EXPORT POTENTIAL AND EFFICIENCY IN KENYA: AN APPLICATION OF THE STOCHASTIC FRONTIER GRAVITY MODEL

RONNY GITONGA MUTETHIA
X50/70266/2007

A RESEARCH PAPER SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF ARTS IN ECONOMICS OF THE UNIVERSITY OF NAIROBI

NOVEMBER 2019

DECLARATION

This research paper is my original work and has not been presented for any award in any other institution.

Signature: ..... Date: .....

RONNY GITONGA MUTETHIA
X50/70266/2007
UNIVERSITY OF NAIROBI
SCHOOL OF ECONOMICS

SUPERVISOR'S DECLARATION

This research project has been submitted for examination with my approval as University supervisor.

Signature: ..... Date: .....

PROFESSOR ANTHONY WAMBUGU
UNIVERSITY OF NAIROBI
SCHOOL OF ECONOMICS

DEDICATION

I dedicate this research project affectionately to my parents; to my brothers, Kevin, Ernest and Jeffrey; to my dear sister, Georgina; and most pertinently, to my lovely nieces, Ashley, Audrey, Amanda and Anita.

ACKNOWLEDGEMENT

At the onset, I would like to acknowledge and appreciate the guidance, sage and insightful counsel, patience and encouragement provided by my supervisor, Professor Anthony Wambugu, during the entirety of this research project. I also wish to recognize and thank Dr. Ruth Kagia, Ambassador Tom Amolo, Dr. Muthoni Karumba, Mr. Peter Magati [soon to be Dr. Magati}, Ms. Elizabeth Mueni and all friends and colleagues whose steadfast support, inspiration, encouragement, and kind facilitation enabled me to undertake and complete this research work. I remain indebted to all of you.

ABSTRACT

The primary aim of this study was to provide estimates of the export potential and efficiency of Kenya's bilateral trade with its top 20 trading partners using a stochastic frontier gravity approach. The paper's specific study objectives were to analyse factors determining Kenya's exports and to analyse the impact of region-specific trade agreements on Kenya's exports. The Stochastic Frontier approach allows prediction of Kenya's exports at the frontier of the trade gravity function where free and frictionless trade is assumed. The study revealed that GDP growth in both the home and importing countries had a positive effect on Kenya's exports. Population growth was not found to increase exports, contrary to the trade gravity model, and the effect of distance was statistically insignificant. Trade with members of the European Union and trade within the AGOA framework was found to be statistically significant and trade-enhancing with respect to Kenya's exports. However, trade within the COMESA framework was not found to be trade-enhancing. The study showed that Kenya had the highest export efficiency when trading with the United States, the United Kingdom, Pakistan, Uganda and Egypt. The study further revealed that Kenya had the highest export potential in non-traditional markets in the Middle East and Europe, and within its neighbouring region; mainly in Rwanda, Burundi and Somalia. These findings call for a review of Kenya's tactical approach to trade negotiations to put more emphasis on removing barriers to trade within the region, deepening intra-African trade integration and a deliberate campaign to explore underutilized market potential in non-traditional markets in the Middle East and Europe.

Keywords: *Stochastic Frontier, Bilateral Trade, Preferential Trade, Trade Potential, Trade Efficiency, Gravity Model*

JEL Classification: *C15, D24, F13, F14, F17, F53*

ACRONYMS AND ABBREVIATIONS

ACP-EU :African Caribbean Pacific – European Union Partnership

AfCFTA :African Continental Free Trade Agreement

AGOA :African Growth and Opportunity Act

APEC :Asia-Pacific Economic Cooperation

ASEAN :Association of Southeast Asian Nations

BOT :Balance of Trade

COMESA :Common Market for Eastern and Central Africa

DFQF :Duty-Free Quota-Free

DRC :Democratic Republic of Congo

EAC :East African Community

EPA :Economic Partnership Agreement

FTA :Free Trade Agreement

GDP :Gross Domestic Product

H-O :Heckscher-Ohlin

KNBS :Kenya National Bureau of Statistics

MAR :Market Access Regulation

MENA :Middle East and North Africa Region

OLS :Ordinary Least Squares

PTA :Preferential Trade Agreement/Arrangement

REC :Regional Economic Community

ROO :Rules of Origin

RTA :Regional Trade Agreement

SDT :State Department of Trade

SFM	:Stochastic Frontier Model
TE	:Trade Efficiency (Export Efficiency)
TIWG	:Trade and Investment Working Group (Kenya-U.S.)
U.A.E.	:United Arab Emirates
UK	:United Kingdom
US	:United States
USD	:United States Dollars
WTO	:World Trade Organization

LIST OF TABLES

LIST OF TABLES

TABLE OF CONTENTS

CHAPTER ONE: INTRODUCTION

1.0. INTRODUCTION

A synopsis of Kenya's export trade, including a summary of the operational and legislative framework that governs Kenya's export sector is provided at the beginning of the chapter. The synopsis is followed by the; problem statement; study objectives; justification and significance; and finally, the organisation of the paper.

1.1. BACKGROUND OF THE STUDY

According to the Integrated National Export Development and Promotion Strategy (SDT, 2018), Kenya has consistently pursued an export-led economic growth strategy since 1986 premised on the acknowledged contribution of exports to economic growth. It is argued in this strategy document that the growth trajectories of the emerging Asian economies between 1960 and the 1990s support the argument that a vibrant export sector is critical for the attainment of accelerated economic growth, the emergence of strong manufacturing sectors, employment creation, and poverty alleviation.

Despite official acknowledgement of the importance of exports to the national development process, a review of trade statistics over the last two decades (2000 – 2017) reveals that the rate of growth of Kenya's exports has not kept pace with the rate of growth in imports.

1.1.1 Export Sector Overview

Kenya's top five export markets by country destination in the year 2017 were Pakistan, Uganda, USA, Netherlands and the United Kingdom respectively. By region, COMESA, the European Union and the EAC held the status of Kenya's most important export destinations.

