UNIVERSITY OF CAPE COAST

LOGISTICS AND DISAGGREGATED TRADE AMONG SELECTED SUB-SAHARAN AFRICAN COUNTRIES

ABIGAIL YAWSON

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BY

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

.

Candidate's Signature:…...………………… Date……………………………
Name: Abigail Yawson

Supervisor's Declaration

I hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines on the supervision of the thesis laid down by the University of Cape Coast.

Supervisor's Signature ……………………..… Date ………………………..
Name: Dr. Camara K. Obeng

Co-Supervisor's Signature ……………….…… Date ………………………..
Name: Dr. Isaac Dasmani

ABSTRACT

The improvement in technology and reduction in transportation cost as well as the liberalization of trade has led to the tremendous growth in global trade. However, the contribution of the sub- Saharan Africa (SSA) region to world trade is very low due to the high cost involved in trading. The SSA region is characterized by weak and inefficiencies in its logistic structures, among other factors, causing the region's poor performance and contribution to global trade. To this end, the study employed the Stochastic Frontier Gravity Model (SFGM) to analyze the effects of logistics on disaggregated trade for a panel of 24 SSA countries over the period 2007 to 2018. The frontier estimates revealed that aggregated logistics performance has a positive and significant effect on all the disaggregated trade products. The results of the disaggregated logistics also revealed that all the individual logistics indicators are efficient for the trade-in agricultural, forestry, and fishery products for the selected SSA countries whilst international shipment, logistics quality, and competency, and tracking and tracing are efficient for the smooth trade of mineral products, and manufactured products for the selected countries with customs service, infrastructure, and timeliness being inefficient for the trade of these products.

KEYWORDS

Disaggregated trade

Logistics Performance Index

Stochastic Frontier Gravity Model

Sub-Saharan Africa

Traditional Gravity Model

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DEDICATION

To my late parents

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LIST OF ACRONYMS/ABBREVIATIONS

AFTA	Asian Free Trade Area
APEC	Asian -Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
CEPII	Centre d'Etudes Prospectives Et d' Informations Informationales.
CEEC	Central and Eastern European Countries
DOLS	Dynamic Ordinary Least Square
EAC	East Asian Community
EAP	East Asia and Pacific
ECA	Europe and Central Asia
ECI	Economic Complexity Index
ECOWAS	Economic Community of West African States
EEC	European Economic Community
EFTA	European Free Trade Area
EU	European Union
EPA	Economic Partnership Agreement
FEM	Fixed Effect Model
FMOLS	Fully Modified Ordinary Least Square
FDI	Foreign Direct Investment
GATT	General Agreement on Tariff and Trade
GDP	Gross Domestic Product
G2SLS	Generalized Two Stages Least Square
HO	Heckscher Orlin

IMF	International Monetary Fund
LAC	Latin American And Caribbean
LPI	Logistic Performance Indicators
MLE	Maximum Likelihood Estimation
MENA	Middle East And North Asia
NBPML	Negative Binomial Pseudo Maximum Likelihood
OECD	Organization of Economic Cooperation and Development
OLS	Ordinary Least Square
REM	Random Effect Model
RTA	Regional Trade Agreement
SA	South Asia
SAARC	South Asian Association for Regional Corporation
SADC	South African Development Community
SSA	Sub Saharan Africa
SFGM	Stochastic Frontier Gravity Model
SIC	Standard Industrial Classification
TEU	Twenty-foot Equivalent Unit
TGM	Traditional Gravity Model
UNCTAD	United Nations Conference on Trade and Development
UN COMTRADE	United Nations Community Trade Statistics Database
WB	World Bank
WDI	World Development Indicators
WITS	World Integrated Trade Solutions
WTO	World Trade Organisation

CHAPTER ONE

INTRODUCTION

This research is important because, for trade to be enhanced to promote and sustain growth in SSA, there is the need to know the state of logistics and which indicators of the logistics will enable efficient trade flow within and outside the regional block. This chapter comprises the background to the study, problem statement, objectives, research hypotheses, and the significance of the study as well as the organization of the various chapters.

Background to the Study

Global trade has ballooned since the 1970s, increasing from US$2.5 trillion in 1970 to US$22 trillion in 2015 (WTO, 2017). This remarkable growth has been driven by the reduction in trade transportation cost and improved technology as well as liberalization of trade which has also contributed to the reduction of trade tariffs alongside other artificial trade barriers (Takele, 2017). However, the contribution made by the sub-Saharan African (SSA) region to global is very low compared to other developing regions. SSA's share in world trade was 2.11 percent in 2014 and 2.40 percent in 2015; Although there was an increase in SSA's contribution to world trade in 2015. According to UNCTAD (2017), the contribution made by SSA was the least compared to the contributions of other developing regions. This relates to an assertion made by Gani (2017) that the desire of countries to improve their trade and perform well in the global trading system do not depend only on liberalized economic systems but also depend on the quality and efficiency of their trade support structures. This is to say that SSA countries have liberalized their trade, yet are not performing well in global trade even trade among the region is very low ranging between 1.3 percent and 2.2 percent over the last two decades (Nutor, 2014).

The reasons for the poor performance of the SSA region in the global trading system are multifaceted. One of the primary causes is the high cost to trade with the SSA region. This is in line with studies (Limao & Venables, 2001; Clark, Dollar, & Micco, 2004; Behar & Manners, 2008; Turkson, 2011) which concluded that trade costs are higher in SSA and has impeded the international trade flows of the region and even with trade among the region.

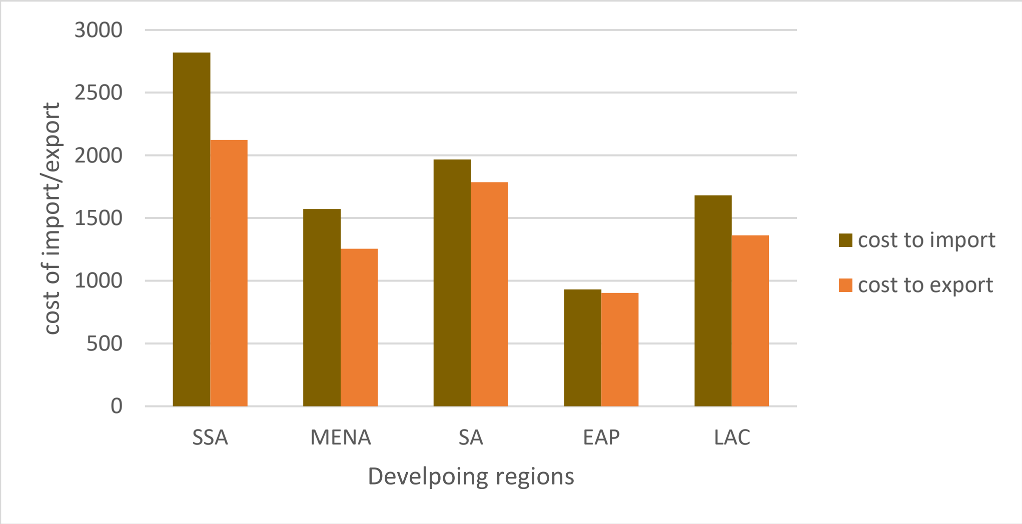

Figure 1: **Costs to Import and Export (US$ Per Container) among the World's Developing Regions**

Source: Yawson (2020)

The average costs of export and import procedures are displayed in Figure 1 and indicate that the SSA region has the highest cost procedures and is followed by SA, LAC, MENA with EAP having the lowest cost to import and export. The SSA region has naturally been handicapped by its distance and is also faced with many landlocked countries of 40 percent of SSA's total population, this makes market accessibility difficult and increases the cost of transportation. Furthermore, artificial trade costs, customs, and border costs are the highest in SSA relative to other developing regions (Turkson, 2011). This has made trading among the SSA region and other regions unattractive and has led to the continuous fall in SSA's trade performance and contribution to global trade.

A major issue that has recently been given much attention as a factor that limits the trade and contribution of the SSA region in world trade is "Logistic Services". De Souza, Goh, Gupta, and Lei (2007) defined logistics as "Part of the value chain which plans, implements, and controls the efficient flow of goods, services, and information from source to consumer. They argued that the ultimate importance of logistics is its ability to efficiently solve transportation, and storage issues, increasing the competitiveness of businesses and the country as a whole". In contrast, inefficient or poor logistics services such as slacks of customs clearance process at ports, costly and infrequent shipping, delays in tracking and tracing amongst others can lead to bottlenecks in the smooth flow of goods and increase the cost of international trade (Arvis, Saslavsky, Ojala, Shepherd, Busch & Anasuya, 2014).

Studies (Hausman, Lee & Subramaniam, 2012; Turkson, 2011, Iwanow & Kirkpatrick, 2009) argued that the inability of SSA to perform well in global trade is due to the inefficiencies in its logistics. The World's Bank has since 2007 introduced an index that assesses the logistics positions of 160 countries. The index comprises; infrastructure, customs, timeliness, quality, competency, international shipment, and tracking and tracing. The overall logistics of each country is the average of the indicators in the index, which is scaled from 1(low) to 5(high) (Arvis et al., 2012). SSA region has lagged in all the rounds of the LPI relative to the other developing regions since its introduction. For instance, in 2010's LPI: LAC, SSA, MENA, EAP, SA, and ECA obtained values of 2.7, 2.4, 2.8, 3.1, 2.5,3.2 whilst 2.67, 2.46, 2.58, 2.77, 2.58, 2.77 were obtained in the 2012 LPI by the developing regions respectively (Arvis et al., 2014). These values indicate that SSA is not doing well in terms of its logistics performance. Figure 2 shows the most current position of SSA in the recent rounds of the World's Bank LPI. The figure compares the LPI values in 2016 to the values in 2018. Just as in the case of the initial rounds of the LPI, SSA lagged again in both 2016 and 2018 World's Bank LPI. This position explains why to date SSA is irrelevant in the global trading system and why there is a need to give more attention to the issues concerning logistics in SSA.

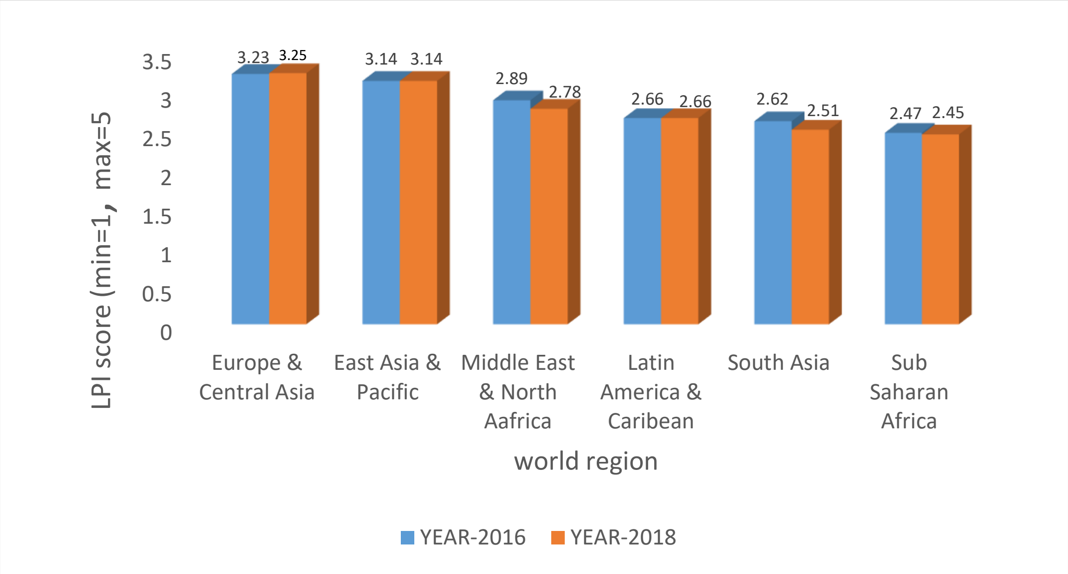

Figure 2: **Overall LPI Score By World Region, 2018 vs. 2016**

Source: Yawson (2020)

Political instability is another issue that must be addressed with much concern since it has an adverse impact on trade. In particular, domestic political instability is the main source of uncertainty for trade agreements. According to Political uncertainty, Molders (2016), discourages successful negotiation between partner countries and makes trade agreements difficult to enforce.

There is still a chance of termination even though these agreements have been implemented. Again, political instability depletes the trade and economic potentials of countries. Thus, no country and foreign investors would like to trade with a country that is not politically stable. An example is a fall in foreign direct investment to Nigeria, the biggest oil exporter in SSA caused by growing terrorism by Boko Haram and Niger Delta Avengers' sabotage on the capital structure in recent years (Wook, 2017). Increasing political instability in SSA countries including; Burundi, Ethiopia, Kenya, and Mozambique among others has also accounted for the limited trade among the region its trade with other regional blocks.

Intra-regional trade opportunities exist within the SSA, especially for countries that share a common border. Neighboring countries also have related transport networks and, in some cases, have bilateral transport or customs contracts (Nutor, 2014). This inhibits intra-regional trade among the SSA region. Most countries in SSA trade more with countries in other regions than with the SSA region. For example, over 80 percent of the exports from low-income-Sub-Saharan countries go to countries outside of the sub-Saharan region ($85.2bn in 2006). These countries only exported $4.5 billion to Sub-Saharan middle-income countries and $9.4 billion to other Sub-Saharan low-income countries. Similarly, the majority of SSA middle-income countries trade with countries outside the sub-Saharan region". Sub-Saharan countries often primarily import from countries that are not in their respective regions. Figure 3 shows the trade within the regional block of SSA and its trade with other regional blocks.

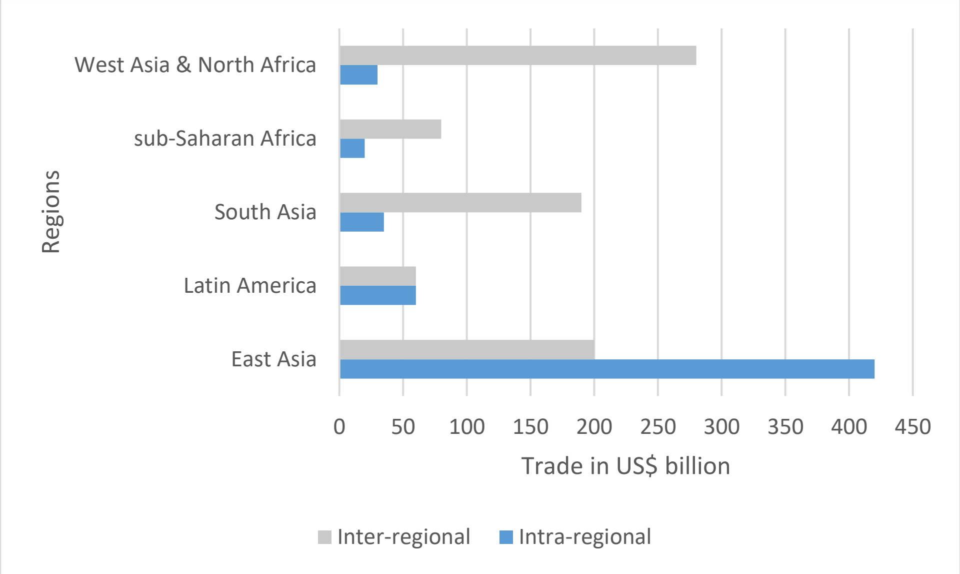

Figure 3: **Intra/Inter-regional Trade among Developing Regions**

Source: Yawson (2020)

Although various factors such as trade flows, economic size, population, distance, economic growth, the exchange rate between countries are determined by FDI inflows (Karbalaei, Md-Yusuf, & Ho 2014). Various researchers (Hoekman & Nicita, 2011; Portugal-Perez & Wilson, 2012) have acknowledged that efficient logistics service influence trade performance and this confirmed that improving a country's logistics performance reduces trade cost and improves trade, especially in SSA. This also implies that how effective countries will be in the flow of their disaggregated trade is determined by how quality and efficient their logistics services are. Figure 4 shows the trends of SSA's logistics and trade.

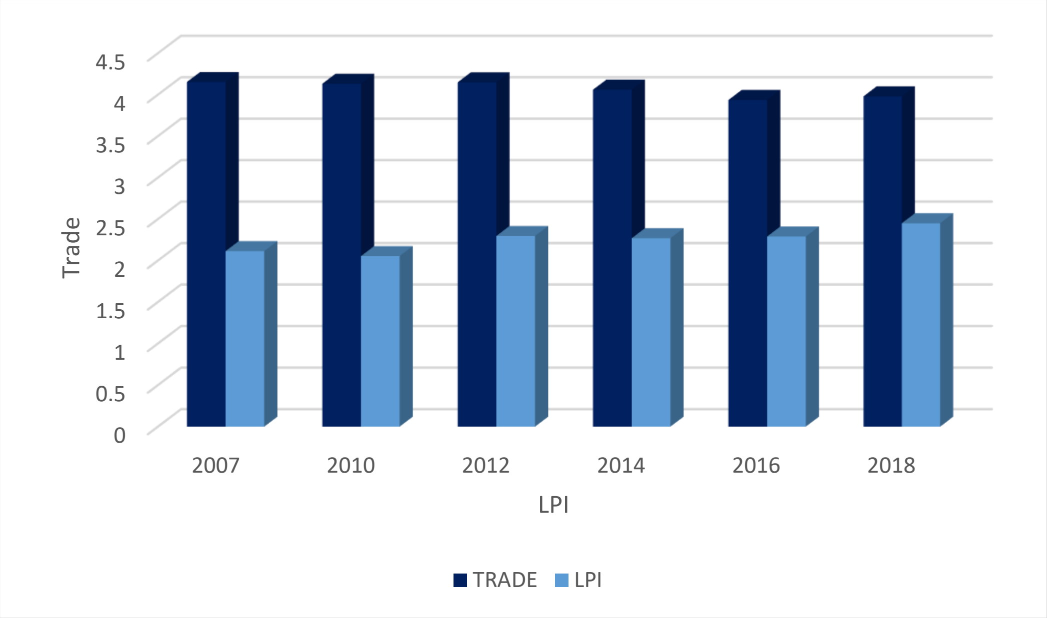

Figure 4: **Trends of SSA's LPI and Trade from 2007 to 2018**

Source: Yawson (2020)

The Figure indicates a positive trend between SSA's logistics and trade, this is to say that any improvement in logistics will also enhance trade. On the other hand, as logistics becomes inefficient, trade deteriorates alongside.

Statement of the Problem

Trade is one of the inevitable factors that contribute to economic growth and development. Hence, global trade has improved in various regions, yet the SSA region remains the least contributor to world trade (WTO, 2015). The major problem the SSA region faces due to its poor logistics structures is the high cost of trading, this is because the poor logistics infrastructure of the region causes a delay in the transportation of goods which increases the cost burden of countries trading with the region. Hence, trading with the region has become unattractive which has resulted in the poor performance of the region's trade among itself and other regional blocks as well as the contribution of the region in global trade. The introduction of LPI by the WB was to boost trade; however, the inefficiencies and inadequacies of logistics services as the support structure of trade has drastically affected the region's trade. Despite the significant role of logistics in enhancing and improving trade, current literature (Takele, 2017; Nutor, 2014; Virjil & Wagner, 2012; Turkson, 2011) points out there is few empirical works on how logistics influence disaggregated trade, especially in SSA. Shepherd (2011) attributed the limited availability of empirical works to the missing numerical measure of logistics performance consistently.

