0.040029	0	0.269231	n = 62501
	within		0.076801	-0.26167	0.969099	T-bar = 25.9529
RTA	overall	0.048027	0.213822	0	1	N = 1622082
	between		0.17266	0	1	n = 62501
	within		0.126744	-0.91351	1.009565	T-bar = 25.9529
GDP_PC	overall	12529.35	18896.89	115.4357	145221.2	N = 732045
	between		22342.31	236.3643	145221.2	n = 31820
	within		3222.293	-12262.3	52738.57	T = 23.0058
Contiguity	overall	0.01676	0.12837	0	1	N = 773280
	between		0.128372	0	1	n = 32220
	within		0	0.01676	0.01676	T = 24
Common official language	overall	0.137679	0.344562	0	1	N = 773280
	between		0.344568	0	1	n = 32220
	within		0	0.137679	0.137679	T = 24
Common colonizer post 1945	overall	0.096276	0.294969	0	1	N = 773280
	between		0.294973	0	1	n = 32220
	within		0	0.096276	0.096276	T = 24
Weighted distance (pop-wt,km)	overall	7791.673	4418.897	60.77057	19781.39	N = 773280
	between		4418.963	60.77057	19781.39	n = 32220
	within		0	7791.673	7791.673	T = 24
Low income countries	overall	0.019058	0.13673	0	1	N = 1622082
	between		0.115323	0	0.923077	n = 62501
	within		0.073296	-0.90402	0.980597	T-bar = 25.9529

Source: Author's calculation based on EORA tables 1995 to 2015, WTO RTAs database and I-TIP-Goods, WITS, Ghodsi et al., (2017), CEPII database, and De Sousa (2012).

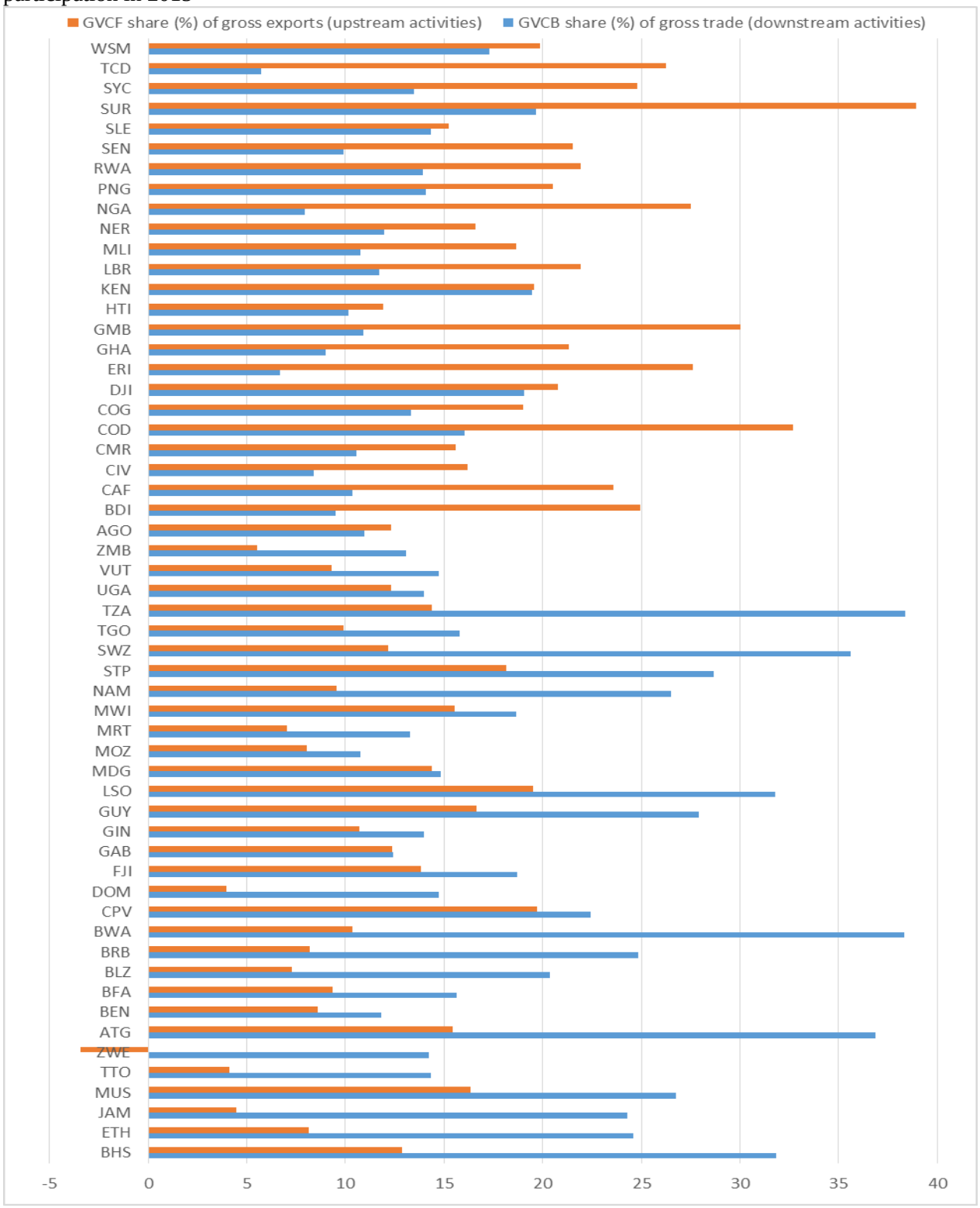
Table 26 presents 70 ACP countries included in this study