Over the decade leading up to the year 2017, Kenya's total exports grew by 116.32% from KES 274,658 million (USD 4,382 million) in 2007 to KES 594,128 million (USD 5,745 million) in 2017, while total imports grew by 185.17% from KES 605,116 million (USD 9,655 million) to KES 1,725,622 million (USD 16,687 million) (KNBS, 2007; KNBS, 2017). The result was a record BOT deficit of KES 1,131,494 million (USD 10,942 million) in the year 2017. Table 1 shows the increase in the annual Balance of Trade deficit.

TABLE 1: KENYA'S EXPORT AND IMPORT PERFORMANCE (2007 - 2017)

Year	Total Exports (KES' 000)	Total Imports (KES' 000)	Balance of Trade (KES' 000)
2007	274,657.58	605,116.80	-330.46
2008	344,946.66	770,651.18	-425.70
2009	344,948.99	788,096.74	-443.15
2010	409,540.39	947,205.59	-537.67
2011	512,604.11	1,300,749.43	-788.15
2012	113,322.35	864,770.20	-751.45
2013	502,286.35	1,413,315.60	-911.03
2014	537,235.92	1,618,321.30	-1,081.09
2015	581,045.23	1,577,556.91	-996.51
2016	578,066.86	1,431,754.54	-853.69
2017	594,128.49	1,725,622.56	-1,131.49

Source: Economic Survey, KNBS

According to the World Bank (2019), 34% of Kenya's total exports in the year 2017 went to countries in the Sub-Sahara region of Africa, 25% went to Europe and Central Asia, 13% and 12% to South Asia and MENA regions respectively, and 9% to North America. Analysis of the trend of Kenya's exports by region and country destination between the year 2010 – 2017 shows that exports to traditional market destinations; such as COMESA, the EAC, Africa in general, and the United Kingdom remained relatively restrained while total exports to distant, non-traditional markets such as the United States and Pakistan were on the rise. Table 2 shows the trends of Kenya's exports in these select market destinations between the years 2010-2017.

TABLE 2: KENYA'S EXPORTS FLOWS 2010-2017 (KES MILLIONS)

Year	2010	2011	2012	2013	2014	2015	2016	2017
COMESA	135,809.82	181,521.72	175,732.34	163,670.72	169,976.56	179,072.63	170,234.59	166,426.75
Total EAC	101,311.76	137,154.64	134,946.40	124,957.05	125,797.88	126,782.11	121,701.81	114,841.12
Total AFRICA	189,113.22	247,600.14	250,589.06	231,474.50	241,363.12	242,186.82	234,673.14	223,865.20
United Kingdom	40,211.07	47,109.87	40,630.33	37,612.52	35,868.10	40,668.30	37,581.39	38,552.67
EU	97,921.81	115,866.25	108,718.79	104,645.07	119,957.75	125,932.31	121,267.47	125,615.31
USA	22,522.18	25,772.21	26,404.81	29,936.11	38,289.78	40,724.63	43,353.94	47,269.90
M. East	30,525.08	32,939.73	42,064.80	39,502.26	35,805.71	45,207.08	50,525.44	51,374.65

Year	2010	2011	2012	2013	2014	2015	2016	2017
Pakistan	18,069.27	21,009.54	23,888.82	24,130.11	22,021.86	35,249.59	40,254.31	64,057.80
China	2,511.55	3,802.59	5,383.88	4,199.16	6,597.43	8,470.74	10,061.00	9,997.52
Total Exports	409,540.39	512,604.11	113,322.35	502,286.35	537,235.92	581,045.23	578,066.86	594,128.49

Source: Economic Survey, KNBS

The relative decline in the volume of exports to Europe and Central Asia and the increasing volumes to North America, East Asia, and the Middle East is the culmination of a longstanding trend. Table (3) shows the share of Kenya's exports by region in the year 2007 and the year 2017. Comparison of the changes recorded between these two years shows a very distinct decrease in the total share of Kenyan exports to Europe and Central Asia and a significant increase in exports to North America and the East Asia/Pacific countries.

TABLE 3: KENYA'S EXPORTS FLOWS 2010-2017 (KES MILLIONS)

KENYA	2000	2017	% Change
World	100.00%	100.00%	
Sub-Saharan Africa	33.08%	33.06%	-0.02%
Europe & Central Asia	35.20%	24.82%	-10.39%
South Asia	11.62%	12.43%	0.81%
Middle East & North Africa	11.64%	12.08%	0.44%
North America	2.70%	8.59%	5.89%
East Asia & Pacific	3.78%	6.18%	2.39%
Other Asia	0.01%	0.63%	0.62%
Latin America & Caribbean	0.24%	0.63%	0.38%

Source: World Integrated Trade Solution, World Bank (2019)

Notably, despite increasing preferential trade terms between African countries, particularly within the East African Community and the COMESA region, the relative share of Kenya's exports to Sub-Saharan countries between the year 2007 and the year 2017 did not experience significant increase.

1.1.2 Contribution of Exports to Economic Growth

The role of exports in Kenya's economic growth - measured by the percentage share of exports in total GDP - reached a peak of 28.51% in the year 2005, dropped below 20% in 2013 and maintained a steady decline reaching a low of 13.17% in 2017 (World Bank, 2019). In addition, as shown in the Table (4), the contribution of exports to GDP in Kenya over the past decade

has consistently remained below the global average and also below the average contribution in Sub-Saharan Africa:

TABLE 4: COMPARISON OF PERCENTAGE CONTRIBUTION OF EXPORTS TO GDP

Year	Percentage Contribution of Exports to Kenya's GDP	Contribution of Exports to Sub-Saharan Africa GDP	Contribution of Exports to World GDP
2008	22.67%	34.62%	30.71%
2009	20.03%	28.17%	26.50%
2010	20.66%	31.41%	28.83%
2011	21.63%	33.70%	30.53%
2012	22.23%	31.98%	30.61%
2013	19.93%	28.45%	30.41%
2014	18.30%	27.98%	30.19%
2015	16.59%	24.17%	29.31%
2016	13.97%	23.91%	28.51%
2017	13.17%	24.69%	36.95%

Source: World Integrated Trade Solution, World Bank (2019)

1.1.3 Kenya's Trade Policy Framework and Trade Agreements

Kenya's export-oriented trade policy has hitherto been anchored on several preferential trade agreements aimed at reducing the effects of tariffs and technical barriers to trade. Some of the country's most significant bilateral, regional and multilateral trade agreements include Kenya's participation in the EAC, COMESA, AGOA, the ACP-EU Economic Partnership Agreements (EPAs), among others.