However, with the introduction of the Logistic Performance Index by the World Bank in 2007 researchers have studied logistics around the world. Studies (Behar & Manners, 2008; Arvis et al. 2007, 2010 & 2012; Hoekman & Nicita, 2010; Turkson, 2011) used the Traditional Gravity Model (TGM) to examine the impact of logistics performance on trade and the findings showed that there exists a direct relationship concerning logistics performance and trade. Specifically, in SSA, it is rare to come across empirical works on the effects of logistics on disaggregated trade. Even related literature (Njinkeu, Wilson & Fosu, 2008; Wilson, 2012; Nutor, 2014; Takele, 2017) examined the effects of logistics on trade using the TGM.

Nevertheless, none of the studies mentioned above concentrated on the effects of logistics on disaggregated trade. However, Gemmell and Hasseldine (2015) stated that making inferences in terms of conclusions and recommendations based on aggregation may be inefficient due to the large margin of error that may result from the aggregation so the best inferences should be made based on disaggregation. Again, studies focused on disaggregated trade will enable countries to know the exact indicator in their logistics index which will enhance their trade, this is because not all products or goods countries are involved in trading will need all the logistics indicators to improve its facilitation. Previous studies have also used the conventional approach of the gravity model, which has been criticized for its lack of theoretical basis and its shortcomings in regulating unnoticed trade resistant variables (Ravishankar & Stack, 2014; Bhattacharya & Das, 2014). The difference between earlier studies and this current study is that this study uses the stochastic frontier gravity model to examined logistics performance and disaggregated trade which is the advanced form of the traditional gravity model. This study will bring to light the effect of each logistics indicator on the country's trade given the type of products (Agricultural, forestry and fishery, Mineral Commodities, and Manufactured Commodities) they are involved in trading. This study will also expand the data used by previous studies to involve the current rounds of the logistics performance index (2016 and 2018). The use of the SFGM approach in estimating trade logistics is more consistent with the trade theories, as it adequately and sufficiently controls for multilateral trade resistance terms (Ravishankar & Stack, 2014; Bhattacharya & Das, 2014). Therefore, the study filled literature gaps by examining logistics and disaggregated trade using the Stochastic Frontier Gravity Model (SFGM).

Purpose of the Study

The purpose of the study was to examined logistics and disaggregated trade among selected sub-Saharan Africa countries.

Objectives of the Study

Specifically, the study:

i. Estimate the effects of aggregated logistics on disaggregated trade in SSA.

ii. Examine the effects of disaggregated logistics on disaggregated trade in SSA.

Hypotheses of the Study

H_0: Aggregated logistics has no significant effect on disaggregated trade in SSA.

H_1: Aggregated logistics has a significant effect on disaggregated trade in SSA.

H_0: Disaggregated logistics has no significant effect on disaggregated trade in SSA.

H_1: Disaggregated logistics has a significant effect on disaggregated trade in SSA

Significance of the Study

The poor performance of trade among SSA countries and other regional blocks is an issue of major concern for development policymakers in the region, SSA's natural handicaps have prevented the region from fully assessing its trade potentials. Policymakers in the region have desired to enhance trade to improve trade among SSA countries and countries outside the region as well as the trade position of the region in world trade. Although numerous measures are in play to improve SSA's trade, the importance of trade logistics to enhance competitiveness and improve trade levels between SSA countries and other regional blocks cannot be overlooked. Efficient logistics and effective policy measures tend to lower costs, increase trade volumes, and also attract new investments. There is, therefore, the need for special analysis or emphasis on improving trade logistics services along with establishing a supportive legal framework between countries in SSA. The study's findings will provide empirical evidence on which indicator of logistics will improve the disaggregated trade of SSA countries. This study will also apprise how efficient or inefficient the SSA region is in its logistics services, this will help the region to improve on the inefficiencies in their logistics and lead to the enhancement of trade and hence economic growth.

In a nutshell, this study will help countries to identify the logistics indicator that will boost their trade and improve the efficiency of these logistics, hence their trade position. This study will also provide a rationale for policymakers on how improving trade logistics will enhance the country's trade competitiveness. Also, this study will enlighten countries as to which of the indicators in the LPI to pay more attention to based on the type of goods they are engaged in trading (Disaggregated trade). It is of this interest this study is motivated to examine the effect of logistics on disaggregated trade in selected sub-Saharan African countries using the stochastic frontier gravity model.

Delimitations

The study focused on 24 Sub-Saharan African countries due to the unavailability of data for all sub-Saharan Africa countries. SFGM approach was applied to data since this approach in estimating trade efficiency is more consistent with the trade theories, as it adequately and sufficiently controls for multilateral resistance terms.

Limitations

Because of data unavailability for some SSA countries, the analysis did not cover all 46 SSA countries and thus limited the number of SSA countries selected for the study. For instance, out of 46 Sub-Saharan African countries, only 24 countries were included due to missing values and no data on disaggregated trade and logistics. If more SSA countries were included in the study, more precise conclusions could have been drawn to know the countries in Sub-Saharan Africa that are more efficient or inefficient in their trade logistics.

Organization of the Study

The study consists of six chapters, the first one which comprises the background, the problem statement, objectives, and the significance of the study. The second chapter gives a general overview of the logistics and trade in SSA. The third chapter reviews the literature on models of international trade preferences available to less developed countries and empirical literature relating to logistics and trade of countries. The next chapter presents the research design, the model, and the methods employed in the study. It also covers the description of data and their sources. In the fifth chapter, descriptive statistics and results of the estimations regarding the study are presented. The sixth and final chapter summarises the results, conclude, limitation, and presents relevant policy recommendations and directions for future research.

CHAPTER TWO

OVERVIEW OF TRADE AND LOGISTICS IN SUB-SAHARAN AFRICA

This section presents a summary of the trends of trade and disaggregated trade among SSA countries. It also brings to light details on the state of logistics and how it affects the performance and contribution of the SSA region in the global trading system.

Trade Among SSA Countries

No country has maintained its growth without a rise in the integration of itself into the global economy. Trade among SSA countries has greater potential for building sustainable economic development and integration. However, the trade and integration of the SSA region face various setbacks in the smooth flow of trade among and beyond the region including the reduction in administrative and transaction costs as well as an enabling infrastructure for the efficient flows of goods. These barriers have accounted for the region’s low trade performance.

Since the 1950s, Sub-Saharan Africa's trade has risen at relatively low rates, with the result that trade between SSA countries today stands at about 1 percent, down from more than 3 percent in the mid-fifties, even the share of world trade in the region has ranged from about 1.3 percent to 2.2 percent over the past two decades. Besides, the region’s trade is usually based on primary, agricultural, and manufactured goods. Thus the region is involved in exporting primary and agricultural commodities. Most of these commodities undergo less processing before they are re-exported. Cocoa beans from Ghana and cote d'Ivoire and crude oil and petroleum products from Nigeria are examples while the imports of the region are mainly manufactured commodities. For instance, the region's import of manufactured goods tripled to US 260 billion from 2007 to 2015 (WTO, 2017).

Trade volume in the SSA region decreased from 7.9 % in 2005 to 2006 to 6.4% in 2007 on a cross-country average basis, these estimates represented the lowest growth rate in trade among the developing world regions. Subsequently, export growth reduced from 8 percent to 6.1 percent in the previous decade. From 2010 to 2015, the trade volume of the region rose to 5.1 percent but trade volume decreased to 2.6 percent in 2016. However, there was a rise in trade by 0.24 percent and 2.7 percent in 2017 and 2018 respectively yet, this was the lowest trade growth compared with other developing regions.

Concerning the trade of the disaggregated products, the region's trade is mainly in agricultural, fishery, and forestry products, mineral products, and manufactured products. The volume of trade of these disaggregated products is represented in Table 1.

Table 1: Disaggregated Trade among SSA Countries

Product Division	SIC Code	SSA's Trade (In US$)		
		2016	2017	2018
Agricultural, forestry, and fishery products	0	1057248	1085577	274752.1
Mineral products	1	1426409	1275336	1530602
Manufactured products	2	2101565	2463040	540635
Total		2417577	2854805	5105240

Source: Yawson (2020)

The disaggregated products displayed in Table 1 show that SSA's trade in agricultural, fishery, and fishery products experienced a rise from US$ 1,057,248 million in 2016 to US$ 1,085,577 million in 2017. This rise can be attributed to the strong growth in SSA's agricultural production, which was mainly attributable to the expansion of the region and the intensification of cropping systems, as opposed to large-scale productivity improvements

(OECD, 2016). Forestry and fishery products also accounted for the growth in SSA's trade but fishery products' contributes are greater than both the agricultural and forestry products. The rapid growth in fishery products can be due to the growing demand for healthy diets, as is the case in many countries, and SSA is a good source of fish as the majority of fish captured in SSA is exported. In marine and inland waters, the area has extensive fish resources and is characterized by diverse fishing communities. A number of species are targeted for local and foreign consumption by small-scale and industrial-scale fishing.

However, given the region's growth in its agricultural, fishery, and forestry trade, the region at a certain point in time is faced with setbacks that account for the region's low trade. For example, the region's trade in agricultural, fishery, and forestry products fell from US$ 1,085,577 million in 2017 to US$ 274,752 thousand in 2018. Among other factors, some of the setbacks faced by the area include: adequate water and fertilizers again, SSA agriculture is mostly rain-dependent, and this dependence makes it susceptible to late rainfall and prevents it from having the best possible production.

Again, Table 1 predicts a fall in mineral trade from US$ 1,426,409 million in 2016 to US$ 1,275,336 million in 2017. The World Bank noticed the fall in mineral trade was a result of the fall in mineral commodity prices in 2016 whose real effect was felt on the SSA region in 2017. "The decrease in the price is a major shock since more than 60% of the region's exports is accounted, the World Bank states. Nigeria and Angola, are the main oil producers in the country, accounting for more than 90 percent of exports. Economic growth fell from an average of 5.4 percent in 2014 to an average of 2.9 percent in 2016 in all SSA oil-exporting countries, with low prices per barrel.

Nevertheless, in 2018 the region experienced a rise in its mineral trade resulting from the increased demand for mineral products. A lot of multinational firms joined with local objects to increase production capacity, and natural resources use as well as increasing industries. In recent years, SSA countries like South Africa, Angola, Botswana, Namibia, and Mauritius have started adding value to their raw diamonds in aid of boosting domestic revenue and employment. Processed diamonds are used for jewelry manufacture items such as rings, necklaces, bracelets, pins, and earrings. The rise in SSA's mineral products is also attributed to increasing mining industries in the region hence, trade increasing to US$ 1,530,602 million in 2018.

Manufactured products play a more limited role in the SSA's exports compared to other regions due to the limited integration into the global value chains. But the trade of manufactured products among the region is high making up 42 percent on intra-regional compared to 15 percent extra-regional exports. This has lead to the increased manufactured trade among SSA countries rising from US$ 2,101,565 million in 2016 to US$ 2,463,040 million in 2017. Nonetheless, the region's inability of adding value to its product has caused its trade in manufactured products to fall to US$ 540,635 thousand in 2018.

Logistics in Sub-Saharan Africa

Coordination and integration of logistics operations, such as transport management, material processing, warehousing, inventory management, marketing, development, and finance, is the responsibility of logistics management. Logistics infrastructures are very essential to facilitate the success of international trade in countries.

Logistics has become one of the fundamental supports of the economic growth of countries by linking individuals and companies to market opportunities (Arvis et al., 2016). However, the logistics infrastructure of the SSA region is poor and inefficient, which hampers the regular facilitation of trade between the region and other regions and affect the international trade opportunities available to the SSA region. For example, in the WB's LPI measure, the SSA region has lagged behind other developing regions in all rounds to date. This has made trading with the region unattractive as poor logistics increases the cost of trade with the region. Countries trade less with those with high trade costs; this affects the growth of the region because trade is a key indicator of economic growth and development.

Borders and Customs Procedures

Borders distinguish the territories of sovereign states such as land, sea borders, and air borders. Countries whose borders are crossed have the mandate to enforce rules to allow the entry of persons and goods. While international agreements are subject to several of these guidelines. Customs clearance is carried out at control points to ensure that border crossing traffic complies with the legal requirements of the country (Miller, et al., 2012).

According to a World Bank database, SSA has the maximum cost of both export and import in the world. These clumsy border measures increase transaction costs and delays in the settlement of exports, imports, and transit cargo. These problems hamper the competitiveness of worldwide trade in the region.

Infrastructure in SSA

Infrastructure denotes capital which consists of transport-related facilities, communications, power generation, and distribution. Infrastructure growth is considered a prerequisite for development (Strub, 2008). Commercial and transport infrastructure is divided into two: rigid and soft. Rigid infrastructure includes physical infrastructure (ports, airports, railways, roads) and information and communication technologies. Soft infrastructure is linked to business and regulatory environments (Portugal-Perez & Wilson 2012). For this study, hard infrastructure (physical infrastructure) will be considered.

Road infrastructure in SSA

Roads are the main mode of transport for most of the exchanges that occur between countries that share a border and the most important means of Land Transport. But the roads and railways of sub-Saharan Africa are poor in general condition. As noted by the World Bank Global Development indicator, in SSA, the total length of highways is 1,66 million km, with a road density of 104 km/1, 000 km2.15. Out of the total length already mentioned, only 9% of it has been covered, and also highways arterial are largely left dirt in the course of the last decades, (Nutor, 2014). Drivers take alternative routes that make them spend longer traveling time which in turn increases the cost of trading due to poor road infrastructure in many SSA countries. The straight path to the coast of Burundi is to pass through Tanzania, but because of the poor infrastructure, the distance increase by 600 km making trade unattractive. Also because of the bridge washing in Togo, many shipments of goods from northern Togo have to be transported through Ghana, Ouagadougou, Burkina Faso leading to a deviation of about 1,750 km.

Railway infrastructure in SSA

In SSA, railway capacity has decreased due to the decline of infrastructure and failures, as well as frequent delays leading to endemic unreliability in operations. In the 1980s, twenty thousand kilometers of railway lines were constructed in southern Africa, but only half of it was in use as at the end of the year 2002. Although in SSA, South Africa is the country with the most innovative rail sector, but 3.5 million tons is the current capacity of the railway linking the manganese mines and Port Elizabeth. As in the case of road transport, SSA rail transport is long and unreliable: it can take 14 to 21 days for a 1,145 km train journey from Kampala in the country of Uganda, to Mombasa in Kenya. Ghana has experienced a long and serious decrease in rail transport, and most of its goods are now being transported by truck with the exception of manganese and bauxite because of their weight to compensate for 83% of Ghana's rail traffic (Nutor, 2014).

Port infrastructure in SSA

Trade between countries without shared borders takes place primarily through the ocean. The main means of transport for goods like petroleum, iron ore, coal, and wheat are transported through maritime. These products are transported and traded on maritime because of their weight. Changes in technology and institutions have lowered the costs of shipping over the years. This includes the development of open register shipping scale effects from increased trade and containerization. However, SSA ports are globally inefficient and lack adequate space, resulting in higher port charges, higher shipping costs, and hinders the competitiveness of SSA's commercial costs. In SSA, many of the ports are choked due to inadequate capacity, delays in the procedure leading to delays in goods entering or leaving the ports. Problems in one SSA port can also influence port schedules on the same shipping route in other SSA ports, aggravating delays and creating uncertainty. For example, as noted by Nutor (2014), port operations during the course of West Africa affected the quality and competitiveness of fruit shipments and exports.

International Shipments

The Maritime Administration in 2008 defined the shipment as “the offering of cargoes at once from a shipper to a consignee on a bill of lading”. In -shipping sense, WB'S LPI defined it as the ease of organizing the shipment of goods at competitive prices. In ensuring a correct mode of transport and carrier factors like risk, weight, and value of goods, perishable and urgency should be considered for the selection of foreign forwarders for cross-border trade (RGX 2016). The WB LPI ranking shows that the SSA region's ability to arrange shipping at a competitive price is very low as a result of the poor state of the region's logistics infrastructure making the cost of shipping goods higher for SSA compared to other regions. For example, SSA, SA, LAC, MENA, and EAC obtained the values of 2.487, 2.677, 2.691, 2.958, and 3.081 respectively in the 2016 LPI ranking for the international shipping indicator showing that SSA has an inefficient ability to organize shipping at competitive prices compared to other developing regions.

Logistic Quality and Competency

In promoting the international exchange in goods transported both by sea and by air, quality logistics services play an important role and must be considered. In terms of infrastructure, customs processes, logistics expertise, monitoring, tracing and tracking, high-quality commercial logistics services improve a country's exports by minimizing costs and delaying the distribution of goods. It is therefore important for SSA to improve its logistics quality and competency since its far from major markets (Korinek & Sourdin, 2011). Yet, SSA is characterized by inefficiencies in its logistic infrastructures. The loyalty of countries to trade frequently with others lies in the satisfaction they attain in terms of the quality and competency of the logistics structure of the countries they trade with (Kilibarda & Andrejic, 2012). This is why SSA's trade performance is still poor due to the inefficiencies in the quality of its logistics.

Tracking and Tracing

Tracking is characterized as the capability to keep an eye on the supply chain path of a traceable item as it travels between parties. Tracing refers to the ability to use its code to find the origin, characteristics, or background of a specific traceable object found within the supply chain (Ryu & Taillard, 2007). That is GPS, GTIN, RFID, Barcode, on their shipments through the logistics chain. To improve integrated logistics networks and customer support, real-time monitoring and tracing are important. But, in SSA the linkage between technology and trade is weak in both directions. Thus the role of technology in trade competitiveness and knowledge transfer through trade. This has led to the SSA region ranking low in the LPI rankings in terms of its tracking and tracing efficiency. For example, in the 2018 LPI, the SSA region had the lowest position in terms of racking and tracing with a value of 2.50 relative to the values of other developing regions, i.e, SA (2.56), LAP (2.68), MENA (2.79), and EAP (3.18).

Timeliness

Parties involved in trading have an obligation of meeting the agreed time for the delivery of goods, this enhances smooth trade flow (UNIDROIT, 2010). The main target of many service delivery is achieving on-time time delivery of goods and services. Thus OTIF delivery must deliver the quantities ordered by the customer on the requested date and time without any problem (Rushton, Croucher & Baker, 2010). The ability of a country to export her goods and services on time gives her a source of comparative advantage when trading with other countries. Gamberoni, Lanz, and Piermartini (2010) argued that the area of production has an influence on the time in which the goods and services will be delivered. The poor logistics structures of SSA causes the delayed shipment of goods which inturned increases the cost of trading. This makes timeliness a major problem for SSA because it affects its trade negatively since failure in time delivery increase trade cost makes trade unattractive.

Logistics and Trade of SSA over the Period under Study

Improved logistics service enhance and ensure that products are transported in a speed and safer manner to reduce the cost of trading among countries. The trends of the effect of logistics on trade under the period under study are presented in figure 5. The estimates show that a slight improvement in logistics has a corresponding increase in SSA's trade. This shows that logistics play a vital role in the enhancement of trade as well as economic growth and development.