No	Country code	Bloc	No	Country	Bloc	No	Country	Bloc	No	Country	Bloc
1	CAF	CA	19	LCA	Cariforum	37	SYC	ESA	55	BFA	WA
2	CMR	CA	20	SUR	Cariforum	38	ZMB	ESA	56	CIV	WA
3	COD	CA	21	TTO	Cariforum	39	ZWE	ESA	57	CPV	WA
4	COG	CA	22	VCT	Cariforum	40	FJI	Pacific	58	GHA	WA
5	GAB	CA	23	BDI	EAC	41	KIR	Pacific	59	GIN	WA
6	STP	CA	24	KEN	EAC	42	PNG	Pacific	60	GMB	WA
7	TCD	CA	25	RWA	EAC	43	TON	Pacific	61	GNB	WA
8	ATG	Cariforum	26	SDS	EAC	44	TUV	Pacific	62	GNQ	WA
9	BHS	Cariforum	27	TZA	EAC	45	VUT	Pacific	63	LBR	WA
10	BLZ	Cariforum	28	UGA	EAC	46	WSM	Pacific	64	MLI	WA
11	BRB	Cariforum	29	COM	ESA	47	AGO	SADC	65	MRT	WA
12	DMA	Cariforum	30	DJI	ESA	48	BWA	SADC	66	NER	WA
13	DOM	Cariforum	31	ERI	ESA	49	LSO	SADC	67	NGA	WA
14	GRD	Cariforum	32	ETH	ESA	50	MOZ	SADC	68	SEN	WA
15	GUY	Cariforum	33	MDG	ESA	51	NAM	SADC	69	SLE	WA
16	HTI	Cariforum	34	MUS	ESA	52	SWZ	SADC	70	TGO	WA
17	JAM	Cariforum	35	MWI	ESA	53	ZAF	SADC			
18	KNA	Cariforum	36	SDN	ESA	54	BEN	WA			