Kenya's memberships to both the East African Community (EAC) and the Common Market for Eastern and Southern Africa (COMESA) free trade area collectively affords the country the opportunity to export its products to over 20 countries on duty free or preferential duty terms (SDT, 2018).

Outside the neighbouring region, Kenya, alongside other African, Caribbean and Pacific (ACP) countries, has enjoyed duty free market access into the European Union for most of its products under the Cotonou Agreement of 2000 (SDT, 2018). In order to comply with EU MAR 1528/2007 and guarantee sustainability of these preferential terms, which have been accessible

to Kenya for over 30 years courtesy of the successive Lomé conventions and most recently through the Framework for Establishment of an EPA (FEPA), the Kenyan Parliament ratified a single country EPA with the EU in October 2016 (SDT, 2017). The ratification of this agreement ensures that Kenya will continue exporting any products that qualify under the Market Access Regulation (MAR) Rules of Origin (ROO) on DFQF basis to all 28 EU countries, pending conclusion of negotiations between the EAC and the EU (SDT, 2018).

Kenya has also been a significant beneficiary of AGOA which was enacted in 2000 and remains in force up to 2025 courtesy of a series of extensions. AGOA allows Kenya and other recipient countries from the region access to the U.S. market under preferential terms for over 6000 tariff lines (SDT, 2018). Efforts to negotiate an agreement, whether on a bilateral or regional basis, to guarantee preferential market access beyond the current term's expiry date of 2025 are currently ongoing (USTR, 2018).

Kenya's framework for trade development is further complemented by the deployment of commercial representatives in Kenya's diplomatic missions abroad and the signing of over 30 complementary bilateral trade agreements with several countries; including Canada, China, Egypt, Ethiopia, India, Mauritius, Russia, South Korea, Thailand and Turkey (SDT, 2018). This is in addition to initiatives such as the ongoing US-Kenya TIWG (USTR, 2018). Kenya was among the first African Union member States to sign the Continental Free Trade Agreement (AfCFTA) under the AU framework which aims to liberalize trade in goods and services across the continent of Africa (SDT, 2018).

1.2. STATEMENT OF THE PROBLEM

The standard trade gravity model postulates that, given two bilateral partners, exports will be proportional to their respective GDPs and negatively correlated with their geographical distance. It is expected that the existence of PTAs, shared borders, and similar language will be trade-enhancing, while high tariff rates and inefficiencies occasioned by poor infrastructure, poor institutional trade support, among other constraints, will inhibit trade. A review of the contemporary trends of Kenya's exports however contradicts the expectations of the standard gravity model. Kenya's trade volumes with traditional bilateral partners; with whom it enjoys preferential treatment and where it has historical relationships; such as COMESA, the EAC regional bloc and the United Kingdom, have been on the decline, while trade with distant non-traditional partners such as Pakistan and the United States has been on the rise. This contradiction points to a need to deepen studies of the evolving nature of Kenya's export trade.

In addition to the Gravity Model contradiction, the recent relative decline in exports to neighbouring markets where Kenya has negotiated preferential terms calls for an investigation into the efficiency of the export sector. Finally, there is a lack of adequate studies comparing Kenya's actual export trade volumes and the export potential in the country's key markets.

1.3. OBJECTIVES OF THE STUDY

1.3.1. Main Objective:

The main objective is to evaluate the export potential and export efficiency of Kenya's bilateral exports to its top twenty (20) trading partners.

1.3.2. Specific Objectives:

The main objective is attained by the following specific objectives:

i. To estimate the export potential and export efficiency of Kenya's bilateral trade with its top twenty (20) trading partners

ii. To analyse factors determining Kenya's exports to its top twenty (20) market destinations; including the impact of region-specific trade agreements on Kenya's exports;

iii. To suggest policy options that can be pursued to enhance export performance.

1.4. SIGNIFICANCE OF THE STUDY

The study estimated export potential and efficiency.

The study used the comparatively more efficient stochastic frontier gravity model to study Kenya's trade in exports. Previous studies, including, Shepherd (2010); Orindi (2011), Mahona and Mjema (2014); and Ngugi (2016), used the standard gravity model to analyze determinants of Kenya's exports. The standard gravity model is however constrained by its inability to account for all aspects of the 'economic distance variable' which, in addition to geographical distance, also includes other hidden social, political and institutional constraints, which countries seek to minimize through RECs and FTAs (Kalirajan K. , 2007). As highlighted by Assefa (2007), the stochastic frontier gravity model used in this study helps overcome the common challenge of inadequate information regarding all the factors influencing the 'economic distance variable'. Additionally, since estimates from frontier models correspond to the upper limits of data, they offer the best estimates for 'free and frictionless' trade at its highest potential (Assefa, 2017).

The study used Maximum Likelihood to estimate the stochastic frontier gravity model. Use of Maximum Likelihood Estimation (MLE) enabled both the stochastic frontier gravity model and the 'export inefficiency' model to be estimated simultaneously thereby, in following with Battese & Coelli (1995), eliminated estimation biases that stem from two-tier estimation processes.