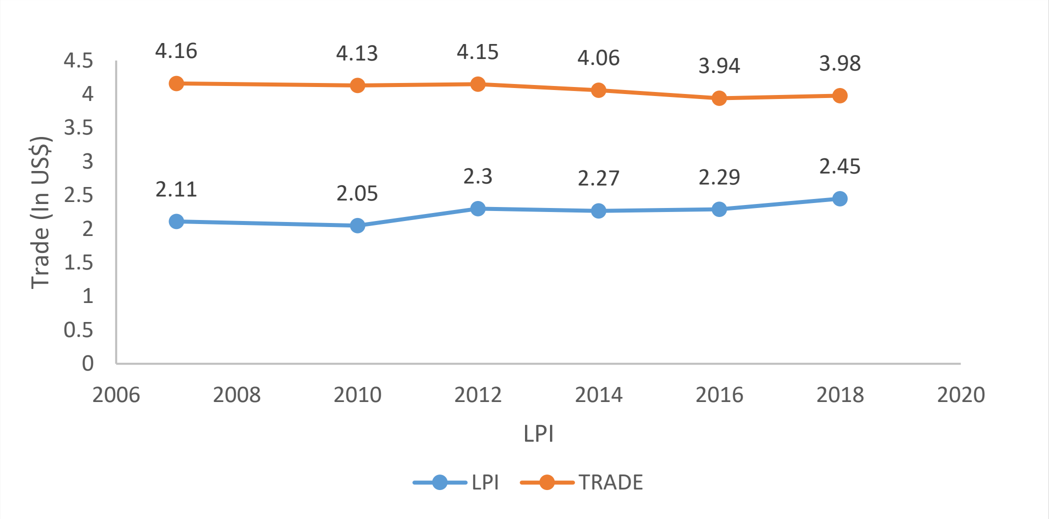

Figure 5: **Trends of SSA's LPI and Trade under the study period**

Source: Yawson (2020)

Conclusion

From the above discussion, the state of the logistics infrastructure of the SSA region and how they affect trade among and beyond the region have been brought to light. This gives a valid indication of the need to research the effect of logistics on trade.

CHAPTER THREE

LITERATURE REVIEW

Introduction

This section of the study provides theoretical literature on the development of the gravity model. It also provides empirical works on the traditional gravity and the linear panel of fixed and random effect approaches, as well as the Stochastic Frontier Gravity Approach in estimating countries ' trade potentials.

Theoretical Review

This subsection reviewed theories that explain the gravity model. The reviews are subdivided into three headings, the first part focused on the growth of the gravity model from the 1960s to 1970s. The second part also concentrates on how the general equilibrium model was used to develop the gravity equation and the last review works on the gravity model.

Theoretical Developments of the Gravity Model (1960s–1970s)

There have been many theories regarding international trade over the last centuries. The first trade theory as proposed by Adam Smith (absolute advantage) stated that countries should specialize and trade in goods and services that they have an advantage of producing more using the same amount of resources. Accordingly, David Ricardo in 1817 developed a theory known as the comparative advantage theory. This theory proposed that a country should specialize and trade in products that have a lower opportunity cost. Ricardo thus argued in favor of specialization and free trade among countries.

In the 1920s, Eli Heckscher and Bertil Ohlin presented a theory called the factor proportions model. The theory emphasized that countries should trade in goods that they are well endowed in production by emphasizing differences in resource endowment between countries. Piermartini and Teh (2005) criticized the H.O and the standard Ricardian theory that does not provide enough foundation for the gravity model.

Tinbergen (1962) and Poyhonen (1963) used the gravity model to performed econometric analyses of trade flows but they fail to provide a justification for the use of the model. According to Tinbergen, countries that trade in relation to their respective GDPs and proximity, just as planets are equally attracted by their scale and proximity (Nutor, 2014).

General Equilibrium Models (1979- 2003)

Inference of trade cost from trade flows using gravity equations

Several trade economists have used the gravity model in the last few decades to explain how trade barriers affect global trade flows (Bergstrand & Egger, 2013). Based on conclusions from the standard gravity model, two main theoretical approaches have been drawn from the model. These are the conditional and unconditional general equilibrium paradigm that describes trade flows between two countries in the global trading system.

According to Bergstrand and Egger (2013), the striking contrast between these two methods is the belief that decisions on output and consumption are "separated from decisions taken on bilateral trade. The unconditional general equilibrium theory attributed the inability to separate decisions on consumption and output from that of bilateral trade as a result of making the positions of technology and market structure more visible (Bergstrand & Egger, 2013).

The conditional general equilibrium approach assumes production and the decisions of the consumer to be specified, and hence, each country should specialize in the production of products that they are well endowed. The general equilibrium theory presumes that there is one good generated exogenously for each country. It recognized the lack of separability of output and consumption decisions from bilateral trade decisions by making the positions of technology and market structure more visible (Bergstrand & Egger, 2013).

The conditional general equilibrium gravity equation consists of two major calculations namely; versions 'conventional' and 'theory-based'. Based on Tinbergen (1962) and Anderson (1979), the conventional gravity formula to infer non-observable trade costs is of the form:

$$\mathrm{lnEX_{ij}} = \phi_1 y_i + \phi_2 y_j + \sum_{n=1}^{N} B_u \ln(G_{ij}^n) + \omega_{ij} \qquad (1)$$

Where $\mathrm{lnEX_{ij}}$ is the log of exports from country i to j, y_i and y_j are the log of GDP of the exporting and importing countries respectively, G_{ij}^n $(n = 1, \ldots. N)$ is a collection of observables associated with bilateral trade barriers and ω_{ij} is the random disturbance term. The basic postulation in deriving equation (1) was that prices across products are uniform, suggesting consistency in the cost of a trade. Bergstrand included prices in the equation due to the occurrence of asymmetric exchange costs (Bergstrand & Egger, 2013).

McCallum's (1995) Anderson and van Wincoop (2003) made a proposition of theoretical dynamism of equation (1) based on their findings. McCallum (1995) modified equation (1) to include two variables for the United States and provinces of Canada. After distance and size were controlled by McCallum (1995), trade between provinces within Canada was 22 times greater implying that there is a higher trade cost across the borders of the United States to Canada. McCallum (1995) found a significantly overestimated effect on bilateral trade costs which Anderson and van Wincoop (2003) attributed to the failure of the conventional gravity model to compensate for the effects of multilateral trade resistance on bilateral trade costs. Anderson and van Wincoop (2003) were subsequently driven to include theoretical modification of the standard gravity model to include multilateral trade resistance variables (the theory-based gravity model).

Different studies have used the gravity model to estimate the gravity equation in various ways as specified in equation (2) and (3) respectively:

$$EX_{ij} = \frac{GDP_i GDP_j}{GDP^W} * [\frac{TC_{ij}}{v_i * p_j}]^{1-\theta} \qquad (2)$$

$$TC_{ij} = \sum_{n=1}^{N} (G_{ij}^{n})^{\alpha\eta} + \omega_{ij} \qquad (3)$$

Where EX_{ij} is the nominal exports from country i to j, GDP_i and GDP_j are the GDP of the exporting and importing countries respectively, GDP^W is the nominal income for the world, TC_{ij} is the bilateral trade costs, $\propto$ is the elasticity of substitution among goods, v_i and p_j are outward and inward multilateral resistance variables respectively. G_{ij}^{n} $(n = 1, \ldots. N)$ is a collection of observables associated with bilateral trade barriers and θ is the elasticity of substitution among goods or between varieties.

The elasticity of substitution measures the degree to which products are differentiated to determine the relative effect of the cost of exchange on trade flows (Turkson, 2012). The higher the elasticity of substitution between products, the stronger trade barriers turn to influence trade flows and vice versa (Chaney, 2008, Turkson, 2012).

The elasticity of the substitution (Θ) value is very critical in determining the trade cost factor. In the work of Anderson and van Wincoop (2004), their findings indicate that Θ generally falls within the range of 5 to 10 (Novy, 2012).

Versions of conventional and theoretical gravity equations have been applied in many studies to calculate the different parts of global trade costs, in particular trade barrier costs and environmental costs. Studies have focused on the different components of trade costs by quantifying the overall cost of trade barriers using different versions of the theoretical gravity equation Kortum (2002).

Costs of trade barriers were classified under two main components by costs related to cross-border trading (also known as border-related barrier costs) and costs of natural trade friction. Costs associated with border trade barriers include non-tariff policies (customs unions and/or regional trade agreements), currency, contract compliance and information, interaction, and language barriers. Costs of natural trade friction relate to geographical friction such as distance, adjacency, time, and landlocked. In a country or region trading networks, procedures and logistics are also often included as border costs. The main distinction is that whereas the former relates to differences in policies, procedures, or structures between trading partners (hence border-related), the latter arise from natural characteristics (and may affect trading costs in a country equally) (Turkson, 2012).

The Recent Development of the Gravity Models-2003 Onwards

In literature, the gravity model of trade has gain more attention because of its assumption (Evenett & Venables, 2002; Haveman & Hummels, 2004). Based on the arguments raised by Helpman, Melitz, and Rubinstein (2008), neglecting non-trading nations, will lead to bias estimates. They added that the normal specifications of the gravity model give results that are inconsistent with data. Helpman et al. (2008) demonstrated an ingenuity of the biases that result from ignoring non-trading nations hence postulated a theory that considers both trading and non-trading countries and uses the theory to obtain estimation processes that contain information on trading and non-trading countries. Since then, their model has become one of the models for foreign trade in differentiated goods and heterogeneous businesses. .By introducing heterogeneity in productivity, they can disintegrate the effect of trade costs on trade flows into an intensive and extensive margin. The situation where the productivity of all firms in a country, say i, is lower than expected, would make exporting to say country j more beneficial than zero trade could be said to have occurred. Asymmetries between export volumes from i to j and from j to i are as results of differences in trade costs and strong heterogeneity. The equation below shows the gravity equation.

$$X_{ij} = \frac{GDP_i GDP_j}{GDP_w} * \left[\frac{t_{ij}}{p_i * p_j}\right]^{1-\sigma} * v_{ij} \qquad (4)$$

Where V_{ij} is a function of the ratio of exporters from a country i to j. Helpman et al. (2008) illustrate that bilateral volumes of trade are zero when no country/sector firm is sufficiently efficient to cover the fixed and variable export costs. Under these conditions $V_{ij} = 0$. It can be shown as a unique case, i.e. with homogenous firms, it can be shown that gravity equation (4) for Helpman et al. (2008) reduces to Anderson and Wincoop's gravity equation (2).

In summary, the research line referenced in this chapter shows that the new product differentiation-based trade theory should be perceived as a supplement to traditional methods rather than a replacement. The equation of gravity can emerge from a broad spectrum of standard and new theories of trade. However, there are differences in the assumptions and models, and such variations explain the different literature, specifications, and the variety of empirical outcomes (Martínez-Zarzoso & Nowak-Lehmann, 2003). Although, the emphasis is now on its empirical implementations are well rooted in its theoretical base and can be related to all of the accessible and applicable theoretical frameworks. Regardless of the theoretical structure taken, however, the majority of subsequent gravity equation justifications are versions of the one first obtained in Anderson (1979).

Theoretical Justification of the Gravity Model

The model has been criticized on the basis of its lack of theoretical foundations (Frankel et al., 1997). In the late 1970s, the gravity model was reanimated to stipulate theoretical explanations due to the increasing importance of the geographical factors of international trade Helpman and Krugman (1985, 1987), Deardorff (1995), and Anderson and van Wincoop (2003) are among the studies that have significantly explained the theoretical basis of the gravity model.

Anderson (1979) established theoretical reasons for the gravity equation after Armington's (1969) work. He used both the Cobb-Douglas and constant-elasticity-of-substitution (CES) preferences. Thus, a country will consume a good from another country depending on the price to import and export (Bacchetta & Van Wincoop, 2000). Anderson (1979) also represented trade costs as "iceberg" costs, where part of the goods shipped arrives at the destination, with the rest having transported in transit to reduce trade flows (Nutor, 2014).

Further explanations of gravity were made by Bergstrand (1985). However, Bergstrand (1985) further explained the gravity model by using the microeconomic basis of simple monopolistic competition models. A more versatile utility function was used and this indicates that imports were seen to be close substitutes for each of the domestic products. Based on this, his equation was referred to as the generalized gravity model (Frankel, Stein, & Wei, 1997; Rahman, 2009; Thai, 2006).

The works of Helpman (1987), Helpman and Krugman (1985) provide a theoretical rationale for the concept that bilateral trade depends on GDP. Once the population of the economy doubles, consumers also increase their usefulness, not in the form of greater quantities but more variety. By growing the potential for customers to become much more diverse, foreign trade can have the same impact (Bonuedi, 2013). Therefore, if two nations have comparable skills and preferences, they will trade more with one another to boost the number of consumer choices available**.** Frankel et al (1997) stated that this property does not have the classical H-O principle, as it does in the gravity model that bilateral trade depends on revenue products.

Deardorff (1995) emphasized that the simple gravity model could be developed from the hypothesis of Heckscher–Ohlin, Staffan Linder, and Helpman–Krugman. Heckscher–Ohlin model and other models focused explicitly on competitive advantage and perfect rivalry, indifferent consumers and producers hence the absence of all trade barriers in homogeneous goods. Deardorff studied two separate cases of HO-model equilibria, one with frictionless trade (literally zero barriers to trade) and the other without it, and showed that a gravity model would emerge from a conventional factor-proportions interpretation of trade preferences (Makochekanwa, Jordaan & Kemegue, 2012). (Makochekanwa, Jordaan & Kemegue, 2012). Deardorff defines each trade business as a selection of a worldwide product pool where producers place their products first and customers choose their products accordingly from this pool. The next situation which has to deal with the presence of the trade barrier assumed that every country produces only one product, therefore there are differentiated commodities with bilateral trade patterns in the HO model (Deardorff, 1998).

Theories including Helpman's theory fail to include distance and therefore cannot appropriately be called the basis of the complete gravity model (Frankel et al., 1997). But, some literature works on the theoretical basis of the gravity equation have brought to light relative and absolute distance issues related to trade between two countries (Sohn, 2005). In this respect, the feedback from Anderson and van Wincoop (2003) article was particularly important, demonstrating that the regulation of relative trade costs is essential for a well-specified gravity model. They argued that average trade between the two regions known as "multilateral resistance" continues to decline as a result of the trade barriers guiding their trading activities. If a nation has an average trade barrier that is relatively high, it will trade more with a nation with a small bilateral barrier. The logic is that ceteris paribus, two nations encircled by other big trading economies, will trade less among themselves than if they were bordered by oceans (Bacchetta & Wincoop, 2000). Anderson and van Wincoop argued that, depending on distance measurements, multilateral resistance can not be measured using distance variables since it does not capture boundary impacts, but rather that the gravity model must be resolved by considering the impact of barriers on prices (Bonuedi, 2013).

Empirical Literature Review

This section discussed the determinants of trade flow within the traditional gravity and the augmented gravity model. It also assessed the use of the stochastic frontier gravity model over the traditional gravity model. It finally reviewed the literature on the SFGM in the estimation of trade and logistics efficiency.

Determinants of trade within the Framework of Traditional Gravity Model and the Augmented Gravity Model

Globally, many empirical works have widely used the gravity model in examining the factors that influence trade and its patterns. This sub-section of the study is scoped at asserting a comprehensive examination of some literature on available studies and will serve as a guide in the selection of a suitable model and variables in this research work.

Tinbergen (1962) used data from 18 countries and the gravity model to determine the association, distance, and common border effects on the impact of global trade. Among the trade resistance measures, he added the geographical distance, common borders, and the British Commonwealth and Benelux membership dummies. His findings revealed that both income and distance had their expected signs and statistically influence trade. Tinbergen also found that the trade flow with the British Commonwealth (Benelux FTA) membership of a country and the distance between trading partners is 5% and 2% greater, respectively (Bonuedi, 2013).

Bergstrand (1985) augmented the gravity model to evaluate the factors that influence bilateral exports between 15 OECD countries in 1976. Besides the conventional variables of gravity suggested by Tinbergen, Bergstrand incorporated exchange rates, export, and import price indices, GDP deflators in both nations and dummies for adjacency, membership of the European Economic Community (EEC) and the European Free Trade Area (EFTA) in the augmented gravity equation. Bergstrand found that variables such as the index of import rates, the economic size of the countries concerned, the adjacency and membership of the EFTA had a positive impact on exports between the country and its trading partners, but that the geographical gap between the countries had a negative impact on the number of exports of the countries concerned.

Sohn (2005) conducted a study in Korea in order to assess the degree to which the gravity model matches Korea's bilateral trade flows and the various types of Korea's trade policy. Based on the outcomes of the regression, Korea’s bilateral trade patterns have been found to fit well with the basic gravity model and his findings revealed a positive and significant coefficient for the trade structure (TCI) of Korea. Based on these results, he concluded that inter-industry trade is prevalent in Korea’s international trade, as explained in the Heckscher-Ohlin model. Membership of APEC was also found to have a significant positive impact on the volume of trade in Korea. Sohn concluded that Korea has a huge untapped trade potential with Japan and China.

Márquez-Ramos (2007) used the augmented gravity model to determine the variables that affect the pattern and volume of bilateral trade flow in Ghana and South Africa. For the autor to efficiently handle sector heterogeneity, he estimated a gravity equation using disaggregated data to evaluate trade determinants of these countries. In addition to conventional gravity variables, other explanatory factors, such as the tariff rate and technological progress in the importing country and trade imbalances between trading partners, were included in Marques-Ramos' export model. He found that South Africa, which is a developed African nation, will significantly increase its exports to other African nations, while Ghana, which is a developing nation, exports more to nations of high economic freedom, such as the EU. It has also been proven that lowering transport costs has no important impact on African countries' exports. The findings reveal that the impact of multilateral liberalization on global trade is negative and substantial for South Africa, and exports from Ghana are not encouraged by regional integration (ECOWAS). In championing global trade, the income of importers was found to be important, but the tariff effect was found to differ between countries.

In the sense of the gravity model, Gani (2008) analyzed the determinants of Fiji's foreign trade. Gani's results from the panel showed that the population and infrastructure of Asian nations and the distance between their port and the exporting countries in Asia had a tremendous impact on Fiji's imports from its Asian trading partners. His research revealed that GDP is insignificant for both exporting and importing countries.

Eita (2008) has used an expanded version of the gravity model with panel data covering 39 countries from 1998 to 2006 in assessing the factors affecting Namibian exports. To capture the effect of such dummies on Namibia's export flows, the model was expanded to include dummy variables, such as the sharing of a common border with Namibia and belonging to the South African Development Commune (SADC) and the EU. The study indicated that both countries' rise in GDP leads to a significant rise in Namibian exports to their importers. Importers' per capita GDP was discovered to have an adverse impact on exports, while Namibia's real exchange rate and per capita GDP had no effect on exports. The distance was discovered to have a theoretically coherent adverse association with exports. It was found that SADC membership, EU membership, and sharing a common border with Namibia had a beneficial and substantial effect on Namibia's export promotion. The study showed that with the United Kingdom, Belgium, Kenya, Mauritius, the Netherlands, Australia, Portugal, South Africa, and Switzerland, Namibia has untapped export potential.

Similarly, Rahman (2009) also employed the augmented gravity model to analyze Australia's international trade flows with 57 trading partners utilizing data from 1972-2006. Variables such as the per capita GDP of Australia and its trading partners, the per capita GDP difference and its trading partners, language dummies, the Regional Trade Agreement (RTA), and the openness of its trading partners. Australia has the ability to trade with the United States, Canada, Japan, Mexico, Pakistan, Argentina, Brazil, Uruguay, Austria, New Zealand, Turkey, Chile, Hungary, India, Nepal, Kenya, Peru, Hong Kong, and South Africa, the findings revealed. Also, the study mentioned that bilateral trade in Australia is positively influenced by income, common language, free RTA, and partner's openness. Nevertheless, the distance between Australia and its trading partners and the GDP per capita differentials harmed Australia's bilateral trade.