Source: EORA data

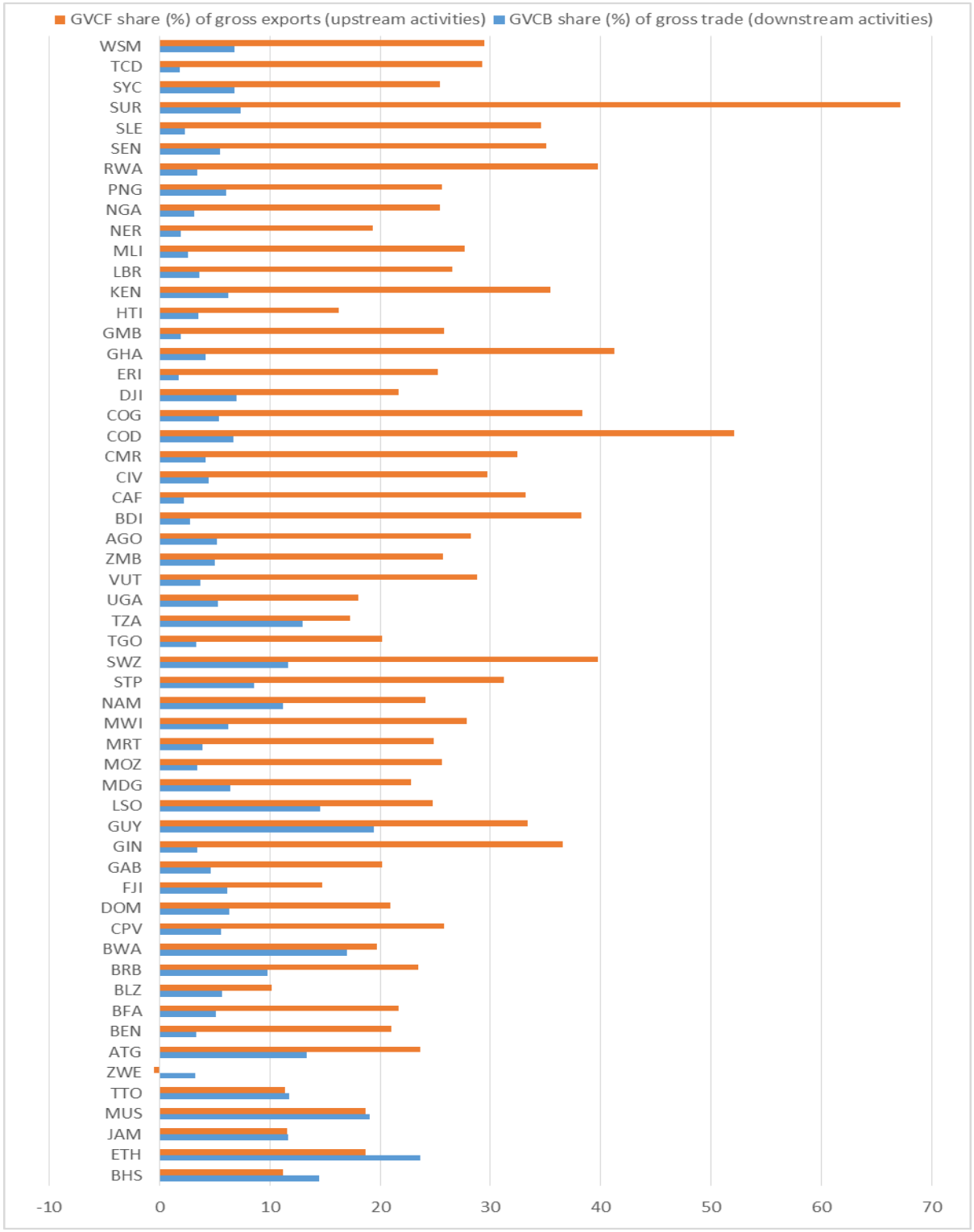
Notes: Total 70 ACP countries: Southern African Development Community (SADC) 7 countries, West Africa (WA) 17 countries, Central Africa (CA) 7 countries, Eastern and Southern Africa (ESA) 11 countries, East African Community (EAC) 6 countries, Caribbean Forum (Cariforum) 15 countries, Pacific 7 countries.