A common factor with previous studies using the standard gravity model is the use of Ordinary Least Square (OLS). As noted by Greene (1980), depending on the level of asymmetry in the dataset, MLE estimation offers numerous efficiency gains over OLS estimation method. The estimates obtained using OLS however come from, and therefore represent, centred values of the data [See Deluna & Cruz (2014); Kang & Fratianni (2006), among others]. The stochastic frontier gravity model, estimated using Maximum Likelihood Estimation (MLE), allowed this study to generate estimates that correspond to free-trade.

Finally, by using the stochastic frontier gravity model, which has not been used before to study export potential and efficiency in Kenya, the study adds substantive knowledge to the international trade literature. The model and scope of the study also offer strong theoretical and policy benefits which will be useful to Kenya's international trade negotiators and policymakers.

1.5. ORGANIZATION OF THE PAPER

Following this first chapter, Chapter 2 will briefly review the relevant theoretical and empirical literature. The methodology, model specification, data and data sources will be presented in the next Chapter. Chapter 4 will provide results of the estimation of the model and other diagnostic tests; and finally, Chapter 5 will conclude the paper with policy recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.0 INTRODUCTION

A summary of the main theories in international trade and their implications on export potential and efficiency measurement is provided in this chapter. The chapter also provides a review of trade gravity model empirical studies. In conclusion, an overview of the literature is provided.

2.1 THEORETICAL LITERATURE REVIEW

2.1.1. Classical Theories

Since the turn of the 17th Century, economists have established several theories to explain the process and the rationale for countries to trade with one another. Historical theories come from the classical school which sought to explain international trade from the perspective of the country. These include the Mercantilist Theory; Adam Smith's Absolute Advantage Theory, and David Ricardo's Comparative Advantage.

Mercantilism is considered one of the earliest attempts to come up with a sound economic theory to explain international trade. According to Salvatore (2016), mercantilists believed that a nation would only become prosperous if it exported more than it imported. The trading nations would settle any resulting export surplus mainly by gold and silver. This philosophy made the governments of the day to encourage exports while discouraging imports. According to Irwin (1992), the mercantilist concept of international trade has a striking resemblance to modern Strategic Trade Policy in that both theories believe that international trade is characterized by the predominant presence of rents arising from imperfect competition with trading countries aiming to acquire these rents for their own benefit. There is a prevailing opinion that Mercantilism ideology still exists in modern international trade. Salvatore (2016) highlights the tendency of developed industrialized countries to pursue protectionist policies in order to safeguard sensitive industries that are deemed to be important sources of domestic employment. Such practices resonate well with mercantilist philosophy.

The philosophy of the mercantilist writers lost popularity mainly after the release of Smith's "Wealth of Nations." In a two-country, two-product economy, and given Smith's absolute advantage, each trading nation will gain by focusing on the good which it produces at the lowest cost while importing the good where its production costs would be higher than those of the trading partner. Carbaugh (2009) elaborates Smith's hypothesis that the resultant specialization and division of labour would lead to an increase in overall productivity of all respective trading

nations and the trading nations would all be better off as a result. A notable weakness of Smith's absolute advantage theory, however, was that it failed to account for occasions where one nation was the efficient partner in all goods; a "looseness" that led to the development of the "Principle of Comparative Advantage" by Ricardo.

Salvatore (2016) provides a simplification of Ricardo's comparative advantage, whereby, even when a nation is less efficient in the production of both commodities, a valid rationale for trade still exists. The less efficient nation will benefit from specialising in products where it has minimum absolute disadvantage and importing the products where it has a more considerable absolute disadvantage. Despite its relative success, the underlying assumptions that underpin the theory of comparative advantage provide its main flaws. Suranovic (2015) points out that unrealistic assumptions, including the model that assumes two countries, two products and one factor of production is not in suitable to the reality of many countries, producing many goods, using a multiplicity of factors. Suranovic (2015) highlights additional assumptions such as perfect competition, fixed labour productivity, full employment, which contribute to the model's weakness. The assumption that a worker moving from one industry to another will immediately become as productive as the existing workers is also unrealistic. The comparative advantage theory further assumes that only technological differences exist between countries, which is not accurate.

The theories proposed by both Smith and Ricardo were noted to have several additional shortcomings. According to Carpenter & Dunung (2012), one such shortcoming is that both theories are not able to highlight the particular products that would give a country the stated trade advantage. The succeeding neo-classical theories attempted to resolve these weaknesses.

2.1.2. Neo-Classical Theories

In the early 20th century, Economists Eli Heckscher and Bertil Ohlin conducted studies to determine how countries could generate a trade advantage by focusing on goods which utilised the abundantly available factors. With land, labour and capital as production factors, Heckscher and Ohlin established that supply and demand determined the cost of all factors, i.e. Factors in high supply vis their demand are inexpensive; while those in high demand have a higher cost. The resultant Heckscher-Ohlin (H-O) theory states that "countries would produce and export goods that required resources or factors that were in great supply and, therefore, cheaper production factors [while], in contrast, countries would import goods that required resources that were in short supply, but higher demand" (Carpenter & Dunung, 2012, p.61).

In 1953, Wassily W. Leontief used an input-output matrix to test the soundness of the H-O theorem and its applicability to U.S. trade. Smyth (1997) notes that, during that period, capital per capita was clearly more abundant in the US than all other nations and therefore, in tandem with the Heckscher and Ohlin's theorem, the United States was expected to export a higher volume of capital-intensive goods. Leontief's study however uncovered results that were misaligned to the H-O theorem. According to Smyth (1997), US imports were paradoxically revealed to be more capital intensive than its exports, hence the Leontief Paradox. According to Ngugi (2016), Leontief paradoxical findings, and other subsequent inconclusive findings necessitated the development of alternative theories of comparative advantage to account for the vast amount of modern trade among similarly endowed countries which was not explained by Heckscher-Ohlin.