To take a stab at Ethiopia's export determinants, Yishak (2009) adopted the gravity model using the Generalized Two Stages Least Squares (G2SLS) technique on the panel data from 1995 to 2007. The study divides Ethiopia's export output into internal supply-side contributions (macroeconomic climate, real exchange rate, efficiency, FDI, and external market access conditions (geographical distance, transport costs, tariffs, and non-tariff). Ethiopia's GDP and its importers, actual exchange rates, the environmental performance index, foreign direct investment (FDI), internal transport, the international trade policy index, and the geographical gap between Ethiopia and its destination for export are the variables incorporated in the model. However, the result showed that the export volume of Ethiopia was significantly influenced by an improvement in the GDP, infrastructure, and productive institutional efficiency of Ethiopia. There is no measurable impact on real exchange rates and FDI on their exports. The export volume of Ethiopia is also affected by geographical distance and import barriers from trading partners.

The augmented gravity model was again used by Roy and Rayhan (2011) to examine the primary determinants of the trade flow of Bangladesh. The study included Bangladesh and other 13 countries, which have a bilateral trade agreement with Bangladesh, including the South Asian Regional Cooperation Association (SAARC). The researchers used data spanning from 1991 to 2007 in their study. These researchers created both basic and extended gravity models based on their preliminary results. The variables used in the study included: the size of the economy of Bangladesh and that of its partners, the openness of the economy of the partner, and the exchange rate that significantly decided Bangladesh's trade flows and the findings revealed that members of SAARC and borders are factors that influence Bangladesh’s trade flows.

Reviewed Literature on Logistics and Trade

Bougheas et al (1999) were the first to incorporate infrastructure into the standard gravity model along with the original gravity model variables. The relationship between the infrastructure inventory and the sum of trade was analyzed after discovering that nothing has been said about the resource costs of infrastructure and the relationship between infrastructure and transport costs in the trade literature. As the gravity model only uses distance to model transport costs, its theoretical model shows that the availability of public infrastructure (road, port, and telecommunications networks) is also a function of distance, in addition to transport costs. By expanding the Dornbusch-Fisher-Samuelson (DSF, 1997) Ricardian trade model, the authors were able to validate their theoretical results using data from European countries. Behar and Manners (2008) used the new and systematic logistics efficiency measure to increase the gravity model to determine how logistics impact developed countries' bilateral exports. Their findings showed that logistics can have a huge effect on bilateral exports in both the exporting and partner countries. The authors concluded that improvement in the quality of the logistics of the exporter's deviation would increase exports by almost 60%. Behar and Manners also stated that the exports of landlocked countries rely on the logistics of their neighbors, but the quality of their logistics is not as important as that of other countries. In addition, they found that, but without removing them, logistics work to reduce the trade effects of distance.

The impact LPI has on trade using the gravity model was explored by Hoekman and Nicita (2010) and a positive relationship between logistics performancee and trade was found. Their findings also showed that the impact was quantitatively important: an average 15 percent improvement in the LPI score from a low-income country to a middle-income country.

A gravity equation was estimated by Turkson (2011), improving it with logistics and remoteness measures. Instead of the Poisson pseudo maximum probability, the study adopted the negative binomial pseudo maximum likelihood (NBPML) estimation to explain the unobserved variability between countries and zero trade flows. The results suggest that the aggregate Logistics Performance Index (LPI) of both exporters and importers have a significant influence on bilateral trade flows. The customs productivity, infrastructure, and timeliness coefficients, concerning the aggregate LPI group, suggested that the status of logistics indicators in developing countries (as importers) had a greater effect on trade flows than the status of logistics indicators in developed countries. With regard to individual logistics measures, the comfort and affordability of shipping and timeliness had the greatest and least effect, respectively, on bilateral exports. The findings generally show that logistics appears to have a greater influence on trade flows in developing countries than logistics in developed countries, indicating that increasing trade between developing countries is important for logistics.

Nutor (2014) also study the influence logistics performance has on the volume of bilateral trade for SSA countries using data spanning from 2007 to 2012 and augmented gravity model. The study's results suggest a positive effect of logistics performance on volumes of bilateral trade among countries in SSA over time.

About how logistics performance affects international trade, Gani (2017) relied on the 2014 LPI data to examine the overall logistics performance as well as disaggregated logistics. The empirical research involved estimating standard export and import equations that integrate logistics efficiency measures. The findings show that total logistics positively influenced exports and imports. The report also extends by discussing whether the specifics of the logistics are relevant to international trade. The results show that multiple dimensions of logistics production significantly and positively affect exports.

Takele (2017), analyzed the impact of LPI and the cost of exporting a TEU on exports from African countries in bilateral trade flows using data from LPI 2014. In augmenting the gravity model of foreign trade, he included the expense of exporting a TEU. The study revealed that Africa has the lowest LPI scores compared to the region's trading partners, especially in terms of trade and transport infrastructure efficiency, and customs and border clearance. Africa is also one of the regions for a TEU with the highest cost of export/import. He further concluded that reducing export costs would optimize trade benefits for African countries, as well as improving any of the LPI components (customs clearance, development of infrastructure, foreign shipments, quality of competence and logistics service, tracking and tracing as well as timeliness) could lead to significant export growth for African countries. This study is in line with Hausman, Lee, and Subramanian's analysis (2012). They argued that a major determinant of the total cost of landings may be the performance of logistics between the two countries.

Based on the literature reviewed it is clear that all the studies mentioned above used the traditional or conventional gravity model which has been criticized by Anderson (1979) for its lack of theoretical foundations. Miankhel et al. (2009) also criticized this methodology for its inability to control the multilateral resistance in trade, which leads to inconsistent results. The traditional gravity model uses the OLS estimation, which gives estimates of the placed values of the data set but for the true potential of trade to be felt, then the estimated values must be the upper values of the data set, the SFGM makes it possible to measure potential trade because it uses the maximum likelihood estimation technique. Also, the studies stated above focused on logistics and total trade. But when considering factors that affect trade especially when looking at logistics effect on a trade then, it should be on disaggregated trade rather than total trade. This will aid in knowing which of the logistics indicator is most crucial for the smooth flow of any of the disaggregated trade products. This means that depending on the type of disaggregated trade commodity a country is involved in trading, much attention will be given to the improvement in the appropriate logistics measure that will help trade in that product reach its full potential. Again, previous studies used LPI data from the initial rounds of the LPI. Data on LPI is published every two years since its introduction in 2007 and therefore any changes or improvement in the logistics components of the selected countries will be seen in the current rounds of the LPI rather than the initial rounds. It is then very necessary to use current data when estimating the impacts of logistics on trade to prevent inefficient or biased results. This current fills these stated gaps by using the advanced methodology (SFGM) which stands to correct all the shortcomings of the traditional gravity model. Again, this current study is focused on disaggregated trade rather than aggregated trade and this current study will use data on all the various rounds of LPI available (i.e. 2007-2018).

The use of the Stochastic Frontier Gravity Model (SFGM) in the Estimation of trade Potential

A relatively new advanced gravitational strategy used to calculate trade potential is the Stochastic Frontier Gravity Model (SFGM). This approach is heavily based on (Aigner, Lovell & Schmidt, 1977; Meeusen & Van den Broeck, 1977) Stochastic Frontier Production Framework. The weakness of the traditional model to sufficiently control trade resistance is one of the major reasons for the search for an enhanced gravity methodology in the computation of trade potential. The distance and categorical variables, such as a common language and adjacency to control trade resistance factors in traditional gravity equations, do not sufficiently control trade resistance, as most of them are not observed. Put differently, the known variables in the traditional gravity equation for trading resistance control do not control what Anderson (1979) calls “economic distance”. This notion of “economic distance” is linked to the variables of multilateral trade resistance that Anderson's gravitational modeling (1979) formally introduced and popularized by Anderson and van Wincoop (2003).

Via multilateral trade resistance, Anderson and van Wincoop (2003) proposed that trade flows between countries depend not only on trade resistance between them but also on trade resistance between the countries and all their separate trading partners. For example, the trade volume between Ghana and Nigeria depends not only on the trade resistance (economic distance) between Ghana and Nigeria but also on each country’s trade resistance with all its various trading partners. If, as a result of a successful bilateral trade agreement, trade resistance between Ghana and Nigeria or any of its trading partners other than the USA is reduced, Ghana's multilateral resistance will be reduced, which will facilitate trade between Ghana and Nigeria and reduce trade between the USA and Ghana. The multilateral resistance factor exposes a substitutability element in international trade (Starck, 2012). This resistance term has attained such affirmation in the literature of trade. Failure to monitor these multilateral resistance terms in any gravity model calculation leads to the commitment of a gold medal error in the gravity estimate, (Baldwin &Taglioni, 2006).

The word multilateral resistance is mainly unnoticeable and difficult to assess, according to Miankhel et al. (2009). Inability to control "economic distance" properly and by extension, of multilateral gravity estimation resistance results in inconsistent and inefficient parameters. According to the writers, in the traditional gravity model estimated with OLS, wrongful control or omission leads to a violation of the normality assumption of the error term and generates heteroscedasticity in the often-unknown error term. In a linear log form, the traditional gravity model is estimated and log-linearization in the presence of heteroscedasticity generates inconsistent estimates, according to Silva and Tenreyro (2006). "The reason is that a random variable's anticipated logarithm value depends completely on its distribution at moments of greater order".

Many methods were created and implemented in the literature to regulate the estimation of the gravity of multilateral resistance terms. Multilateral trade resistance factors were addressed in terms of observed trade price determinants by Anderson and van Wincoop (2003) a tailored non-linear least square estimator was used to obtain coherent parameter estimates. With their strategy, the primary downside is that it is very complex (Baier &

Bergstrand, 2009). It also contributes to reduced inefficiency. Multilateral resistance with country-specific fixed effects are less taxable and often used technique (Feenstra, 2015). This method produces consistent estimates of parameters, but the partial impacts of many potentially useful explanatory variables cannot be estimated immediately due to their ideal collinearity with country-specific effects (Baier & Bergstrand, 2009). Kalirajan (2008) also argued that the fixed effects strategy is not based on economic theory.

Pioneers of the Stochastic Frontier Gravity Model hypothesized that SFGM sufficiently controls the multilateral terms of trade resistance. The obvious reason for this is that SFGM enables the direct estimation of the degree of relevance of non-observable trade barriers that prevent trade flows between a pair of countries from reaching their borders given trade determinants (Kalirajan, 2008; Miankhel et al., 2009; Ravishankar & Stack, 2014). However, Armstrong (2007) points out that a faith element is involved in the assumption that the term "non-negative disturbance" that unobservable trade controls are an impediment. The use of the SFGM approach to estimate trade potential is much more in line with the trade potential theory (Kalirajan, 2008; Ravishankar & Stack, 2014; Bhattacharya & Das, 2014). It is developed in the estimation of trade potential as an alternative and improved technique to the traditional gravity technique since it is in line with the theory of trade potential. The conventional gravity method predicts the potential for trade using the average effect of the trade determinants to measure the potential for trade.

However, according to theory, considering the determinants of trade and the least resistance to trade, the highest possible amount of trade flow is anticipated. This requires estimating the data set's upper boundaries representing the most liberalized economies that the traditional OLS gravity technique lacks. The techniques of maximum likelihood are used to estimate SFGM as they enable estimation of the upper information limits (Kalirajan et al., 2009). Therefore, the theory of trade potential is more compatible with empirical estimation.

The following advantages in the use of the SFGM in estimating trade potential were recognized by (Kalirajan, 2008; Kalirajan et al., 2009). First, the use of SFGM is not affected by efficiency losses. The combined impacts of the word "economic distance" ('behind the border' variables) can also be estimated, which results in heteroscedasticity and non-normality, and isolates it from the term of statistical error. The investigator can effectively evaluate the bias term factors. The SFGM again offers trade estimates close to free trade estimates as it represents the highest information volumes from those countries with the most liberalized trade constraints. Finally, it has important trade consequences and theoretical consequences. In other words, it offers theoretical and policy suggestions on how to support socio-political-institutional free trade considerations (Bhattacharya & Das, 2014). Although SFGM is not so prevalent in the empirical literature, it has been used in several types of research to calculate the trade potential of nations. Kang and Fratianni (2006) used the SFGM strategy to assess trade efficiencies for several nations, ten geographic areas, and eleven regional trade agreements. Their trade efficiency estimates for the nations were extremely small. They asserted that "the use of stochastic frontier estimates is justified when the equation of trade gravity is considered as the consequence of cost decrease'.

To match the trade performance of East Asia with South Asia, Armstrong et al. (2008) estimated a global export frontier. Their findings indicated that East Asia has outperformed South Asia and the remainder of the globe in terms of trade opportunities. Their results disclosed the enormous untapped trade potential of South Asian nations.

In order to determine Australia's trade potential with 65 of its trading partners for the period 2007-2008, Kalirajan et al. (2009) used the stochastic frontier gravity model. Instead of aggregate trade flows, their study used various product classifications. Their results indicated that the non-negative parameter disturbance term estimates, which show the importance of “behind the border” variables in stopping trade flows from achieving their actual potential levels, are statistically significant for all product groups except one. They asserted that considering the statistical significance of this error term, the traditional gravity model would have generated inconsistent estimates of parameters due to its lack of control over non-observable trade barriers. Their evaluation of different Australian product groups’ trade potential with particular nations and areas showed distinctions in ratio to real trade flows. As a consequence of its results, Australia is mainly far from attaining its trade potential with distinct nations and regions.

The Stochastic frontier gravity model was also adopted by Ravishankar and Stack (2014) to calculate trade efficiency scores for ten Eastern European countries (new European Union members) with seventeen Western European countries. Ravishankar and Stack (2014) estimated the model of importing nations with 10 new members from Eastern Europe using the export flows of the 17 existing members of the European Union. Panel estimation approach of

1994- 2007 was used by the authors. Their research showed high-efficiency scores, indicating a high degree of trade inclusion over the period under research between the ten Eastern European nations and their Western European trading associates.

Bhattacharya and Das (2014) used the SFGM to study the potential and level of trade effectiveness among country pairs of six South Asian Association for Regional Cooperation (SAARC) countries. The writers used panel information from 1995-2008 in each of the six nations to estimate the stochastic gravity equation. For the period 1995-2000 and 2001-2008, they calculated trade efficiency levels between nations. Their estimates showed that Pakistan had the greatest amount of trade efficiency with other participants between 1995 and 2000 and that Sri Lanka was strongly followed. Bhutan was the nation with the smallest efficiency in the same era as other members. Bhattacharya and Das (2014) concluded that India's work with other nations has been comparatively poor in exploiting its trade potential.

To determine the extent to which trade arrangements will help India minimize its balance of trade deficit with the counterpart country, China, Kalirajan, and Paudel (2015) applied the SFGM framework to undertake a counterfactual analysis of India's free trade agreement or preferential trade arrangement with China. The authors designed Panel data to cover export data from 1995 to 2010 per the stochastic gravity equation for China and as well as India. Kalirajan and Paudel did find that 68 percent of Indian export potential with China has been exploited with the present tariff systems and exchange rate, while 86 percent of China's export potential with India has been achieved. They carried out a simulative hypothetical decrease of 50% in the simple average tariff, which amounted to about 7.7% for China and 11.5% for India in 2010. The counter-factual free trade assessment between India and China disclosed a 20% increase in India's export potential to China, while China will assist to boost India's export potential by 28%. Given their simulation exercise outcomes, they advised that India must first achieve its export potential with China by reducing its “behind the border” trade-resistant factors before trying either to establish a trade agreement with China.

An assessment of Pakistan's trade potential was carried out by Gul (2011) within the stochastic frontier gravity framework and panel data for the period 1981-2005 was used. The model-acquired coefficients are then used to forecast the country's trade capacity internationally as well as within national trading blocs. Their results showed that Pakistan has the highest trade potential with the Asia-Pacific (ASEAN), the European Union (EU), the Middle East, Latin America, and North America (ASEAN) countries. In particular, Japan, Sri Lanka, Bangladesh, Malaysia, the Philippines, New Zealand, Norway, Sweden, Italy, and Denmark have the greatest potential, suggesting that Pakistan should explore ways and means to further expand its trade ties with the countries concerned, and should focus on ASEAN, the Middle East, and the EU, with a view to increasing their market share to the greatest extent possible. Despite the existence of significant potential, they noticed that the amount of trade between Pakistan and other members of the South Asian Association for Regional Cooperation (SAARC) and Economic Cooperation Organization (ECO) is very poor. The primary barriers according to Gul (2011), are the political and cultural tensions between neighboring nations, especially between Pakistan and India, which are SAARC's key partners.

Another study within the SFGM framework was conducted by Deluna Jr and Cruz (2013) to assess Philippine export efficiency and potential. Based on the trading partner's features, the writers looked at export efficiency and potential. They used the Stochastic Frontier Gravity Model, which measures potential from the limit, as opposed to the normal gravity model calculation and OLS which measuring potential from the mean. Results from their research indicate that the Philippine export flows of goods are significantly influenced by income, the size of the market, and the distance between the Philippine and trading partners. Technical usefulness ranged from 38% to 42% for all nations, according to their results. Countries with larger markets showed elevated export potential, with potential ranging from $10 billion to $30 billion, such as the USA, China, and Japan. The findings of the technical inefficiency model in their estimation showed that the membership of the Philippines in ASEAN, APEC, and WTO improved Philippine export potential. Also, reducing corruption and the free labor market in the importing nation and commonality of language enhanced Philippine export potentials.

Following the theoretical orientation of production function, Ebaidalla and Mustafa (2018) used the Stochastic Frontier Gravity Model (SFGM) to explore intra-Arab trade efficiency and potential over the period 1998-2015. These researchers focused primarily on exploring the presence of restrictions on trade flows between Arab countries, in particular, behind and beyond border restrictions. Their study showed that the constraints of 'behind the border' were responsible for a substantial difference between Arab countries' potential and real trade. Their findings again revealed that the impact on trade flows among the Arab countries of 'behind the border' constraints has decreased over time. In addition, Ebaidalla and Mustafa disclosed that intra-Arab trade efficiency scores indicate a relatively limited degree of trade inclusion between Arab countries, confirming the existence of rigidities both 'behind the border' and 'beyond the border' toward intra-Arab trade.

Using panel data to analyze the key factors and weaknesses of the export sector of Bangladesh and its ability to enhance its trading role with its top 40 trading partners, Hassan (2017) introduced a stochastic frontier gravity model approach. Research by Hassan revealed that gross national product (GDP), population, distance, average tariffs, trade arrangements, and exchange rates were the primary determinants of export volume for Bangladesh. However, it has been found that tariff rates and distances between Bangladesh and its partner nations have a negative effect on trade. The study also reveals social-political-institutional constraints such as customs procedures, port inefficiencies, and bribery limit trade behind the border. Hassan discovered that there are substantial variations in export prices, even within countries within the same trade blocks, which means that a high degree of untapped export potential can be discovered by eliminating behind-the-board constraints and assimilating them more efficiently to the global market.

Conclusion

From the analysis in this segment, it was noted that the stochastic frontier gravity model has many benefits in estimating trade efficiency over the traditional gravity model because of its capacity to adequately control multilateral terms of trade resistance and also because it is not influenced by losses inefficiency. The SFGM enables the direct estimation of non-observable trade barriers that prevent trade flows between a pair of countries from reaching their frontier given the determinants of trade (Kalirajan, 2008; Kalirajan et al., 2009; Ravishankar & Stack, 2014). There was also evidence from the literature reviewed that the studies that used the traditional gravity model adopted the ordinary least squares (OLS), which measure trade potential from the mean, but potential trade should be the maximum level of trade possible. But the SFGM adopts the MLE to estimate trade potential from the frontier.