Figure 7 shows ACP countries' food & beverages sector backward-GVC & forward-GVC participation in 2015



Source: Author's calculation based on EORA data 2015

Figure 8 shows ACP countries' agricultural sector backward-GVC & forward-GVC participation in 2015



Source: Author's calculation based on EORA data 2015

FINDINGS AND CONCLUSION OF THE THESIS

This thesis consists of three essays. They are all related and investigate trade (at aggregate and value-added level) relations between African, Caribbean, and Pacific (ACP), and the European Union (EU) with a focus on the post-Brexit scenario. The first goal of the analysis is to understand how all preference arrangements (Economic Partnership Agreements (EPAs), Free Trade Agreement (FTAs), and Generalized Scheme of Preferences (GSPs)) have affected the ACP-EU trade (at aggregate level) relationships. This ex-post assessment will be used to make predictions about the post-Brexit scenario. Then the thesis investigates in depth the notion of trade in value-added, this thesis analyzes the trade in value-added (TiVA) providing an overview of the participation of these regions in international network production. Finally, this thesis investigates further how non-tariff measures (NTMs) affect ACP's agriculture and food sectors' participation in backward and forward Global Value Chains (GVC).

This first essay focuses on the policy analysis of Brexit impact on ACP-UK gross trade flows to better understand the historical and institutional setting that have been governing trade relations between the two regions (ACP & UK) since the 1970s within the context of EU-ACP EPAs framework with a focus on Caribbean Forum (Cariforum) countries.

Based on the findings, this study concludes that, If, Cariforum and the rest of the African & Pacific countries continue to access the UK market under EPAs: 1) On average, the trade volume of HI Cariforum countries increases by 25%. Specifically, Antigua and Barbuda, the Bahamas, Barbados, Saint Kitts, and Nevis, Trinidad, and Tobago. 2) Also on average, the trade volume of UMI Cariforum countries increases by 25%. Namely, Belize, Dominican Republic, Grenada, Guyana, Jamaica, Saint Lucia, Saint Vincent, and the Grenadines, Suriname. 3) no significant impact on the trade volume of Dominica. Negative impact on Haiti (signed EU-Cariforum EPA but not applying it). 4) Apart from some LDCs (Cameroon, Sao Tome and Principe), Namibia, and, Papua New Guinea, and South Africa, no significant impact on the trade volume of the rest of the African and pacific EPA members states.

If all ACP countries continue to access the UK market under EPAs, still the overall impact of EPAs on trade flows from ACP to the UK will be nonsignificant for the majority of ACP countries, namely African and Pacific blocs.

Generally speaking, the EU EPAs have a significant impact only on few HI & UMI ACP EPA countries and a nonsignificant impact on the majority of ACP countries (i.e. most ACP countries are either LI or LMI countries). So the overall impact of EU EPAs on ACP countries is nonsignificant.

Similarly, the EU assessment of Cariforum-EU EPA in 2014 reviewed the implementation and impact of Cariforum-EU EPA over the period of 2008-2013 (i.e. during the five years of its implementation). This assessment shows that Cariforum's gross exports to the EU witnessed an increase in their gross exports to post-2008 global recession but the Organisation of Eastern Caribbean States (OECS) witnessed a decline in their exports until 2011 then started to increase. During the period from 2006-2008 before the signature of Cariforum-EU EPA, Cariforum exports began to plateau and decline in some cases because of energy and food price shocks. In an exceptional case, Trinidad and Tobago exports increased to the EU-including methanol, crude oil, ammonia, urea, and increasingly liquefied natural gas.

Before Brexit, the EU regulating the UK's trade relations in goods and services with all developing countries, and the policy is managed by the European Commission. The UK government has committed itself to replicate the EU agreements post-Brexit. But the extension of the EU GSP scheme might negatively affect developing countries that need preferential treatments.

So the EU trade and development regime towards developing countries has led to some facts that the UK government should take into account when designing future trade and development policy for developing countries post-Brexit:

1. Most developing countries lack policy and institutional coherence to take advantage of the free market access granted to them by the EU.