The Overlapping Demands theory, posited by Staffan Linder in 1980, is among the theories that expand on the H-O theory. Despite the relevance of the H-O theory in describing and providing a basis to the trade of primary products, Carbaugh (2009) notes that the theory falls short when it comes to explaining trade in manufactures primarily due to the importance and influence of domestic demand conditions to these type of trade. According to Salvatore (2016), the Linder Hypothesis predicts that nations will export manufactured goods where a sizeable domestic market exists and where, in attempting to cater to this domestic market, the nation acquires added efficiency that consequently enables it to export the manufactured goods to other similarly situated countries that have similar income levels and hence similar tastes. The theory assumes overlapping demand structures within nations of similar per-capita income. Notably, the theory does not necessarily overrule trade between developed and developing nations, especially in manufactures, but instead explains this occurrence by taking note of overlapping demand structures resulting from unequal income distribution within nations. In accordance with Linder's theory, we expect higher trade efficiency when measuring Kenya's trade with similarly situated economies in Africa and other parts of the world where overlapping demand structures are likely to exist.

2.1.3. New Trade Theories

According to Ciuriak, Lapham, & Wolfe (2011), in reality, international trade patterns do not align with absolute and comparative advantage arguments as presented in classical and neoclassical trade theory. Indeed, in the 1980s, Nobel prize-winner Paul Krugman pioneered the "new trade theory", which lays more emphasis on industries as opposed to countries, in

response to this growing anomaly between international trade theory and observed trade patterns. Notably, the new trade theory provides a credible basis for the incorporation of industrial policy[1] by governments. Ngugi (2016) further highlights that new trade theory seeks to address issues such as the effects of economies of scale or increasing returns, technological know-how, and other effects of added efficiency and industry-level productivity that had been left out by the mainstream theories.

According to Carbaugh (2009), the classical theory also does not sufficiently explain why regions that are characterized by relatively similar levels of productivity, e.g. Europe and the United States, continue to trade to the extents that they do. Classical theory also fails to explain continued intra-industry trade, e.g. Trade in automobiles between the leading automobiles exporting countries. To address this challenge, Carbaugh (2009) points to the increasing-returns trade theory to explain how nations with similar factor endowments, and thus negligible differences in comparative advantage, may still find it beneficial to trade by taking advantage of the prevalent phenomenon of economies of scale.

Despite the theoretical gains provided by the new trade theories, Medin (2014) notes that the theory is constrained by its inability to address the issue of entry barriers in foreign markets. According to Medin (2014), prohibitive entry barriers, including, inter alia, costs of information gathering and customer awareness creation, as well as non-tariff barriers such as differences in product standards and other regulatory requirements, require firms to make costly product adjustment before commencing export. By considering only variable costs of trade, new trade theory initially did not provide a credible theoretical basis to explain the fixed costs. This led to the development of 'new' new trade theory with heterogeneous firms to address these shortcomings. Melitz (2003) is the seminal article generally considered to have come up with this approach by shifting the focus from sectors, as was the case with new trade theory, and placing more focus on firms.

2.2 EMPIRICAL LITERATURE REVIEW

A review of empirical studies that have used the trade gravity model in its different iterations to measure export efficiency and export potential is provided in this segment. The review looks

[1] Industrial policy is any "policy aimed at influencing a country's industrial structure so as to create the highest possible national income". Industrial policy can also be deemed to be "government interventions that target certain firms or industries with different types of policy instruments; including various kinds of subsidies, taxes and public ownership, as well as other types of regulations that affect the industrial sector, such as legislation on concessions, competition and public procurement."

at studies done in foreign jurisdictions, as well as studies conducted in Kenya and its neighbouring countries.

Studies conducted in Foreign Jurisdictions

Kang & Fratianni (2006) used the stochastic frontier gravity model to measure trade efficiency in eleven regional trade agreements, 177 countries and ten geographical regions. The study estimated the model assuming that the efficiency component was half-normally distributed. A subsequent comparative evaluation between the results of the stochastic frontier estimation and results from OLS estimates was also performed. The findings of their study computed low efficiency measures due to large disparities between potential and actual trade flows which were taken to imply that frictions in international trade are still very large for virtually all countries (globally).

Hassan (2017) used a stochastic frontier methodology to study the determinants and constraints in the export industry in Bangladesh. The study's aim was to expose unutilized export potential between Bangladesh and its top 40 trading partners. Hassan (2017) concluded that Bangladesh's volume of exports was primarily influenced by distance, GDP, population, exchange rates, preferential agreements and average tariff rates. Distance and tariffs affected exports adversely, while additional trade agreements, depreciation of exchange rate, population and GDP growth boosted exports. Other factors noted to constrain Bangladesh's exports included corruption, port inefficiencies, and restrictive border and customs procedures. Hassan proposed that removing these constraints would unshackle untapped potential for trade, especially within countries in the same regional bloc.

A study done by Miankhel, Thangavelu & Kalirajan (2009) investigated Australia's export trade with 65 trading partners from 2006 to 2008 using the gravity approach. The study found output growth (GDP) of the trading partner to be positively correlated to the growth of Australia's exports, while distance had the opposite effect. Population and tariffs however were not found to be significant variables in this study. Miankhel, Thangavelu & Kalirajan (2009) revealed unexploited trade potential for Australia with the United Kingdom, New Zealand, France, Germany, Switzerland and Canada, while also finding significant potential to increase trade within the ASEAN and East Asia Region. Their study however found that for some products, such as those from fishing, forestry and agriculture, trade between China and Australia had surpassed the potential estimated by the gravity model. Similar findings of

overtrading were also revealed when the study explored the potential of SAARC from a regional perspective as opposed to individual countries.