CHAPTER FOUR

RESEARCH METHODS

Introduction

This chapter presents information on the methods adopted to achieve the objectives of this study. It began with the research design of the study and gave a summary of the weaknesses of the traditional gravity model and the linear panel Fixed and Random Effect model in the estimation of trade potential. Again, it offered a description of the Stochastic Frontier Gravity Model's theoretical foundations as well as its strength. This chapter also discussed the models that were estimated, justified, and measured the variables which included the source of data, estimation technique, and post- estimation tests.

Research Design

For the stated objectives of the study to be achieved, the study employed the positivist research philosophy and used the quantitative research approach. The quantitative research approach is preferred to the qualitative research approach for this study because; it allows the researcher to maximize objectivity, generalize the results, and replicate other researchers' findings, making the data of the study more trustworthy and less open to contention. The findings of a quantitative analysis approach often provide an example of the effective use of statistical tests and, as a consequence, the interpretation of data and the presentation of results are very simple and less prone to error and subjectivity. Again, the quantitative research approach appears to be either descriptive when the subject is measured once in nature or experimental when the subject is measured before and after treatment. All these are some advantages of the quantitative research approach which the qualitative research approach falls short of but, this study attempts to analyze, the effect of trade logistics on disaggregated trade among some selected SSA countries and is descriptive in nature since it is measured once. Therefore, the quantitative research approach is more appropriate for this study than the qualitative design. This implies that variables relevant to the stated objectives of the study are valid and accurately presented.

Theoretical Model Specification

This presents a summary of the limitations and strength of the linear panel's standard gravity model, fixed and random effect models, followed by the strength of the stochastic frontier model, the theoretical formulation, and empirical specification of the stochastic frontier gravity model. It also discussed the source of data and research estimation techniques.

Weaknesses of the Traditional Gravity Model Linear Panel Fixed and Random Effect Models

Although the standard gravity model, as well as the linear panel Fixed and Random Effect models, have been used by many empirical studies to achieve fruitful estimates of trade flows, the model has been criticized because of its lack of theoretical underpinnings (Frankel et. al, 1997:53).

Fixed and random effects are estimation techniques employed when using a panel data estimation but, the selection of any of these techniques is contingent on the assumptions that underline each of these techniques. For instance, the random effect assumes the explanatory variables do not correlate with the unobserved heterogeneity (individual effects), on the other hand, the fixed-effect model suggests that the unrecognized heterogeneity is associated with the error term. When a zero correlation hypothesis is accepted, it implies that the effect is efficient at random. This is to say that both effects are consistent, however, the random effect is more consistent than the fixed yet, the fixed effect is consistent with a condition where the null hypothesis is rejected hence the random effect becomes inconsistent. The drawback of the fixed effect model is that it makes the dummy variables invariant, such as common border, geographical distance, common language, among others. Thus estimates that use the fixed-effect model drops all invariant variables (dummies variables) from the model, this may omit some variables that have a theoretical basis and are of relevance to the gravity model. Eager (2002) asserted that the random effect model also has a high frequency of altering estimates inconsistent. He related this inconsistency to the unlikelihood between the independent variables and the unnoticed consequence of the orthogonality presumption that occurs.

The practice of log linearization and estimation of the gravity model with Ordinary Least Squared (OLS) to be out of line was challenged by Santos Silva and Tenreyo (2006). This is because the predicted value of the term for the linearized error depends on the covariates for the regression and this affects the properties of the term for the error. Hence the use of the OLS as an estimation technique for the standard gravity model is inconsistent, although the observations of the dependent variables are positive. Also, Santos Silva and Tenreyo (2006) argued that the linear transformation of the gravity equation which results in inconsistent and biased estimates is intrinsic to the OLS results obtained from estimating the standard gravity model and on the heteroscedasticity problem following the OLS estimation. They contend that bilateral trade flows have frequent zero values and that, in the presence of these zero values, estimating a linear gravity model results in theoretical and methodological problems, especially where many zero values occur. Subsequently, predicting a linear regression in the data with zero trade flows implies that such observations must be either dropped or substituted by an arbitrary positive value, which may result in selection bias or loss of knowledge. The remedy suggested in the empirical literature to solve this zero trading flow record is the use of the censoring or truncation method before the linear estimation techniques are applied. The truncation method drops the value of zero while the censoring method chooses an arbitrary positive value instead of zero. Nonetheless, these methods have no theoretical and empirical support. Consequently, this may impact the results leading to inaccurate estimates (Flowerdew & Aitkin, 1982; Eichengreen & Irwin, 1998; Linders & De Groot, 2006).

One of the most intrinsic flaws of the traditional gravity model in the estimation of trade potential is that it cannot control trade resistance sufficiently (Kalirajan et al., 2009). According to these authors, the motive of including categorical and distance variables such as adjacency and common language in the traditional gravity equation is to better control trade resistance factors, but the standard gravity model does not control trade resistance sufficiently because most of them cannot be observed. Kalirajan et al (2009) argued that, if you fail to properly control for economic distance in the gravity equation, it will lead to the estimates of inconsistent and inefficient parameters. This is because erroneous control of the factors of trade resistance leads to a violation of the normality of the error term, which causes heteroscedasticity in the error term (Santos Silva & Tenreyro, 2006).

Strengths of the Stochastic Frontier Gravity Model over the Traditional Gravity Model

The SFGM approach is an improvement over traditional gravity and linear panel models of Fixed Effect and Random Effect. A key strength of the SFGM over the TGM is its ability to decompose the error term into two parts, in particular, the non-negative error term that reflects the inefficiencies behind the border that limit trade from achieving its potential, and the random error term that captures all other disruptions, like 'beyond the border.'However, the fixed and random effect linear panel models and the traditional gravity models only capture the random error term. The traditional gravity model cannot capture the term of non-negative error that represents the inefficiency.

The Stochastic Frontier Gravity Model (SFGM) is believed to control for the multilateral trade resistance factors properly (Kalirajan, 2008; Kalirajan et al., 2009; Ravishankar and Stack, 2014). They argue that, given the determinants of trade, the SFGM allows the direct estimation of non-observable trade barriers which prevent the trade flow between a pair of countries from reaching its maximum trade potential. In estimating trade potential, the use of SFGM is more consistent with the theory of trade potential as suggested by Kalirajan (2008), Ravishankar and Stack (2014), Bhattacharya and Das (2014). This informed its development as an alternative and improved method to the traditional gravity approach and the fixed and random effect linear panel method. The traditional method of gravity estimates the trade potential using the average effect of the determinants. However, according to theory, the potential of trade must be the maximum level of trade flow given both the determinants and the least trade resistance. To do so, it is important to estimate the upper limits of the set of data. The SFGM makes it possible to estimate the upper limit of the data by using the maximum likelihood estimation, which makes the theory of trade potential more consistent with empirical estimation. The traditional gravity model, on the other hand, uses OLS to estimate the data which is a central limit and is inconsistent with empirical estimates.

Theoretical Foundations of the Stochastic Frontier Gravity Model

The Stochastic Frontier Production Function (SFPF), which was independently developed by Aigner et al. (1977), and Meeusen and Van den Broeck, is one of the most important methodologies widely used in productivity and efficiency literature (1977). The SFPF can be referred to as the highest output attained from a given point of input and technology to a structural part of the production function and a decomposed disturbance term. The Stochastic Frontier Gravity Model combines both the conventional or standard Gravity Model and the Stochastic Frontier Production Function Model originally attributed to Kalirajan (2000) to address the weaknesses imposed by the conventional gravity trade model and to estimate potential trade flows between countries. This can be written as;

$$k_{it} = f(\alpha_{it}; \pi) + v_{it} - u_{it\,,\, i=1,2,\ldots\ldots,n.;t=1,\ldots\ldots,T_i} \quad (5)$$

Where k_{it} represents the logarithm of the output of firm i at time t, α_{it} is vector logarithm of inputs of firm i at time t, π is a vector of unknown parameters, $f(.)$ is a known production frontier function (e.g., Cobb-Douglas or Translog), v_{it} is a two-sided symmetric random disturbance representing factors that are beyond the firm's control such as weather, topography, machine performance, etc. $u_{it} \geq 0$, is a one-sided disturbance representing technical inefficiency.

It is assumed that $v_{it} \sim i.i.d\ N(0, \sigma_v{}^2)$, $u_{it} \sim i.i.d\ N^+(0, \sigma_u{}^2)$, where N^+ (...) denotes a half-normal distribution. Finally, it is assumed that v_{it} and u_{it} are independent and both errors are independent of x_{it}. The zero value of u_{it} indicates that the firm is fully efficient (no production inefficiencies). On the other hand, any positive value of u_{it} indicates that the firm is operating below the frontier, implying that there exists productive inefficiency within the production process of the firm.

The Gravity Model is amongst the vibrant frameworks that have cross out in the empirical work of international economics. The model of gravity is based on the Newtonian Universal Law of Gravity, which states that the force of gravity between objects is proportional to the mass of objects and is inversely connected to the square distance between objects (Newton, 1687). Tinbergen (1962) introduced the TGM to empirical economic literature. His model predicted that the amount of trade flows between a pair of nations is proportionally related to the two countries' scales, which are primarily represented by the two countries' gross national products and vice versa by the geographical distance between the two nations, which is a proxy primarily for the transport costs of the goods.

The stochastic frontier gravity model (SFGM) has become an improved alternative framework for the assessment of trade potential. In general, the SFGM version of the TGM is based primarily on the stochastic frontier production model (SFPM) concept in equation (6) and can be stated as:

$$X_{ijt} = f(px_{ijt}; N) + v_{ijt} - u_{ijt}, \qquad (6)$$

Where X_{ijt} represent actual export from country i to country j at time t, $f(px_{ijt}; N)$ is a function of a vector, px_{ijt}, are the determinants of potential export of country i to j at time t, N is a vector of unknown parameters, v_{ijt} is a two-sided error term capturing the impact of other determinants of export flows, including statistical errors and implied beyond border limitations not controlled by the reporting nation, and u_{ijt} is a one-sided error term that represents country-specific factors of the exporting country at time t that constrain its exports from reaching the potential level given the determinants of its export (behind the border factors or inefficiency elements). The one-sided error term also identifies the degree to which actual export levels deviate from the potential export levels. These deviations from the potential export level can be a result of bilateral, multilateral, and socio-political-institutional factors. If this error term assumes a value of zero, it means that factors "behind the border" are insignificant and that actual exports are the same as potential exports provided that there are no statistical errors. If a value other than zero is taken, it implies that country-specific variables are crucial and that actual exports are restricted from achieving the potential level.

Empirical Model Specification

This study fell on the stochastic frontier gravity model as proposed by Armstrong (2007). The model specification put forth by Armstrong comprises of two phases of estimation. The first stage includes a trade frontier estimate. The second stage includes estimating the determinants in the unilateral error term explaining the variation. Armstrong (2007) asserted that gross domestic products (GDPs), relative distance ($dist_{ij}$), border effects, and other determinants such as Language are the basic elements for the estimation of the trading frontier. Trade resistances among country i and j is specified in equation (7) as follows.

$$RE_{ij} = f(dist_{ij}, \text{ other factors}) \quad (7)$$

According to Armstrong (2007), natural resistances are barriers to trade that are not policy-oriented whereas man-made trade barriers are instituted for policy. By including both the natural and manmade resistances, equation 7 can be extended and rewritten as;

$$RE_{ij} = f(\text{trade resist}_{ij}) = g(\text{natural}_{ij})h(\text{manmade}_{ij}) \quad (8)$$

Equation (8) is further decomposed into man-made and natural resistances in equations (9) and (10), respectively.

$$g(\text{natural}_{ij}) = RDist_{ij}^{\varphi_1} \exp(\text{border}_{ij}^{\varphi_2} + +\text{lang}_{ij}^{\varphi_4} \dots) \quad (9)$$

$$h(\text{Manmade}_{ij}) = q(TA_{ij}, \text{pol dist}_{ij} \text{ regional blocs, institutions}, \dots) \quad (10)$$

Where $RDist_{ij}$ is the relative distance between country i and j, $border_{ij}$ is a dummy variable that takes the value of one if i and j share a common border or zero if otherwise, landlocked is a dummy with value one if the country is landlocked and zero if otherwise, $lang_{ij}$ is a dummy variable that takes if i and j share a similar language. TA_{ij} is a dummy variable that represents a trade agreement between i and j, pol $dist_{ij}$ is a measure of the political distance or proximity between i and j, regional blocs is a dummy variable for regional trading groups, tariff represents various tariff measures and institutions capture institutional settings.

Taking the log of equation (8) yields

$$\ln RE_{ij} = \ln g(\text{natural}) + h(\text{manmade}) \quad (11)$$

Equation (11) captures all the trade resistances between country i and country j Which generally specified by Armstrong as stated in equation 12.

$$\ln T_{ijt} = B_0 + B_1 \ln Y_{it} + B_2 \ln Y_{jt} + B_3 \ln b(\text{natural}) + \Sigma_m B_m \ln \phi_m + V_{ij} - U_{ij}$$

(12)

Where T_{ijt} is the value of the trade flow from country i to country j at time t, $y_{it}(y_{jt})$, represent the national incomes (GDPs) for i and j at time t respectively, ϕ'^{s} are the other determinants of trade and v_{ijt} is the conventional double-sided error term and u_{ij} is the one-sided error term.

Measurement of Disaggregated Trade

Following Armstrong's (2007) methodology, the stochastic frontier gravity model in equation (12) can be formulated to examine the effects of logistics on disaggregated trade flows in SSA as follows;

$$\text{Log}\,(DT_{\omega ijt}) = B_0 + B_1 \text{Log}(D_{ijt}) + B\text{Log}(Y_{ijt}) + B\text{Log}(P_{ijt}) + B_4(LPI_{ijt}) + B_5 \text{comcol} + B_6 \text{comlang} + B_7 \text{combor} + B_9 \text{landlocked} + B_9(FDI_{ijt}) + B_{10}(INTR_{ijt}) + B_{11}(EXHR_{ijt}) + B_{12}(INFR_{ijt}) - U_{ij} + V_{ij} \quad (13)$$

$$\text{Log}\,(DT_{\omega ijt}) = B_0 + B_1 \text{Log}(D_{ijt}) + B_2 \text{Log}(Y_{ijt}) + B_3 \text{Log}(P_{ijt}) + B_4(LPI_{mijt}) + B_5 \text{comcol} + B_6 \text{comlang} + B_7 \text{combor} + B_9 \text{landlocked} + B_9(FDI_{ijt}) + B_{10}(INTR_{ijt}) + B_{11}(EXHR_{ijt}) + B_{12}(INFR_{ijt}) - U_{ij} + V_{ij}$$

(14)

Where: (LPI_{ijt}) is the aggregated logistics performance index for the countries in year t. (LPI_{mijt}) represents the disaggregated logistics performance index for the countries in year t. It consists of six indicators (namely; customs, infrastructure, timelines, tracking and tracing, quality and competency, international shipment). Log $(DT_{\omega ijt})$ is the logarithm of disaggregated trade flows for the countries in year t, (it is subdivided into three components they are; Agricultural, forestry and fishery commodities, Mineral Commodities, and

Manufactured Commodities). $Log(Y_{ijt})$ is the logarithm of the value of the gross domestic product for the countries at time t. $Log(P_{ijt})$, is the logarithm of the total population for the countries. $Log(D_{ijt})$, represents the logarithm of the absolute distance between selected countries. (FDI_{ijt}), $(INTR_{ijt})$, $(EXHR_{ijt})$, $(INFR_{ijt})$ indicate the foreign direct investment, interest rate, exchange rate, and inflation rate for the countries. $Landlocked_{ijt}$ is a dummy variable that takes 1 if the country, i, or j is landlocked and 0 if otherwise. $Comcol_{ijt}$; is a dummy variable that takes 1 if the countries i and j were ever in a colonial relationship and 0 if otherwise. $Combor_{ijt}$; is a dummy variable that takes 1 if the countries i and j have a common border and 0 if otherwise. $Comlan_{ijt}$; is also a dummy variable which takes 1 if the countries i and j have a common language and 0 if otherwise). u_{ij} is a single-sided error for the combined effects of inherent economic distance bias or "behind the border", constraints, which is specific to the exporting country concerning the particular importing country and, v_{ij} is the conventional error term that controls, statistical errors, and omitted variables.

Measurement and Justification of Variables Inclusion

In the quest to analyze how logistics affect disaggregated trade among selected SSA countries, the study utilized annual data over the period 2007 to 2018. The variables include; disaggregated trade flows among SSA countries $(DT_{\omega ijt})$, Gross Domestic Product for the countries (Y_{ijt}), the population for the countries (P_{ijt}), the distance between the countries (D_{ijt}), landlocked of the countries $(landlocked_{ij})$. The common colony of the countries $(Comcol_{ij})$. The common border of the selected countries ($Combor_{ij}$). The common language of the countries ($Comlan_{ij}$).

Dependent Variables

Disaggregated Trade flows ($DT_{\omega ijt}$)

This is measured by the total value of import and export for the countries based on the Standard Industrial Classification of products (Agriculture, Forestry, and Fishery Products (code (0)), Mineral Products (code (1)), and Manufactured Products (code (2)). In other words, the disaggregated trade flow consists of the total imports and exports of each product traded among the selected SSA countries only.

Independent Variables

The main independent variable of interest in the frontier equation is the Logistics and its indicators. With that said, there are other variables of interest the study will control for like population, the distance between the selected SSA countries, landlocked, the colonial history**,** common language, and the border for the countries among others.

Logistics and its Components

This study used a logistics measure published by the World Bank in 2007 for 150 countries. By measuring logistical barriers to trade, the LPI offers a picture of the supply chain output of countries on six metrics considered to have a direct impact on the amount of trade. These indicators are customs, infrastructure, international shipment, logistics quality and competency, tracking and tracing, and timelines. The aggregated logistics is the primary measure of logistics, measured on a scale of 1(low) to 5(high) as well as all the indicators in the logistics. Aggregated logistics is expected to have a positive sign since improved logistics enhances trade. Thus $B_4 > 0$. The measure of aggregated logistics is the weighted average of the country scores covering the six indicators of logistics.

Customs

It measures the effectiveness and the performance of the timeliness of customs operations (speed, simplicity, and predictability of customs agencies). All of these are arranged through administrative objectives that permit the existence of legislation on international trade to be put in practice as well as taxes on imports or exports of goods and services to be collected. The expected sign of customs is positive because any improvement in the delays and simplicity of the customs services will enhance trade since the more the delay caused, the higher cost incurred by trading parties. Thus $B_4 customs>0$

Infrastructure

It measures the quality of a country's transport and telecommunications. This explains the steps involve in transferring goods from one country to its final destination without the control of any external factors. It is relevant however to measure how institutions contend with available facilities whether it is an advantage or a hindrance to trade competitiveness. In line with the theories and empirical works reviewed, we, therefore, hypothesized that the relationship between Infrastructure and trade would be positive.

International shipment

International shipment represents the easiness shipment can be arranged at a competitive price. The ease at which countries can arrange for shipments at competitive prices will improve trade among trading parties. Hence, international shipment is expected to have a positive sign. There are several factors such as availability of possible alternatives, volume, and weight of cargoes, the value of goods, perishability, urgency, and risk that constitute international shippers for cross-border trade (Takele, 2017).