2. Not to treat all the developing countries as one group rather implement trade and development policy that addresses their different social and economic needs.

3. Some ACP countries were mainly dependent on the EU market because the EU's preferential access was designed as a disincentive to exploit markets beyond the EU, besides other things, export diversification and economic growth. Therefore, the UK government must adopt a trade and development policy to assist these countries to develop and not to be attached to the UK.

4. To ensure continuity in market access to developing countries post-Brexit implies that the UK will roll over the pre-Brexit EU's graduation mechanism. But the pre-Brexit import-share thresholds could involve loss of preferences without improvement in the competitiveness of beneficiary countries, e.g. some developing countries' import-shares may exceed the graduation thresholds, either in the UK market or the EU27 market post-Brexit particularly countries that are close to the graduation threshold (counties with larger import-shares pre-Brexit). Therefore it is necessary that the UK revises the vulnerability thresholds (eligibility to the GSP+ regime) and the graduation thresholds upwards to ensure that pre-Brexit beneficiaries are not removed from the UK's GSP post-Brexit.

The second essay provides an overview of methodologies employed to measure trade in value-added and compute measures of backward and forward GVCs. It further investigates their similarities and differences and then applies the most appropriate method to analyze the ACP-UK/EU-27 trade in global value-added and participation in international network production. This essay compares the most common methodologies on the decomposition of gross exports e.g; Hummels et al., (2001), approach, Koopman et al., (2014), and Borin & Mancini (2019). After a rigorous comparison, this study finds similarities and disparities between these approaches, and finds that Borin & Mancini (2019) is the most appropriate approach for this study because it refines the vertical specialization measure of Hummels et al., (2001), refines and extends Koopman et al., (2014), and addresses the limitations of other previous studies.

Therefore this study uses Borin & Mancini (2019) to analyze the ACP-UK/EU-27 trade in global value-added. To this end, given the limitation of traditional trade statistics, EORA tables combine standard trade statistics with national Input-Output (IO) tables to form production and consumption linkages among industries and countries. Thus EORA tables allow us to evaluate global networks production activities based on gross exports and value-added trade relations of goods between sectors, countries, and regions. This essay's contribution to the literature is the first on an empirical investigation of ACP-UK/EU-27 trade in global value-added and participation in international networks production, using a robust methodology developed by Borin & Mancini (2019) to overcome the limitations of all previous methodologies.

The results show that the ACP blocs with the highest level of overall GVC-related trade activities in bilateral exports to the UK/EU-27 are the Southern African Development Community (SADC) and Caribbean (Cariforum countries). The ACP blocs GVC-related trade activities in bilateral exports to the UK are mainly driven by upstream linkages between ACP blocs and the UK except for the Eastern and Southern Africa (ESA) countries. The ESA countries' GVC-related trade activities in bilateral exports to the UK are based on downstream linkage between the UK and ESA countries. Similarly, the ACP blocs GVC-related trade activities in bilateral exports to the EU-27 are mainly driven by upstream linkages between ACP blocs and the EU-27 except for ESA countries. Conversely, the UK GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the UK and ACP blocs. Also, the EU-27 GVC-related trade activities in bilateral exports to the ACP blocs are mainly driven by downstream linkages between the EU-27 and ACP blocs.

At the country level, the share of Domestic Value-added (DVA) of ACP's gross exports to the UK is very high. The UK is the main destination market for some ACP countries such as Botswana, Mauritius, Guyana, Seychelles, Kenya, Jamaica, Swaziland, Belize, the Bahamas, South Africa, Ghana, Malawi, Namibia, Barbados, Gambia, and Saint Lucia. But ACP markets are not the main destination for UK exports. While the EU-27 is the main destination market for almost all ACP countries. But ACP markets are not the main destination for the EU-27 exports.