Daluna (2013), and later, Daluna Jr. & Cruz (2014) studied Philippines' trade with 69 of its main partners between 2009 and 2012 using the stochastic frontier model. The study defined 'potential trade' as "the maximum possible trade that can occur between two countries that have liberalised their trade restrictions the most, given the provided trade determinants" (Daluna Jr. & Cruz, 2014, p. 007). The study argued that, unlike the OLS estimated augmented gravity models used in some of the previous studies, the stochastic frontier model would provide the most realistic approximations of 'potential trade'. The study used the coefficients obtained from the model to approximate the export potential and efficiency of each of the sampled countries and to reveal country groups effects. The study concluded that merchandise exports in the Philippines were affected by changes in the bilateral partner's income and population, in addition to reduction in corruption, membership to preferential trading groups such as ASEAN, APEC and the WTO, common language, among others.

Notwithstanding increasing interest in the method, studies using the Gravity Model approach to explain Kenya's external trade sector remain scarce. Orindi (2011) used a standard trade gravity model to reveal the determinants of Kenya's exports and to test the influence of trade-resistant factors, such as geographical distance and policy-related factors. Her study evaluated Kenya's export trade with 25 principal bilateral trading partners using OLS estimation and panel data. The study found that the importing country's economic size (income) and its population had a positive influence on Kenya's exports, while geographical distance, as predicted by the standard gravity equation, was negatively correlated with exports. Orindi (2011) further determined that large population countries, especially those with populations above 100 million such as Japan, China, and the United States, were importing from Kenya at levels below the model's predictions. Her study also revealed the highest unrealised export capacity in Spain, Italy, France and Canada. There was also notable unrealised potential, though at a lesser degree, in the UK, Malaysia and Greece.

Ngugi (2016) also studied Kenya's bilateral trade flows with other EAC countries using the standard gravity model. The study aimed to measure the effects of factors such as GDP, distance, RTAs, transport infrastructure and institutional quality on Kenya's bilateral trade flows. The sample of trading partners was selected through a judgmental sampling technique whereby large trading volumes indicate key trading partners and small volumes indicate

otherwise. The study employed OLS and random effects methods to estimate an augmented gravity model equation and found that both countries' GDP positively and significantly influenced exports. It also found that internal transport infrastructure and institutional quality have a favourable influence on trade flows. However, contrary to standard gravity model expectation, membership to the EAC was not revealed to be consequential. The study deduced that the pattern of Kenya's bilateral trade strongly follows the Linder Hypothesis. Her findings also indicated that Kenya exported to and traded more intensely with countries with similar per capita income, factor endowments and demand structures.

Mahona & Mjema (2014) used an aggregated gravity model to study trade and its determinants within the EAC and also to reveal why two countries, Kenya and Tanzania in particular, seemed to dominate trade within the regional bloc. Among the primary findings of the study is that, contrary to Ngugi (2016), empirical evidence seem to show that liberalisation measures, and the formation of the EAC, has a significant and influence on trade. Economic size (GDP) was found to exert a positive influence on exports. The study highlighted that, for trade between Kenya and Tanzania, GDP, rather than GDP per capita, was the significant factor. Since GDP reflects the production capacity of a country as well as the consumption and export capacity, this finding was deemed ordinary. The study also found geographical distance to have adverse effects on trade, implying that several barriers affecting cost of trading, market access, and time-constraints exist within the bloc. In addition to GDP and distance, other notable factors affecting trade in the EAC were noted to be population size, exchange rate coefficient and trade openness.

Shepherd (2010) used the standard gravity model to investigate whether EAC countries were trading below their potential. The study found that, once their respective economic fundamentals are controlled for, the gravity model discloses little evidence that EAC countries are undertrading in industrial products. Indeed, performance on the import side appeared quite strong. The study however found evidence that trade facilitation and logistics performance constitute a significant barrier to further integration with international markets. In the agricultural sector, the study showed strong performance on the import side, as well as relatively strong intra-regional trade performance. The study further found the impact of tariffs and trade facilitation (as barriers to further integration) to be less critical in the agricultural sector than in the industrial sector and postulated that this could be as a result of proliferation of non-tariff measures in the agricultural sector. The study concluded that boosting trade performance in the EAC could be achieved through lowering of the relatively high tariffs,

improving the logistics environment and trade facilitation, and giving more attention to non-tariff measures in the agricultural sector.

2.3 OVERVIEW OF LITERATURE

The theoretical literature review seeks to shed light on the implications of the main international trade theories on estimation of export potential and efficiency. Firstly, the reemergence of mercantilist policies, mainly in the agriculture sectors of industrial nations (Salvatore, 2016), has interpretative value on constrained export potential and increased inefficiencies in bilateral trade between Kenya and industrialized nations. Secondly, the traditional dominance of labour-intensive agricultural exports in Kenya and the predominant importation of capital goods such as machinery and capital leads to a prediction that the H-O factor-endowments model, explained by Carpenter & Dunung (2012), is applicable to the Kenyan context. High export efficiency should therefore be evident in Kenya's trade with capital-intensive countries. Thirdly, in contradiction to the Linder hypothesis explained by Salvatore (2016), Kenya's recent trade statistics (See Table 3) show that exports to neighbouring and similarly situated economies, where overlapping demands are expected, are on the decline, while exports to disparate and distant economies such as the United States are on the increase. Finally, Melitz (2003); Carbaugh (2009); Medin (2014) Ciuriak, Lapham, & Wolfe (2011); and Ngugi (2016); highlight contributions of the New and New "New" trade which conform well to the policy objectives of this study primarily due to their accommodation of industrial policy and government intervention as a means of aiding domestic exports.