Logistics quality and competency

This represents the position, adequacy, and quality of logistic service of the customer and how the relationship between customers and organizations can be achieved. How competent and quality a country is in terms of its logistics makes it very competitive and increases its trade. Therefore logistics quality and competency are excepted to improve trade. Thus B_4*logistics quality and competency >0.*

Tracking and tracing

It tracks shipment and tracing. The precise location and the path of each consignment before it is shipped to the final customer must be identified. If countries can track and trace their shipped goods till it gets to the final destination, then they will trade more among themselves which will increase their trade. Therefore the prior sign of tracking and tracing is positive. i.e., B_4*tracking and tracing >0.*

Timelines

It represents the punctuality of delivery times for shipments. Timeliness is a significant factor to consider because failure to comply with delivery schedules is undesirable due to the high level of competition, and this may affect the competitiveness of a country's trade. The ability of countries to deliver goods on agreed and schedule time will make trading with such countries very competitive. Hence we expect the timeliness indicator of logistics to have a positive sign. Thus B_4*timeliness >0.*

Gross Domestic Product

The gross domestic product is the market value of products produced in a country over a given period. In our study, real GDP was used to measure the market value of products produced in a country because real GDP takes into account inflation. Data on GDP source from the World Bank's, World Development Indicators (WDI) database. The GDPs of selected countries are used as a proxy for their income and are expected to have a positive effect on their trade performance. This is because as the income of countries increase their trade is expected to improve. Hence $\beta_2 > 0$.

Population

The population refers to the total number of people living in a particular area or country, regardless of the status of people. In this study, population refers to the economic size of the countries under study. The population of this study represents the total number of people in all selected SSA countries under study. According to Bergstrand (1989), the interpretation is that a positive coefficient for an exporting country indicates that exports are labour-intensive while a negative coefficient indicates that exports are capital-intensive. Glick and Rose (2002) also explain that a negative coefficient indicates that there is a large domestic market for the local produce hence fewer exports. Since theoretical literature regarding the expected coefficient of this variable is ambiguous, we therefore expect $\beta_3 \lesseqgtr 0$. Data on population was sourced from WDI and it is measured in millions.

Distance

This is a time-invariant variable measuring the geographical distance between the capital city of the selected countries which is measured in kilometers (km). Distance is often used to proxy the cost of transportation. The distance equation follows the great circle formula, which uses center longitudes and latitudes to capture the measure of weighted distance. The distance variable is expected to have a negative coefficient, hence $\beta_1 < 0$. This is because the wider the geographic distance between the trading partners, the higher the cost of transportation. This is in line with the studies done by Roperto (2013), Didia et al. (2015), and Baah (2015). However, a study by Xue-bin LIU Ming-Xue and Yi-Ying (2007) refutes this expected sign using innovations and technology. The distance variable data is obtained from the distance measurement database of CEPII gravity data.

Landlocked

This is a dummy variable, which assumes a value of 1 if the countries are landlocked and 0 otherwise. Landlocked countries are likely to trade less since they have to incur a higher cost in transporting goods from neighboring countries where they can access ports. Therefore, a negative relationship between Trade and landlocked is expected. Hence $\beta_8 < 0$.

Common Colony

This is a dummy variable, which assumes a value of 1 if countries have common colonial ties and 0 otherwise. Countries with common colonial ties tend to face fewer trade obstacles, hence their ability to import more from their trading partner. Hence positive relationship is expected ($\beta_5 > 0$) between trade and common colony. Common colony data was extracted from the CEPII gravity database.

Common Border

This study includes a dummy variable to identify countries that share a border either adjacent or contiguous and takes a value of 1 if trade partners share a common border and 0 if otherwise. The expected sign of this variable is positive. This is because countries that share common turn to trade more with themselves since it reduces transport costs. Hence $\beta_7 > 0$. This is in line with the study by McCallum (1995). This data is sourced from the CEPII gravity database.

Common Language

The common language is a dummy variable with the value of 1 representing countries with a common language and zeroes if otherwise. The inability to communicate and cultural differences will increase transaction costs, a trade impeding effect of distance; hence we would expect a positive relationship between countries that speak the same language. would trade more. Thus, $\beta_6 > 0$. This data is obtained from the CEPII gravity database.

Foreign Direct Investment (FDI)

This represents the amount of direct investment in the selected SSA countries that are made by foreigners and it is measured as the net inflows (percentage of GDP). The expected sign for FDI is ambiguous. Thus if a foreigner's intention for investing in a specific country is to utilize the comparative advantage a country has over its exports then, the exporting country's FDI will be positive while the expected sign of FDI for the importing country will be expected to be negative.

Inflation Rate

Inflation rate represents the annual percentage change in the average customer cost of purchasing a basket of goods and services which can be adjusted at prescribed intervals, such as annually, and is determined by the annual GDP growth rate. The expected sign of inflation is negative or positive. This is because the higher the price of domestic goods relative to foreign goods will cause an increase in the demand for foreign goods (imported goods) which will intend to deteriorate trade. Likewise, a fall in the inflation rate of a particular country makes the goods of that country competitive relative to goods of other countries and will increase export hence trade improves.

Exchange Rate

The exchange rate measures the rate at which a country's currency is exchanged with another currency. When the value of the domestic currency falls, prices of goods in that country become cheaper making the trade of such a country very competitive (i.e increasing exports). This will have a positive impact on trade. However, when the value of the domestic currency rises, it makes trade with this country uncompetitive since prices of goods in that country are higher relative to the price of goods in other countries and this deteriorates trade (thus it affects trade negatively). Therefore, we expect either a positive or negative value of the coefficient for the exchange rate.

Interest Rate Differentials

The interest rate, as determined by the GDP deflator, is the lending interest rate adjusted for inflation. The expected sign of interest rate is ambiguous. This is because the higher the domestic interest rate of a country is relative to the interest rate of foreign countries will make the domestic interest rate attractive and this will attract investors from different countries, which will cause a positive rise in trade. However, on the other side, a fall in the domestic interest rate of a country makes investing in such a country unattractive thereby driving away investors hence, a negative effect on trade.

Sources of Data

This study used panel data of 24 SSA countries that trade among themselves, based on the yearly disaggregated data spanning 2007 to 2018. Data used for the study were obtained from numerous sources. For instance, data on disaggregated trade was sourced from World Integrated Trade Solution (WITS). Data on Gross Domestic Products (GDP), Population (P), Logistics Performance Index (LPI), and its indicators in addition to trade flows for the countries were sourced from the World Bank's World Development Indicators database (WDI). Data on Distance (DIST), Landlocked, Common colony (Com colony), Common border (Com border), and Common Language (Com language) were obtained from the CEP II.

Estimation Technique

This study employed the Maximum Likelihood Estimation (MLE) as adopted by Aigner et al. (1977) to assess the impact of "behind border" limitations on disaggregated trade. The choice of the MLE technique as an estimation for the SFGM was due to the potency of the MLE in the SFGM. Also, the selection of the MLE is backed by the theory thus, trade potential must be the maximum level of trade flow, and this implies that the upper limits of the data must be estimated. The Maximum Likelihood Estimation technique can estimate the upper limits, making the SFGM more appropriate for this study compared to the traditional gravity model, which adopts the OLS technique

(Kalirajan et al., 2009). Moreover, the MLE technique was discovered to be significantly more advanced than the Corrected Ordinary Least Square (COLS), in that the inefficiency effects of the total variance is large when using COLS than MLE (Coelli, Rao & Battese, 1998). All of which informed the decision and choice of the estimation technique.

The panel-based approach has been used in many studies including; Turkson (2011) and Nutor (2014). These authors argued that panel estimate is the most desired technique for studying dynamic changes. The panel data approach was a more preferable approach for this study, the reason being that; the panel framework pacifies the bias generated by heterogeneity across countries because it includes time-invariant variables and the inclusion of specific effects. Also, the panel data estimation technique acknowledges the existence of vital variables and the indicators that change through time while establishing the specific time or country effects.

Post-estimation Techniques

The Gamma (γ) Coefficient

With the combined utilization of the joint density functions; u_{ij} and v_{ij}, the maximum likelihood estimation was used to estimate $\beta_o \dots \beta_{12}$ and the total variance and the parameter γ as specified in equation (15).

$$\gamma = \frac{{\sigma_u}^2}{({\sigma_u}^2+{\sigma_v}^2)} \tag{15}$$

The gamma coefficient measures the variation in a trade which is a result of the influence of the socio-political-institutional factors. Thus, γ indicates serves as a robustness test for the stochastic frontier gravity model. When γ is significant, it signifies that the effect of behind the border constraints is responsible for the inefficiencies in trade.

Efficiency Test

To test the capability of SFGM over TGM in estimating the efficiency of trade among the selected SSA countries, we estimated the lambda (likelihood ratio test) as suggested by kumbhakar, Wang, and Horncastle (2015), which is given by:

$$\lambda = -2\{ln[L(H_o)] - ln[L(H_1)]\} \quad (16)$$

H_0: There are no inefficiencies in the logistics of selected SSA countries.

H_1: There are inefficiencies in the logistics of selected SSA countries.

Decision rule; λ > critical value (8.273) – Efficient to use SFGM

Where, $L(H_1)$: is the unrestricted model; $L(H_0)$: is the restricted model which are the log-likelihood function values for the frontier model.

Conclusion

In short, the positivist philosophy research philosophy was used for this study. Concerning this study, both theoretical and empirical models were formulated. This chapter has however elaborated on some theoretical foundation and has justified the use of the gravity model in international trade flows. The study as well adopted the stochastic frontier gravity model which has been identified to have a higher capacity in examining trade flows among countries.

CHAPTER FIVE

RESULTS AND DISCUSSION

Introduction

This chapter gives the empirical results and discussions and is divided into three main sections. The first section shows the descriptive analysis of the main variables used in the estimation exercise, followed by the estimated results for objective one (effects of aggregate logistics on disaggregated trade), and the last section provides the results of objective two (effects of disaggregated logistics on disaggregated trade).

Descriptive Statistics

The choice of variable inclusion in this study was informed by international trade theories and available literature on logistics and trade. Table 2 presents descriptive statistics including the mean, standard deviation, skewness, kurtosis, and the minimum and maximum values of the variables used in the study.

Table 2: **Summary Statistics of Variables, 2007 - 2018**

Variables	**Mean**	**std. dev.**	**Min**	**Max**	**Skew-ness**	**Kurtosis**
Agricultural, forestry, and fishery products	2366	10034	0.001	280553	10.5	169.3
Mineral products	6933	23713	0.001	467249	6.7	68.3
Manufactured products	5286	23748	0	507278	9.3	115.6
Aggregated LPI	3.8	14.3	1.9	202.0	11.4	142.3
Customs	2.3	0.2	1.5	3.2	0.1	3.6
Infrastructure	2.2	0.3	1.3	3.2	0.1	3.8
International shipment	2.5	0.3	1.7	3.2	-0.1	3.1
Quality and competency	2.4	0.3	1.7	3.6	0.7	4.8
Tracking and tracing	2.9	0.3	2.0	4.0	0.3	3.2
Timeliness	2.4	0.3	1.5	3.4	0.2	3.3
Distance	14914	261327	321	6148336	23.4	549.9
Gross Domestic Product	1.39e+10	1.36e+10	7.94e+08	6.23e+10	1.6	4.9
Population	6.32e+06	2.99e+06	4.75e+06	18.01e+06	4.7	24.0
Foreign Direct Investment	7.14e+08	1.04e+09	-7.38e+07	6.70e+09	2.7	10.7
Interest rate	7.8	10.3	-20.3	51.3	1.5	8.1
Exchange rate	0.4	0.1	0.3	0.7	0.2	2.6
Inflation rate	6.0	6.4	-4.3	44.4	2.4	10.9
Common border			0	1	3.2	11.5
Common language			0	1	0.2	1.0
Common colony			0	1	0.5	1.3
Landlocked			0	1	0.7	1.5
Observations	6624					

Source: Yawson (2020)

Note: obs and std. dev represent observation and standard deviation respectively.

The descriptive statistics show that the average trade-in agriculture, fishery, and forestry product (SIC0) among SSA countries is US$2,365 thousand with a minimum of US$0.001thousand and a maximum of US$280,553 thousand. This means that the largest trade in agriculture, fishery, and forestry products recorded by the selected SSA countries is US$280,553 thousand with the least trade in agriculture, fishery, and forestry products being US$0.001thousand. Also, trade-in mineral products (SIC1) among the selected SSA countries have an average of US$6,933 thousand with a minimum of US$0.001 thousand and a maximum of

US$467,249 thousand. Total trade among the selected SSA countries in terms of manufactured products (SIC2) is US$5,286 thousand on average with a minimum of US$0.000 thousand and a maximum of US$507,278 thousand.

Also, as seen in Table 2, the average GDP for the selected SSA countries is approximately US$1.4 trillion with US$ 7.94 billion and US$6.23 trillion for the maximum and minimum values respectively from 2007 to 2018. The summary statistics also reveal the mean scores on the aggregated and the disaggregated logistics for the selected SSA countries. The aggregated logistics reflects the value of all the six indicators. Infrastructure has the lowest value of 2.2 units among the six indicators with the highest value of 2.9 units being the tracking and tracing indicator among the selected SSA countries. Again, the average population of the selected SSA countries is 6.32 million with 14,914 kilometers being the average distance traveled among the selected countries in terms of their trade in the disaggregated products.

Moreover, the summary statistics reveal that all the variables included in the study except international shipment are positively skewed. This means that the variables in the data are not normally distributed. Also, all the values for kurtosis are greater than 3. This leads to a fat tail of the normal distribution curve and is inconsistent with the normal distribution assumption. Hence, both the skewness and kurtosis indicate the non-normality of the data used in this study. This confirms the use of the Maximum Likelihood Estimation Technique (MLE) in this study.

Empirical Results and Discussions

This section presents detailed results and discussions on the empirical results for the estimation of the effects of both aggregated logistics and its components on disaggregated trade among selected SSA countries are presented in this sub-section.

Results of the Effects of Aggregated Logistics on Disaggregated Trade-in SSA

The results of the effects of the aggregated logistics on disaggregated trade are presented in Table 3. These results are based on the stochastic frontier gravity model which employs the Maximum Likelihood Estimation Technique (MLE), the stochastic frontier gravity modeled in equation 13 is obtained by incorporating the aggregated logistics into each disaggregated trade products (agricultural, fishery, and forestry products, mineral products, and manufactured products) specified. As expected, most variables have prior signs and are statistically significant.

Table 3: Effects of aggregated logistics on disaggregated trade

Dependent variables: log of each disaggregated trade variables

	EQN (1) Agriculture, Forestry and Fishery Products SIC 0	EQN (2) Mineral Products SIC 1	EQN (3) Manufactured Products SIC 2
Aggregated_LPI	0.320***	0.196***	0.222***
	(7.21)	(4.34)	(4.91)
Ldistance	-0.069***	-0.403**	-1.193***
	(-2.61)	(-2.20)	(-8.71)
LGDP	0.487***	0.345***	0.491***
	(4.17)	(2.62)	(4.73)
Lpop	-0.469***	0.239***	0.197***
	(-7.36)	(2.88)	(4.30)
Combor(No=0, Yes=1)	2.610***	2.641***	2.694***
	(6.43)	(4.39)	(6.33)
Comlan(No=0, Yes=1)	1.016***	1.026**	0.129
	(3.43)	(2.53)	(0.42)
Comcol(No=0, Yes=1)	0.716**	0.729*	0.197
	(2.32)	(1.74)	(0.63)
Landloc(No=0, Yes=1)	-1.465***	-0.266	-0.094
	(-5.62)	(-0.90)	(-0.40)
FDI	-0.011	0.038	0.005
	(-0.48)	(1.58)	(0.20)
Interest rate	-0.027	0.003	0.120***
	(-0.77)	(0.08)	(3.08)
Exchange rate	-0.041	-0.036	0.319
	(-0.24)	(-0.20)	(1.70)*
Inflation rate	-0.009	-0.013	0.020
	(-0.31)	(-0.41)	(0.62)
Constant	8.224***	9.750***	6.931**
	(3.25)	(3.37)	(2.41)
Sigma_2	2.029***	2.551***	2.018***
	(41.66)	(39.53)	(46.46)
Gamma	0.915***	1.415***	0.591***
	(12.86)	(17.10)	(8.43)
Mu	6.969***	6.609***	7.602***
	(11.14)	(17.42)	(5.45)
Eta	-0.002*	-0.001	-0.001
	(-1.82)	(-0.47)	(-0.65)
Log-likelihood Ratio	-1.054	-1.102	-1.102
Wald chi2	155.26	78.73	397.44
Number of observations	5359	5359	5359

Source: Yawson (2020)

Note: *, ** and *** represent significant levels at 10%, 5% and 1% respectively. T-Statistics are presented in parenthesis. Combor, comlan, comcol, and landloc are the common border, common language, common colony, and landlocked respectively.

The results presented in Table 3 show the estimated coefficients are in line with trade theory and most of them are statistically significant with their expected signs. For instance, aggregated logistics in all the selected SSA countries are positive and have a greater significant effect on all the disaggregated trade products. Thus, any improvement in logistics in any of the selected countries increases their trade in each of the disaggregated trade products. For example, an improvement in logistics will increase the country's trade-in agriculture, fishery, and forestry by 32 percent, mineral products by 19.6 percent with manufactured products increasing by 22.2 percent. The agriculture, fishery, and forestry product have the highest impact, this can be attributed to the nature of these products –Thus these products are mostly unprocessed and highly perishable so, to maintain their quality and taste, effective and efficient logistics are required to keep these products in their preferred taste and quality. Also, agriculture, fishery, and forestry products are more time-dependent, and therefore improved and efficient logistics services are needed to enhance its trade. With manufactured and mineral products having the least impact. This is due to the fact that these products are usually processed and are less time-dependent so any inefficiencies that occur in the logistics services causing delays in the transport of this product will not affect its quality, preference, and taste. This conforms to the study by Turkson (2011).

With regard to GDP, the results revealed a positive and significant impact of GDP on the disaggregated trade products of selected SSA countries at 1 percent. This means that any percentage increase in the income of the selected SSA countries improved their logistics service which increased their trade-in: agriculture, fishery, and forestry by 0.487 percent, mineral products by 0.345 percent, and manufactured products by 0.491 percent which confirms the findings of (Gani, 2008; Rahman, 2009; Yishak, 2009; Turkson, 2011; Bonuedi, 2013).

Again, the statically significant and negative coefficient of distance for all the disaggregated commodities indicates that the longer the kilometers between countries involved in trade, the more likely they are to trade less among themselves. In a situation where the costs of transportation involved in trading and transferring goods from one destination to the other are higher, then less of those goods are traded. This is to say that countries will trade more with their neighboring countries than that of far distant countries. The negative coefficient implies that the SSA countries trade less among themselves due to the higher cost of transportation resulting from a far distance. This suggests that distance is a crucial factor that hinders trade flows among the selected SSA countries. For instance, a percentage increase in the kilometers among SSA countries will decrease their trade-in agricultural, fishery, and forestry products by 0.69 percent and in Mineral products by 0.403 percent and is in support with the findings of similar literature (Heokman & Nikita, 2008; Bhattacharya & Das, 2014; Nutor 2014; Hassas, 2017).