At the sector level, the share of DVA of gross exports of the UK and the EU-27 to the ACP is very high in all sectors. The UK and the EU-27 exports to ACP countries are mainly final goods and high manufactured products. ACP countries export raw materials and intermediate inputs to the UK and the EU-27. The share of DVA of ACP's gross exports to the UK and EU-27 is very high in all sectors. But ACP exports to the EU-27 and the UK are mainly dominated by agricultural products, food and beverage, mining and quarrying, and metal products. Therefore; in the subsequent essay, the focus will be on the agriculture and food & beverages sectors to carry out the empirical analysis. Figures and tables are presented in the appendices section.

The last essay studies the effect of non-tariff measures (NTMs) associated with shifts in trade regimes on ACP countries with a focus on food & agricultural sector participation in backward (the use of foreign intermediate goods for the production of goods for exports) and forward (the use of domestic inputs in third country exports) GVCs. To do so, this essay applies a gravity-like of trade in value-added proposed by Balié et al., (2019), the decomposition framework developed by Borin and Mancini (2019), and the NTMs quantity-based approach proposed by Berden et al., (2009).

This essay is the first to investigate the impact of NTMs associated with shifts in trade regimes on ACP's trade in value-added and food & agricultural forward and backward participation in GVCs. This study contributes to the literature by applying an empirical gravity model of value-added trade to estimate the effect of trade policy on ACP's food & agricultural backward and forward participation in global network productions.

This essay focuses on the agricultural sector and food & beverage sector because ACP's exports are mainly dominated by agricultural products and food and beverage products and NTMs are higher in these two sectors. Policymakers in ACP countries should pay attention to sectors where NTMs are the highest (i.e. where the highest potential gain from trade can be achieved), like the agricultural sector and food & beverage sector.

The results show that the importer country bilateral protection ($tarif_{ji}$) negatively affect the exporter country's food and agriculture integration into GVCF and GVCB, for ACP economies, and the world.

Therefore; bilateral trade protection ($tarif_{ji}$) is not only impeding the trade of goods between two trading partners, but it also affects the participation of exporting countries in GVCF (where intermediate inputs cross national borders multiple times).

The bilateral tariffs applied by the exporter country to its importers ($tariff_{ij}$) have a negative impact on exporter countries' food and agriculture integration into GVCF and GVCB of ACP economies and all the countries in the world. This means that a country's GVCF and GVCB performance does not only rely on the trade protection level it faces from all the countries in the world, but also on its own level of tariffs applied in that sector (e.g. agriculture).

The bilateral NTMs imposed by importer country (NTM_{ji}) have a negative impact on the exporter country's agriculture and food integration into GVCF & GVCB of the ACP economies and the world. Therefore; the bilateral NTMs (NTM_{ji}) is not only hindering trade of goods between country *i* and country *j*, but it also impacts the integration of exporting country *i* into GVCF & GVCB.

The bilateral NTMs applied by the exporter country i to its importers (NTM_{ij}) show a significant negative effect on participation in food and agriculture GVCF & GVCB of ACP, and the world. This means that a country's participation in GVCF & GVCB does not only rely on the NTMs level it faces from all the countries in the world, but also on its own level of NTMs in the same sector.

This study concludes that the bilateral tariffs and NTMs are not only impeding the trade of goods between two ACP partners but also affect the participation of ACP exporting countries in food and agriculture forward-GVC (GVCF) and backward-GVC (GVCB) (where intermediate inputs cross national borders multiple times). Moreover, ACP countries' participation in GVCF & GVCB does not only rely on the trade protection level they face from all the countries in the world, but also on their own level of protection applied in the same sector.

The estimated coefficients exhibit a positive and significant effect of FTA, EBA, EPA (for ACP countries only), EU, and RTAs (at the global level). The RTAs, EBA, FTA, and EPA also show an ambiguous relationship with the participation of the agriculture and food sector in GVCF and GVCB. Therefore this study suggests additional research activities on the deep agreements and how different categories (chapters) of NTMs impact ACP countries' integration into GVCs.