Regarding the empirical findings, there are compelling arguments on the stochastic frontier gravity model's capacity to provide credible empirical estimates of export potential and export efficiency (Daluna Jr. & Cruz, 2014). Kang & Fratianni (2006) found persistent frictions in international trade causing large disparities between potential and actual trade flows globally; Hassan (2017) found that distance and tariffs are negatively correlated to export growth, while preferential trade agreements, population growth and GDP growth boosts exports; Miankhel, Thangavelu, & Kalirajan (2009) found GDP growth in the trading partner to be export enhancing, distance to be a hindrance to exports, and population increases and tariffs to be insignificant; Daluna Jr. & Cruz (2014) found GDP, population and membership to RECs to be significant factors in the estimation of potential trade flows; and Mahona & Mjema (2014) found GDP, population, distance and exchange rates to be significant in the estimation of trade within the EAC. Additionally, the empirical review indicated the presence of differing conclusions on one of the main specific objectives of this study, i.e. analyzing the impact of

region-specific trade agreements on Kenya's exports, with Ngugi (2016), Mahona & Mjema (2014) and Shepherd (2010) all arriving at varying conclusions on the significance of trade liberalisation and EAC membership. With regard to Kenya's export potential, Orindi (2011), using a standard gravity model, concluded that the highest unrealized potential for Kenya's exports were in Spain, Italy, France and Canada, and less substantially, the United Kingdom, Malaysia and Greece.

CHAPTER THREE: METHODOLOGY

3.1 INTRODUCTION

The theoretical framework presented in this section is based on the standard Newtonian gravity equation and its subsequent adaptations to global trade analysis. The framework incorporates the stochastic frontier estimation technique to augment the gravity model.

3.2 ANALYTICAL FRAMEWORK

3.2.1 The Trade Gravity Model

The trade gravity model is analogical to the law of universal gravitation proposed by Isaac Newton in 1687. Newton's model, shown in equation (1) below, explains gravitational force (F_{ij}) on the basis of the respective masses (M_iM_j) of two objects *i* and *j*, and the distance (d_{ij}) between them:

$$\boldsymbol{F_{ij} = G\frac{M_iM_j}{d_{ij}^2}} \quad \text{----------} \quad (1)$$

The first attempt to adopt the law of universal gravitation to the field of international trade is attributed to Tinbergen (1962), who proposed the following trade gravity equation based on Newton's model:

$$X_{ij} = A\frac{y_i^{\propto}y_j^{\beta}}{D_{ij}^{\gamma}} \quad \text{----------} \quad (2)$$

In this instance, α and β are, respectively, the elasticities of the exporting and importing countries GDP's, while γ is the elasticity of distance. A linear relationship of Tinbergen's trade gravity equation can be derived by taking the natural logs and adding an error term. The resultant linear is relationship indicated in equation (3):

$$\log(X_{ij}) = \log A + \alpha\log(Y_i) + \beta\log Y_j - \gamma\log(D_{ij}) + \varepsilon_{ij} \quad \text{----------} \quad (3)$$

Tinbergen's model, however, was criticised for lacking theoretical grounding in international economics. Anderson (1979) contributed to finding a resolution to this challenge. By providing a case built upon Constant Elasticities of Substitution (CES), and with the assumption of homothetic preferences for trade in goods across countries, Anderson (1979) came up with the specification of aggregated trade flows in equation (4) which established the foundational theoretical basis of the trade gravity model:

$$X_{ij} = \frac{\Upsilon_i \Phi_i}{\sum_j \Upsilon_j \Phi_j \frac{1}{f(d_{ij})}} \cdot \frac{\Phi_j \Upsilon_j}{f(d_{ij})} = \frac{\Upsilon_i \Phi_i \Phi_j \Upsilon_j}{f(d_{ij})} \left[\sum_j \Upsilon_j \Phi_j \frac{1}{f(d_{ij})}\right]^{-1} \text{----------(4)}$$

Equation (4) can be rewritten as equation (5) below by adding the error term ε_{ij}:

$$X_{ij} = \frac{\Upsilon_i \Phi_i \Phi_j \Upsilon_j}{\sum_j \Upsilon_j \Phi_j} \frac{1}{f(d_{ij})} \left[\sum_j \frac{\Upsilon_j \Phi_j}{\sum_j \Phi_j \Upsilon_j} \frac{1}{f(d_{ij})}\right]^{-1} \varepsilon_{ij} \text{----------(5)}$$

Where;

X_{ij} represents the total exports from *i* to *j; Y_i* represents the GDP (income) of country *i; d_{ij}* is the distance between *i* and *j;* and ϕ_i is the expenditure on all trade measured as a share of total expenditure in country *i.*

[$\phi_i = F(Y_i N_i)$ where N_i is the total population of i].

According to Anderson (1979), the bracketed term in equation (5) measures the relative economic distance which captures all the inefficiencies that act as barriers to exports, which may include cultural and political differences, regulatory barriers, institutional barriers, poor infrastructure, ethical concerns, among others.

3.2.2 The Stochastic Frontier Gravity Model

The Stochastic Frontier Gravity Model combines the trade gravity model proposed by Tinbergen (1962) with the stochastic frontier production model attributed to Aigner, Lovell, & Schmidt (1977).

The Stochastic Frontier Production Model

Aigner, Lovell, & Schmidt (1977) observed that, with traditional production functions, econometricians had been estimating average production functions based on the parametric production function in equation (6):

$$Y_i = f(X_i; \beta) + \varepsilon_i \text{----------} (6)$$

Where Y_i is output, X_i represents an inputs vector, β is a vector of parameters for estimation, and ε_i is the one-sided disturbance providing a statistical basis for the function. Aigner, Lovell, & Schmidt (1977) extended this equation by redefining the structure of the error term ε_i as follows:

$$\varepsilon_i = \nu_i + \mu_i \text{ ---------- (7)}$$

They argued that this specification was based on the notion that a firm's production process is characterized by two "economically distinguishable random disturbances with different characteristics" which enable estimation and interpretation of the frontier. In this case "μ_i reflects the fact that each firm must lie on or below its frontier $[f(\chi_i; \beta) + \nu_i]$ with all deviations coming from factors under the firms' control [and] …the frontier itself can vary randomly across firms or even over time for the same firm implying therefore that the frontier itself is stochastic, with random disturbance $\nu_i \lessgtr 0$ being the result of favourable and unfavourable external events. Observation errors and measurement on Υ_i may also contribute to $\nu_i \lessgtr 0$" (Aigner, Lovell, & Schmidt, 1977, p. 25).