In addition, the findings show a negative influence of population size on selected SSA country's trade for agriculture, fishery, and forestry products is while mineral products and manufactured products have a positive influence. The negative and statistically significant sign of the coefficient of agriculture, fishery and forestry products implies that the selected SSA countries have a large domestic market for these products and therefore as the size of the population increase, the more the domestic consumption of these products and this leads to fewer exports of such products and diminishes trade in such products. Also, it is more likely for the selected SSA countries to substitute for these products with products from other countries, this usually occurs when the demand for these products by the country's citizens exceeds their supply. This implies that imports of these products are going to exceed their exports and this will also affect the trade negatively. For example, a percentage increase in population size will decrease trade in agriculture, fishery, and forestry products by 0.469 percent. However, concerning mineral and manufactured products, a percentage rise in population size enhances the trade of these products. This is because of the smaller domestic market size SSA countries have for these products, they consume less of the mineral and manufactured products even when their population size increases. This means that exports of these goods will increase and will have a positive influence on trade in the mineral and manufactured products of the selected countries. Thus a percentage increase in population size will increase both mineral and manufactured products by 0.239 and 0.197 percent respectively which will intend to improve trade. This is in line with the Heckscher-Olrlin theory and confirms the findings of (Linders, 2006; Ebaidalla & Mustafa, 2018; Deluna Jr & Cruz, 2013; Hassan, 2017).

For the dummy variables, the common border was estimated to have a positive and significant impact on disaggregated trade among selected SSA countries. This implies that countries that have a common border trade more among themselves because having a common border reduces transport costs among trading partners. For instance, countries that have common borders increase their trade in agriculture, fishery, and forestry products by 26.1 percent; mineral products by 26.4 percent, and manufactured products by 26.9 percent compared to countries that do not share a common border. Also, the common language dummy and common colony have positive signs for their respective coefficients. This implies that countries that have a common language and colonial ties are likely to face fewer trade hindrances hence, their trading in these disaggregated products is enhanced. This means that if the selected SSA countries have a common language, their trade-in agriculture, fishery and forestry products, mineral products, and manufactured products will be increased by 10.2 percent, 10.3 percent, and 12.9 respectively compared to countries that do not have a common language. Likewise, countries with common colonial ties will have an improved trade in these products by 71.6 percent, 71.6 percent, and 19.7 percent respectively compared to countries without common colonial ties. Furthermore, the landlocked dummy variable has negative coefficients for all the disaggregated products. This implies that if countries are landlocked then their trade in agricultural, forestry, and fishery products, as well as mineral and manufactured products, are going to reduce compared to countries that are not landlocked. These findings confirm the findings of (Turkson, 2011; Nutor, 2014; Gani, 2017).

Results for the Effects of Disaggregate Logistic Measures on Disaggregated Trade

Tables 4, 5, and 6 show the effect of each disaggregated logistic (customs, infrastructure, logistics quality and competency, tracking and tracing, international shipment, and timeliness) on each disaggregated trade (agricultural, fishery, and forestry products, mineral products, and manufactured products) individually. Thus the results are estimated individually with each disaggregated logistics component in each disaggregated trade model.

Table 4: Effects of disaggregated logistics on agricultural, fishery, and forestry products

Dependent variable: Log of Agriculture, forestry, and fishery products (SIC 0)						
	EQN 1	**EQN 2**	**EQN 3**	**EQN 4**	**EQN 5**	**EQN 6**
Customs	0.449***					
	(2.02)					
Infrastructure		0.482**				
		(2.52)				
Shipment			0.617***			
			(2.87)			
Quality & Competency				0.465**		
				(2.06)		
Tracking & Tracing					0.561***	
					(2.99)	
Timeliness						0.501**
						(2.27)
Ldistance	-0.059**	-0.058**	-0.057**	-0.061**	-0.054**	-0.068**
	(-2.18)	(-2.15)	(-2.11)	(-2.27)	(-1.97)	(-2.55)
LGdp	0.407***	0.458***	0.463***	0.452***	0.440***	0.455***
	(3.40)	(3.91)	(3.95)	(3.84)	(3.75)	(3.89)
Lpop	-0.406***	-0.420***	-0.424***	-0.422***	-0.400***	-0.432***
	(-6.29)	(-6.57)	(-6.64)	(-6.58)	(-6.20)	(-6.78)
Combor(No=0,Yes=1)	2.593***	2.661***	2.654***	2.659***	2.645***	2.649***
	(6.27)	(6.52)	(6.49)	(6.50)	(6.49)	(6.49)
Comlan(No=0,Yes=1)	0.328	1.010***	1.006***	1.006***	1.006***	1.009***
	(1.29)	(3.41)	(3.39)	(3.40)	(3.41)	(3.42)
Comcol(No=0,Yes=1)	0.266	0.705**	0.707**	0.697**	0.708**	0.688**
	(0.94)	(2.28)	(2.28)	(2.26)	(2.30)	(2.23)
Landloc(No=0,Yes=1)	-1.425***	-1.424***	-1.442***	-1.407***	-1.395***	-1.454***
	-(5.39)	-(5.43)	-(5.49)	-(5.35)	-(5.32)	-(5.54)
FDI	-0.007	-0.012	-0.014	-0.014	-0.009	-0.013
	(-0.28)	(-0.53)	(-0.62)	(-0.64)	(-0.39)	(-0.55)
Interest rate	-0.032	-0.031	-0.031	-0.035	-0.030	-0.031
	(-0.90)	(-0.87)	(-0.88)	(-0.99)	(-0.84)	(-0.88)
Exchange rate	0.001	0.039	-0.018	-0.031	-0.067	-0.012
	(0.00)	(0.23)	(-0.11)	(-0.18)	(-0.39)	(-0.07)
Inflation rate	-0.019	-0.025	-0.012	-0.008	-0.011	-0.018
	(-0.66)	(-0.86)	(-0.43)	(-0.27)	(-0.38)	(-0.63)
constant	9.338***	7.901***	7.640***	8.051***	7.571***	8.141***
	(3.35)	(3.10)	(2.99)	(3.16)	(2.96)	(3.21)
Sigma_2	2.055***	2.039***	2.041***	2.041***	2.034***	2.040***
	(42.62)	(41.46)	(41.47)	(41.46)	(41.35)	(41.49)
Gamma	0.949***	0.924***	0.929***	0.927***	0.918***	0.925***
	(13.57)	(12.91)	(12.98)	(12.95)	(12.80)	(12.93)
Mu	7.748***	6.898***	6.897***	6.881***	6.847***	6.894***
	(7.91)	(11.33)	(11.32)	(11.45)	(11.31)	(11.43)
Eta	-0.002	-0.002	-0.002	-0.002	-0.00133	-0.00202
	(-1.63)	(-1.58)	(-1.44)	(-1.17)	(-1.28)	(-1.52)
Loglikelihood ratio	-1.056	-1.055	-1.055	-1.055	-1.055	-1.055
Wald chi2	122.81	135.99	137.62	133.65	139.36	134.87
Observations	5359	5359	5359	5359	5359	5359

Source: Yawson (2020)

Note: *, ** and *** represent significant levels at 10%, 5% and 1% respectively. T-Statistics are presented in parenthesis. Combor, comlan, comcol, and landloc are common border, common language, common colony, and landlocked respectively.

Concerning the magnitude of the individual effect of the disaggregated logistics on agriculture, fishery, and forestry products, the results revealed a positive and significant coefficient for all the logistic components on each disaggregated trade. This implies that as the logistic services of the selected countries become better, trade in agriculture, fishery, and forestry increases. For instance, any improvement in the speed, simplicity, and predictability of customs agencies will increase trade in agriculture, fishery, and forestry products by 44.9 percent, while any advancement in the quality of transport and telecommunications infrastructure will increase trade in agriculture, fishery and forestry products by 48.2 percent. Also, as the arrangement of international shipment becomes easy and at competitive prices, it increases trade in agriculture, fishery, and forestry products by 61.7 percent. Again, a rise in the adequacy, location of delivery, and competency of trade logistics will lead to a rise in the trade of agriculture, fishery, and forestry products by 46.5 percent and 56.1 percent rise in agriculture, forestry, and fishery trade. Likewise, as the shipment delivery times is enhanced, it will improve trade in agriculture, forestry, and fishery products by 50.1 percent. Since products from agriculture, forestry, and fishery are time-dependent, mostly unprocessed, and perishable, all logistics components must be in their efficient play to enhance its trade. Therefore, when it comes to these time-dependent products all the components of the logistics are needed to maintain the taste and quality of the products through its transport until it gets to its final destination. This is in line with a study by Turkson (2011).

Regarding the GDPs, the GDP for all the individual logistics for agriculture, fishery, and forestry products is positive and statistically significant at 1 percent. This means that as the selected countries experience a rise in their income, they pay more attention to the logistics services, which in turn increased trade in agriculture, fishery, and forestry products. This is to say that as the income of countries increases, their logistics service are improved and this enhances their trade. For instance, a percentage increase in income improves the custom agencies, infrastructure, international shipment, quality and competency of logistics, tracking and tracing, and timeliness of selected countries which in turn increases trade in agriculture, fishery, and forestry products by 0.407 percent, 0.458 percent, 0.463 percent, 0.452 percent, 0.44 percent, and 0.455 percent respectively.

Also, the coefficients of distance are all negative and statically significant for all the disaggregated logistics of the agriculture, fishery, and forestry products which shows that distance is an important element that affects the smooth flow of trade among the selected SSA countries. A negative coefficient of distance means, the further away a country is from each other hinders the trade among such countries because the higher the distance between countries involved in trade, the higher the cost incurred in transporting goods from one country to the other. This makes trading with far distant countries unattractive. Hence, a fall in trade.

In addition, population size also plays an important role in the enhancement of trade. The results showed negative and statistically significant values of the population size for all the individual logistics for the agriculture, fishery, and forestry products. This means that the demand for agriculture, fishery, and forestry products of selected SSA countries is very high therefore more of such products produced by these countries are consumed by the citizens of the countries. Thus exports of agriculture, fishery, and forestry products by the selected SSA countries are less. This negatively affects the trade of these countries.

The results confirmed that countries that have a common border, common colony, common language, and are not landlocked will trade more among themselves than otherwise. Hence, the positive coefficients of the common border, common colony, and common language likewise a negative coefficient of landlocked countries. This means countries with a common border do not spend much in terms of transportation and will trade more with each other. Also, countries that have a common colony are more likely to have colonial ties and due to that, the restrictions on trade are made flexible for such countries and this improves their trade.

Table 5: Effects of Disaggregated Logistics on Mineral Products

Dependent variable: Log of Mineral commodities (SIC 1)

	EQN 1	EQN 2	EQN 3	EQN 4	EQN 5	EQN 6
Customs	-0.017					
	(-0.55)					
Infrastructure		-0.098				
		(-0.96)				
Shipment			0.265***			
			(2.76)			
Quality & Competency				0.241**		
				(2.30)		
Tracking & Tracing					0.215***	
					(2.62)	
Timeliness						-0.016
						(-0.52)
Ldistance	-0.409**	-0.412**	-0.407**	-0.407**	-0.414**	-0.414**
	(-2.23)	(-2.24)	(-2.21)	(-2.21)	(-2.25)	(-2.25)
LGdp	0.345***	0.336**	0.311**	0.300**	0.325**	0.326**
	(2.64)	(2.57)	(2.36)	(2.25) **	(2.48)	(2.49)
Lpop	0.197**	0.198**	0.206**	0.201	0.199**	0.199**
	(2.39)	(2.40)	(2.50)	(2.43)	(2.41)	(2.40)
Combor(No=0,Yes=1)	2.598***	2.609***	2.637***	2.651***	2.607***	2.615***
	(4.28)	(4.30)	(4.36)	(4.39)	(4.30)	(4.31)
Comlan(No=0,Yes=1)	0.246	0.243	0.242	0.212	0.244	0.235
	(0.84)	(0.82)	(0.82)	(0.72)	(0.83)	(0.80)
Comcol(No=0,Yes=1)	0.737*	0.732*	0.743*	0.728*	0.738*	0.738*
	(1.75)	(1.74)	(1.77)	(1.74)	(1.76)	(1.76)
Landloc(No=0,Yes=1)	-1.022**	-1.020**	-1.024**	-1.021**	-1.017**	-1.021**
	(-2.51)	(-2.51)	(-2.52)	(-2.52)	(-2.50)	(-2.51)
FDI	0.0369	0.0382	0.0345	0.0330	0.0385	0.0377
	(1.52)	(1.57)	(1.42)	(1.35)	(1.58)	(1.55)
Interest rate	-0.004	-0.005	-0.001	-0.007	-0.004	-0.004
	(-0.10)	(-0.12)	(-0.04)	(-0.19)	(-0.11)	(-0.09)
Exchange rate	-0.211*	0.013	-0.022	-0.045	0.021	0.018
	(-1.88)	(0.07)	(-0.12)	(-0.25)	(0.11)	(0.10)
Inflation rate	0.011	-0.013	-0.012	-0.007	-0.016	0.212
	(0.06)	(-0.43)	(-0.40)	(-0.22)	(-0.50)	(0.83)
Constant	9.840***	9.796***	9.604***	9.909***	9.819***	9.859***
	(3.45)	(3.42)	(3.30)	(3.37)	(3.41)	(3.42)
Sigma_2	2.565***	2.565***	2.561***	2.561***	2.564***	2.566***
	(38.88)	(38.94)	(38.97)	(39.13)	(38.96)	(39.01)
Gamma	1.429***	1.428***	1.425***	1.424***	1.429***	1.429***
	(16.96)	(16.98)	(16.96)	(17.02)	(17.00)	(17.01)
Mu	6.474***	6.491***	6.503***	6.543***	6.499***	6.509***
	(17.24)	(17.22)	(17.16)	(17.13)	(17.24)	(17.26)
Eta	-0.008	-0.001	-0.005	-0.056	-0.028	-0.029
	(-0.01)	(-0.13)	(-0.43)	(-0.54)	(-0.28)	(-0.29)
Loglikelihood ratio	-1.055	-1.055	-1.055	-1.055	-1.055	-1.055
Wald chi2	62.67	60.09	66.93	64.03	66.08	59.13
Observations	5359	5359	5359	5359	5359	5359

Source: Yawson (2020)

Note: *, ** and *** represent significant levels at 10%, 5% and 1% respectively. T-Statistics are presented in parenthesis. Combor, comlan, comcol, and landloc are common border, common language, common colony, and landlocked respectively.

The results in Table 5 point out the extent to which each disaggregate logistics indicator affects mineral products. The results reveal negative and insignificant coefficients for the customs, infrastructure, and timeliness logistics indicators while there are positive and statistically significant coefficients for quality and competency of logistics, international shipment, and tracking and tracing. This implies that irrespective of the inefficiencies in the customs, infrastructure, and timeliness indicators of the selected SSA countries, there will not be any effect on their trade-in mineral products. Thus, failure to comply with delivery schedules will not affect the trade of these countries in mineral commodities. This is because mineral products are time-independent and any delays that may be caused in the process of transporting these products to their final destination will not cause any harm to the quality of these mineral products. Although delays in the transfer of mineral products to their final destination will not affect its quality. However, it is important for countries involved in the trade to; improve the quality of their logistics service and optimize the relationship between organizations and customers, be able to transport or ship these products at very competitive prices, and also for countries to have the ability to track and trace their shipment until it gets to its final destination or the end-user. Hence, there are positive coefficients of international shipment, logistics quality, and competency, and tracking and tracing. This implies that any improvement in each logistic component increase trade in mineral products. For instance, an improvement in the ease to arrange international shipment will increase trade in mineral products by 26.5 percent, while a better logistics competency and quality will also increase trade in mineral products by 24.1 percent, as well as the ability to track and trace traded goods will lead to a rise in mineral products trade by 21.5 percent.

Also, the GDP for all the individual logistics mineral products is positive and statistically significant. This means that percentage increase in the income of the selected SSA countries, their logistics components improve which in turn increases their trade-in mineral products. For instance, a percentage increase in income improves the custom agencies, infrastructure, international shipment, quality and competency of logistics, tracking and tracing, and timeliness of selected SSA countries which in turn increases trade in mineral products by 0.345 percent, 0.336 percent, 0.311 percent, 0.300 percent 0.325 percent and 0.326 percent respectively.

Concerning the distance between countries, the results show a significant and negative coefficient for all the disaggregated logistics for the mineral products indicating that the countries trade less with far distance countries. Distance stands for transportation cost and the higher the distance between countries involved in trade, the more the cost they bear in transferring traded goods. Hence, countries will trade more with less distant countries and this will have a negative effect on trade.

Furthermore, the findings show a positive and statistically significant coefficient at 5 percent for the mineral products. This indicates that the selected SSA countries have a smaller domestic market size for mineral products. Thus, fewer mineral products are used by the selected SSA countries even as their population grows big, and therefore they will export more of these products because they consume less of them. This will improve the trade of these countries since exports of mineral products will exceed its imports.

Again, the common border has a positive relationship for all the disaggregated logistics indicators. Also, common language and common colony have positive signs for their respective coefficients. While landlocked has negative coefficients for all its coefficients. This implies that trade is enhanced when countries have a common language, share common colonial tires, and are not landlocked compared to countries that do not have a common border, common language, common colonial tires, and are landlocked.

Table 6: Effects of Disaggregated Logistics On Manufactured Products

Dependent variable: Log of Manufactured commodities (SIC 2)

	EQN 1	EQN 2	EQN 3	EQN 4	EQN 5	EQN 6
Customs	-0.164					
	(-1.60)					
Infrastructure		-0.199				
		(-0.88)				
Shipment			0.273***			
			(2.78)			
Quality & Competency				0.295***		
				(2.83)		
Tracking & Tracing					0.339***	
					(4.18)	
Timeliness						-0.052
						(-0.47)
Ldistance	-0.071***	-0.019***	-1.295***	-1.243***	-1.211***	-1.215***
	(-2.66)	(-3.67)	(-9.44)	(-9.12)	(-8.83)	(-8.78)
LGdp	0.480***	0.757***	0.812***	0.642***	0.687***	0.726***
	(4.11)	(6.21)	(8.00)	(5.69)	(6.13)	(6.47)
Lpop	0.433***	0.0316	0.112	0.0232	0.0357	0.0326
	(6.78)	(1.79)*	(4.08)***	(0.38)	(0.58)	(0.53)
Combor(No=0,Yes=1)	2.632***	4.279***	2.749***	2.715***	2.699***	2.719***
	(6.43)	(10.15)	(6.51)	(6.38)	(6.35)	(6.34)
Comlan(No=0,Yes=1)	1.020***	0.0645	0.0470	0.0376	0.0234	0.0216
	(3.47)	(0.19)	(0.16)	(0.12)	(0.08)	(0.07)
Comcol(No=0,Yes=1)	0.710**	0.439	0.285	0.273	0.299	0.312
	(2.32)	(1.24)	(0.92)	(0.88)	(0.96)	(0.99)
Landloc(No=0,Yes=1)	-1.438**	-0.299	-0.248	-0.178	-0.232	-0.246
	(-5.47)	(-1.12)	(-1.12)	(-0.71)	(-0.93)	(-0.98)
FDI	-0.012	-0.002	-0.004	-0.003	0.001	-0.008
	(-0.53)	(-0.07)	(-0.01)	(-0.13)	(0.04)	(-0.03)
Interest rate	-0.0324	0.127***	0.124***	0.122***	0.135***	0.130***
	(-0.91)	(3.21)	(3.19)	(3.09)	(3.44)	(3.31)
Exchange rate	0.0163	0.340*	0.276	0.279	0.209	0.365*
	(0.10)	(1.79)	(1.46)	(1.46)	(1.09)	(1.92)
Inflation rate	-0.0161	0.0239	0.0238	0.0302	0.0330	0.0196
	(-0.56)	(0.74)	(0.75)	(0.94)	(1.03)	(0.61)
Constant	8.409***	-4.707*	1.741	9.003***	4.849*	5.198*
	(3.32)	(-1.84)	(0.61)	(3.66)	(1.77)	(1.90)
Sigma_2	2.041***	2.138***	2.014***	2.02***	2.020***	2.035***
	(41.38)	(44.85)	(46.31)	(47.73)	(45.70)	(45.61)
Gamma	0.927***	0.752***	0.566***	0.576***	.574***	0.594***
	(12.92)	(10.32)	(7.99)	(8.36)	(8.00)	(8.27)
Mu	6.839***	7.103***	7.220***	9.574***	6.909***	6.886***
	(11.48)	(8.30)	(6.16)	(8.30)	(6.95)	(7.36)
Eta	-0.002	-0.001	-0.001	-0.001	-0.004	-0.001
	(-1.34)	(-0.89)	(-1.42)	(-0.96)	(-0.39)	(-0.76)
Loglikelihood ratio	-1.055	-1.109	-1.044	-1.105	-1.105	-1.106
Wald chi2	132.31	211.59	350.14	326.18	338.95	316.11
Observations	5359	5359	5359	5359	5359	5359

Source: Yawson (2020)

Note: *, ** and *** represent significant levels at 10%, 5% and 1% respectively. T-Statistics are presented in parenthesis. Combor, comlan, comcol, and landloc are common border, common language, common colony, and landlocked respectively.

The effects of disaggregated logistics on trade-in manufactured products are displayed in Table 6. From the table, the results indicate that as in the case of mineral products, there are negative and insignificant coefficients for the customs, infrastructure, and timeliness logistics indicators while quality and competency of logistics, international shipment, and tracking and tracing have positive and statistically significant coefficients. This suggests that regardless of how inefficient the customs, infrastructure, and timeliness indicators may be, trade-in manufactured products among the selected SSA countries will not be harmed. This is because manufactured products such as; Food and Kindred Products, Tobacco Products, Textile Mill Products, many among others are time-invariant and any delays that may be caused in their transportation to their final destination will not infect the quality of this manufactured products. Even though slacks in the customs, infrastructure, and timeliness logistics service will not affect trade-in manufactured products, the ability of countries to improve on the competency and quality of their logistics service, track and trace traded goods, and arrange for the delivery of goods at very competitive prices must be enhanced to make trading with selected countries attractive. Therefore, there are positive coefficients of international shipment, logistics quality, and competency, and tracking and tracing which tells that these indicators are necessary for the fluent flow of manufactured products. Thus it implies that any advancement made in the logistics service (international shipment, logistics competency and quality, and tracking and tracing) of selected countries will improve their trade. For example, the more capable logistics becomes, international shipment, logistics competency and quality, and tracking and tracing also begin to undergo improvement, which raises trade in manufactured products by 27.3 percent, 29.5 percent, and 33.9 percent respectively.

Again, the results of GDP showed positive and statistically significant coefficients at 1 percent for all the individual logistics of manufactured products. This means that GDP has a greater effect on the trade of these products in the sense that any changes in income affect its trade. For instance, a percentage increase in income improves the custom agencies, infrastructure, international shipment, quality and competency of logistics, tracking and tracing, and timeliness of selected countries which also positively increase trade in manufactured commodities by 0.48 percent, 0.757 percent, 0.812 percent, 0.642 percent 0.687 percent and 0.726 percent respectively.

Moreover, the findings show that the coefficients of population size for the manufactured products are all positive and statistically significant. This indicates that the selected SSA countries have a small domestic market size for manufactured products. Thus, there is less consumption of manufactured products in the selected countries, therefore more of these products are exported even when their population grows. This will then improve the trade of these countries since exports of mineral products will exceed its imports.

The results revealed positive coefficients for the common border, common language, and common colony while the landlocked had a negative coefficient for all the disaggregated logistics indicators. This implies that trade is enhanced when countries have a common language, share a common border, and colonial tires, while trade declines when countries are landlocked compared to countries that do not have a common border, common language, common colonial tires, and are not landlocked.

Post-estimation Tests

The Gamma (γ) Coefficient

$$\left(\gamma = \frac{\sigma_u{}^2}{\sigma^2{}_u + \sigma^2{}_v}\right) \tag{15}$$

The gamma (γ) parameter is defined by equation (15). Where $\sigma_u{}^2$ represent the variance of the inefficiency error term (behind-the-factors) whiles the $\sigma^2{}_v$ represent the variance of beyond-border factors. The gamma parameter value ranges from zero to one and if the gamma coefficient is close to 1 it means that a great deal of variation is due to technical inefficiencies and therefore the use of the SFGM is justified. The gamma coefficient explains the variation in the composite error term that is due to "behind the border" trade constraints for which the one-sided error term controls. A positive and statistically significant gamma coefficient confirms that trade restrictions under the exporter's control are effective in limiting the exporting country's trade flows from reaching their potential levels. Also, a negative and statistically insignificant gamma coefficient suggests that most of the variation in the composite error term was due to variation in the double-sided error term, which possibly could be coming from "beyond the border" trade resisting factors. In other words, it implies that "beyond the border" factors significantly restrained the importing country's trade from reaching their potential levels. Thus a negative gamma implies that the inefficiencies are coming from the importing countries.

The result shows that sigma-squared (σ^2) is statistically significant at 1 percent for all the dependent disaggregated trade models, suggesting that trade among the selected SSA countries varies over the time of this study. These changes in the trade of the selected SSA countries may result from random factors or the influence of specific characteristics among the selected SSA countries. The gamma (γ) coefficient also further describes the essence of the variation by calculating the ratio of variation due to country-specific socio-political-institutional variables or, in other words, because of the overall variation's behind-the-border constraints. The gamma coefficients are all positive and significant at the one percent. The positive and highly significant coefficients imply that indeed there are inefficiencies in the disaggregated trade of the selected SSA countries and that is accounting for the variation in their trade. This also suggests that in this case, behind-the-border constraints have a significant effect on driving a large proportion of the mean total variance, and therefore the examination of the Stochastic Frontier provides significant and true results in this report.

In simple terms, the factors that are significantly limiting or hindering the smooth trade flows among the selected SSA countries are factors within its control. Also, the eta which is the constant inefficiency in the model tells whether the inefficiencies encountered have seen any improvement or not, positive and significant coefficients of eta indicate that there have been improvements in the inefficiencies, a negative and statistically insignificant coefficient of the eta indicate otherwise. The coefficients in the model are all negative and statistically insignificant indicating that there has not been any improvement in the inefficiencies in the disaggregated trade of the selected SSA countries. Thus the factors that hinder trade among the selected SSA countries from reaching their full potential have not been addressed. This result is consistent with the findings of Ebaidalla and Mustafa (2018) who found a positive and significant sigma-square (σ^2) and gamma (γ) coefficient for the Arab countries in their study, which assessed the Intra-Arab trade integration and potential. The outcome is also in line with the results of Hassan (2017), who used the SFGM to examine the prime determinants and constraints of the export market in Bangladesh. His study found a positive and statistically significant sigma-square coefficient (σ^2) as well as a positive and significant gamma (γ) coefficient result, indicating that the "behind-the-border" constraints have a significant impact and are driving a large proportion of the mean total variation in the bilateral export flow of Bangladesh.

The Efficiency Test (Lambda)

Kumbhakar, Wang, and Horncastle (2015) argued that it is irrelevant to use the gamma (γ) coefficient as a measure to check the validity of the use of SFGM over TGM. They suggest we carry out a likelihood ratio test in which we estimate two models. One is the unrestricted model, $L(H_1)$ and the second one is the restricted model, $L(H_0)$, in the null and alternative hypotheses, which are the values of the log-likelihood function for the frontier model; H_0: there are no inefficiencies and H_1: there are inefficiencies. The results of the lambda model as specified in equation (16) are presented in table 7.

$$\lambda = -2\{ln[L(H_o)] - ln[L(H_1)]\} \quad (16)$$

Table 7: Efficiency test for Justifying the use of SFGM Over TGM

Restricted Models Log-Likelihood Values (H_0)	Unrestricted Models Log-Likelihood Values (H_1)	H_0-H_1	λ
-260768	-1.054	-260767	521533.7
-268150	-1.102	-268149	536297.3
-275746	-1.102	-275745	551489.6

Source: Yawson (2020)

From the results obtained in the table, the lambda (λ) values represent the likelihood ratio test of the one-sided error term. The lambda values of 521533.7, 536297.3, and 551489.6 were compared with the critical values of Kodde and Palm (1986) at one percent with a critical value of 8.273. If the calculated value of the Loglikelihood (LR) test is higher than the critical value of Kodde and Palm (1986), then we reject the null hypothesis of no inefficiencies or inappropriate use of the

SFGM. From the results, the values of the LR test (λ) are all greater than the critical value of Kodde and Palm (1986) at one percent, i.e. 521533.7,536297.3,551489.6 > 8.273 respectively, hence we fail to accept the null hypothesis of no inefficiency. Therefore, we accept the alternative hypothesis, which states that there are inefficiencies in the disaggregated trade flows of the selected countries. This means that the use of the Stochastic Frontier Gravity Model (SFGM) is sufficiently justified.

Conclusion

The Stochastic Frontier Gravity Model was used to analyze the effect of logistics performance on disaggregated trade, which adds to the available empirical literature. The results reveal that 'behind the border' constraints have contributed to poor performance and the contribution of the selected SSA countries in global trade. The results reveal that the inefficiencies in the logistics structure of the selected SSA countries hinder the smooth flow of trade with and among the selected SSA countries.

CHAPTER SIX

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This chapter presents the summary, conclusions, and policy recommendations based on the findings of the study. It also provides policy recommendations based on the findings as well as the limitations of the study and suggested areas for further research.

Summary

The desire of the SSA region since the 1970s has been to improve its trade competitiveness performance in global trade. Notwithstanding the fact that many measures have been put in place to stimulate the region's performance in the world trading system including the liberalization of trade and other trade policies such as General Agreement on Tariff and Trade, Regional Trade Agreements (for example; free trade area, custom unions, common market), yet no progress has been made by the region in boosting its trade performance due to the inefficiencies in the logistics services. Effective logistics facilities promote the mobility of goods, guarantee their protection and speed, and reduce the cost of trading between countries, thus boosting trade between countries. On the other hand, inefficient or poor logistics services such as slacks of customs clearance process at ports, costly and infrequent shipping, delays in tracking and tracing amongst others can lead to bottlenecks in the smooth flow of goods and increase the cost of international trade of the selected SSA countries. The inefficiencies in the logistics services of the selected SSA countries have accounted for the region's poor performance in global trade to date, likewise the poor trade among the selected SSA countries. Also, behind-the-border constraints such as socio-political-institutional constraints hinder the smooth trade among the selected SSA countries.

This thesis examined the effects of the logistics on disaggregated trade among selected SSA countries over the period 2007-2018. This is because; to stimulate trade among the selected SSA countries, it is important to know which logistics indicators will enhance trade in the type of products countries are involved in trading. The study specifically estimated the effects of the aggregated logistics on disaggregated trade as well as the individual effects of logistics on disaggregated trade. The study's theoretical background was based on the H-O theory. For the parameters in the stochastic frontier gravity model to be estimated, the maximum likelihood estimation was used in the study. The estimated coefficients were used to analyze the effect of both the aggregated and individual measures of logistics performance on disaggregated trade.

The frontier estimates revealed that improved logistics in addition to GDP, common border, common language, and common colony have a positive influence on the disaggregated trade for the selected SSA countries whereas disaggregated trade influenced distance between the selected countries as well as landlocked. The estimates also revealed that while the aggregated logistics had a positive influence on all the disaggregated trade, the individual component of logistics, on the other hand, showed that all the logistics indicator are needed for products that are time-dependent thus agricultural, forestry, and fishery products but not for time-independent products. Thus international shipment, logistics quality, and competency, in addition to tracking and tracing are needed for time-independent products such as mineral and manufactured products.

Conclusions

Drawing on the empirical evidence from the first specific objective, which sought to estimate the effects of aggregated logistics on disaggregated trade based on the frontier estimates, brought to light that the aggregated logistics has a positive and significant effect on each disaggregated trade component. Also, the Gross Domestic Products of the selected countries, population size, which proxy the size of the economy of the selected SSA countries, common border, common colony, and common language significantly increased the trade in the disaggregated products of the countries. But, distance, which is a proxy for transportation cost and landlocked of the trading parties had a negative effect on the flow of the selected country's disaggregated trade products.

Again, the second objective of this research was to examine the disaggregated effects of the logistics comprising of the customs, infrastructure, logistics quality and competency, international shipment, tracking and tracing, and timeliness on disaggregated trade (agricultural, forestry, and fishery products, mineral products, and manufactured products). The effect of each disaggregated logistics revealed a positive and statistically significant impact on agriculture, forestry, and fishery products. This is because agriculture, forestry, and fishery products are time-dependent and therefore all the logistics services are needed to keep the quality and taste of these products from their transportation to their final destination. However, the disaggregated effect of the LPI revealed a negative and statistically insignificant coefficient for customs, infrastructure, and timelines in terms of mineral and manufactured products while there was a positive and statistically significant coefficient for international shipment, logistics quality, and competency in addition to tracking and tracing for these products. This means that the mineral and manufactured products do not depend on time and therefore the delays in the transport of these products will not affect their quality. However, it is worthwhile to note that the delays in the transportation of goods increase the cost to transport goods, this is one of the major reasons why SSA countries are not performing well in the trade because the inefficiencies in their logistics service cause delay in the transfer of goods which increases trade cost. This makes trading with the region unattractive. Also, the findings in the second specific objective showed that the Gross Domestic Products of the selected countries, population size, which proxy the size of the economy of the selected SSA countries, common border, common colony, and common language significantly increased the trade in the disaggregated products of the countries. But, the distance and landlocked of the trading parties significantly reduces the flow of the selected country's disaggregated trade products.

The estimated coefficients for both objectives one and two revealed a positive and statistically significant gamma, which tells that indeed there are inefficiencies in the disaggregated trade of the selected countries. Thus the factors causing the inefficiencies in the trade of the selected countries are factors within the control of the countries but whether trade policies are being enforced to improve upon the inefficiencies are determined by the coefficients of the eta. The eta coefficients are negative and insignificant in both objectives which means that there has not been any improvement in the factors accounting for the inefficiencies in the trade of selected SSA countries.

Recommendations

Based on the objectives and estimated results of the study, the following recommendations are proposed to policymakers;

International trade is an important factor that aids the economic welfare and growth of most countries especially developing countries. Thus, for example, it helps in job creation and reduction of poverty. There is, therefore, a need for the SSA countries to find measures (such as; reductions in trade barriers, trade agreements such as the Regional Trade Agreement (RTA) and Economic Partnership Agreement (EPA)) through which improvement in its trade can be ensured. This is why recent international trade studies in SSA are focused mostly on taking actions to facilitate the effective flow of trade. However, inefficiencies in the logistics service of the SSA countries cause them to miss the available global trade opportunities. This study emphasizes to governments of the SSA countries through the Ministry of Trade and Industry, and its trade agencies the need for an efficient and enabling logistics service (examples are; cargo handling, warehousing, freight services (air, road, maritime, etc)) in their respective countries for smooth and vibrant trading activities to take place in their countries.

Primary and agricultural goods are goods mostly traded in the SSA region. Therefore, improved transport infrastructures such as; roads, ports, etc needed to enable the producers of primary and agricultural products to efficiently utilize available resources to access new markets both within the regional block and the international market as a whole. Again effective institutions such as well-established distribution channels will reduce transport costs. This would reduce the burden on local farmers who are typically located in rural and impoverished areas with high producers' costs. As a result, farmers will be able to produce and sell at lower rates, raising wages for some of the poorest members of society, boosting food access, and helping to tackle hunger and poverty issues. Consumers often benefit from access to lower-priced items because simple foodstuffs can travel quicker and at lower prices within countries. This helps to improve welfare benefits and to alleviate poverty.

The competitiveness of a country in global trade is also dependent on the quality and competency in the logistic service. Hence, governments need to implement policies (such as the reduction in customs and border regulations) that enable both the private and public institutions to vigorously improve the quality of their logistics performance because these institutions bear the cost of any unforeseen delays that may occur in the delivery of goods to its final destination. This increases the cost of trading.

The findings which reveal the relationship between disaggregated logistics and the level of disaggregated trade in the selected SSA countries help to direct resources to their most effective uses to improve a country's logistics operations. Thus governments of selected SSA countries through their trade ministries and agencies should concentrate on the logistics indicators (logistics quality and competency, internal shipment, tracking, and tracing) that will boost the trade in the goods they are involved in trading. For instance, governments can compel both private and public institutions that have direct or indirect influence in the improvement of any of the logistics services to develop innovative approaches such as the conversion of manual and paper-based documentation to electronic systems using common documentation to help tackle the delays faced in their logistics. This will help in the rapid increase in the country's ability to compete in the global economy and attract foreign direct investment (FDI).

Suggestions for Further Research

Further studies can take into account the individual trade of each disaggregated trade product. Thus consider the exports or imports of each disaggregated trade product and also exploit the potential gaps between the exports or imports of each disaggregated trade product.

Limitations of the Study

Due to the unavailability of data for some SSA countries, out of 46 Sub-Saharan African countries, only 24 countries were included due to missing values and no data on disaggregated trade and logistics. If more SSA countries were included in the study, more precise conclusions could have been drawn to know the countries in Sub-Saharan Africa that are more efficient or inefficient in their trade logistics. Also, tariffs are important variables that determine the smooth flow of trade but was not included in the estimation due to the unavailability of up-to-date data for all the selected SSA countries included in the study. In spite of the unavailability of data, the results obtained in this study are all credible.

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APPENDICES

APPENDIX A

List of the twenty-four (24) selected SSA countries included in the study by regions

East Africa	Central Africa	Middle Africa	Southern Africa	West Africa
Comoros	Central Africa republic	Cameroon	Botswana	Benin
Ethiopia		Congo Rep.	Lesotho	Burkina Faso
Kenya		Gabon	Namibia	Cote D'ivoire
Madagascar				Cape Verde
Malawi				Ghana
Mauritius				Guinea
Mozambique				Gambia
				Mali
				Mauritania
				Niger

Note: All the selected SSA countries are both importing and exporting countries.

APPENDIX B

Standard Industrial Classification (SIC)

Code	Division	Code	Major Group
0	Agricultural, Forestry and Fishery Products		
		01	Agricultural Products
		02	Livestock and Livestock Products
		08	Forestry Products, nspf
		09	Fish, Fresh, Chilled, or Frozen, and other Marine Products
1	Mineral Commodities		
		10	Metal Ores and Concentrates
		12	Coal and Lignite
		13	Crude Petroleum and Natural Gas
		14	Non-metallic Minerals, Except Fuels ·
2	Manufactured Commodities		
		20	Food and Kindred Products ·
		21	Tobacco Products ·
		22	Textile Mill Products ·
		23	Apparel and Other Finished Products Made From Fabrics, and Similar Materials ·
		24	Lumber and Wood Products, Except Furniture ·
		25	Furniture and Fixtures
		26	Paper and Allied Products ·
		27	Printing, Publishing, and Allied Industries
		28	Chemicals and Allied Products ·
		29	Petroleum Refining and Related Industries