The Stochastic Frontier Gravity Model

Integration of the concept of stochastic frontier estimation into the standard trade gravity equation is attributed to Kalirajan (2000). The resultant Stochastic Frontier Gravity Model enables prediction of bilateral exports using the model in equation (8) below:

$$\ln X_{ijt} = \ln f(Y_{ijt}; \beta) \exp^{(v_{ijt} - U_{ijt})} \text{ ---------- (8)}$$

Where:

X_{ijt} = total exports between countries i and j recorded at year t

$f(Y_{ijt}; \beta)$ = determinants of maximum trade potential (Y_{ijt})

β = unidentified or unknown parameters vector

u_{ijt} = single-sided error term measuring the 'inefficiencies' in the trading system

v_{ijt} = double-sided error term capturing left out variables and randomly distributed errors of measurement in the sample

Daluna Jr. (2013) argues that the variance in actual and potential trade arises from the inefficiencies or economic distance bias – represented by u_{ijt}. The error term ranges between 0 and 1 and when $0<u_{ijt}<1$, the economic distance bias is significant and is responsible for inefficiencies in the country's export function.

Miankhel, Thangavelu & Kalirajan (2009) and Daluna Jr. (2013) find four key advantages of the stochastic frontier gravity approach. These include; the model's ability to safeguard its estimation efficiency; second, its ability to correct for bias arising from the use of geographical distance as a proxy for economic distance; third, its ability to generate trade estimates that closely mirror free and frictionless trade; and finally, its ability to provide credible policy and theoretical inferences on how to handle the historical, institutional and cultural hindrances to free trade.

3.2.3 Estimating Export Potential and Efficiency

The Stochastic Frontier Production Model defines a country to have achieved export efficiency when the country is producing at the frontier of the export function. It is assumed that, at the frontier, export trade is conducted with no restrictions and the highest possible exports levels are achieved. However, taking into account the implausibility of finding a bilateral trade system devoid of any frictions to trade, Hassan (2017) argues that 'export potential' can be defined more realistically as the maximum level of exports which a country can attain given the determinants of its export function.

In this context, export efficiency (EE) is the ratio of actual to potential exports, as shown in equation (9):

$$\text{Export Efficiency (EE)} = E\left[\frac{exp(-U_{it})}{\varepsilon_{it}}\right] \quad \text{(9)}$$

3.3 ECONOMETRIC MODEL

This study estimated a log-linear specification of the stochastic frontier gravity equation, presented in equation (10):

$$\ln \boldsymbol{X_{ijt}} = \boldsymbol{\beta_0} + \boldsymbol{\beta_1} \ln \Upsilon_{it} + \boldsymbol{\beta_2} \ln \Upsilon_{jt} + \boldsymbol{\beta_3} \ln \mathrm{P}_{it} + \boldsymbol{\beta_4} \ln \mathrm{P}_{jt} + \boldsymbol{\beta_5 ExR_{ij}} + \boldsymbol{\beta_6} \ln \boldsymbol{d_{ij}} + \boldsymbol{\beta_7 Year} - \mu_{ijt} + \boldsymbol{\upsilon_{ijt}} \quad \text{(10)}$$

Where:

X_{ijt} = exports from Kenya (country *i*) to bilateral trading partner (country *j*)

Υ_{it} = total GDP of Kenya (country *i*) during year *t*

Υ_{jt} = total GDP of trading partner *j* at year *t*

P_{it} = population of Kenya at year *t* - representing market size

P_{jt} = population of trading partner *j* at year *t*

ExR_{ij} = average foreign exchange rate (per unit of *kshs*)

d_{ij} = distance in kilometres between the respective bilateral trading countries' capital cities

$Year_{ijt}$ = Year of observation of exports from Kenya (country *i*) to bilateral trading partner (country *j*) representing annual neutral 'technological' change in exports.

μ_{ijt} = single-sided error term showing the variance between actual and potential exports.

υ_{ijt} = double-sided error term measuring the influences of omitted variables as well as randomly distributed sampling errors.

The error term is this model is specified as: $\varepsilon_{ijt} = \boldsymbol{\upsilon_{ijt}} - \mu_{ijt}$

The resultant inefficiency model, which explains the significant factors that contribute to Kenya's export inefficiencies, is detailed in the equation below:

$$\mu_{ijt} = \boldsymbol{\delta_0} + \boldsymbol{\delta_1 Av\mathrm{T}_j} + \boldsymbol{\delta_3 DAGOA_j} + \boldsymbol{\delta_4 DEuro_j} + \boldsymbol{\delta_5 Comesa_j} + \boldsymbol{\upsilon_{ijt}} \quad \text{(11)}$$

Where:

$Av\mathrm{T}_j$ = average tariff rate imposed by *country j*

$DAGOA_j$ = dummy variable for AGOA export partner

$DEuro_j$ = dummy variable for membership to the European Union (EU) by *country j:*

$DComesa_j$ = dummy variable for membership to COMESA by *country j:*

δ_0 = country-specific intercept term

$\delta_{i=1,2\ldots5}$ = measurable model parameters

NB: All applicable dummy variables are equal to 1 if applicable and 0 if not applicable

The Battese and Coelli (1995)[2] single-stage maximum likelihood procedure will be used to estimate the model.

[2] Battese & Coelli (1995) proposed a model for estimating technical inefficiency effects in a stochastic frontier production function for panel data based on the work of Aigner, Lovell, & Schmidt (1977). Provided that the inefficiency effects are stochastic, Battese & Coelli's model permits simultaneous measurement of the stochastic frontier, as well as the technical inefficiencies that vary with time. Battese & Coelli (1995) had observed that early empirical papers used a two-stage approach to measure technical inefficiency in firm-level production whereby the first stage involved estimation of the stochastic frontier production function as well as estimating the technical inefficiency effects which were assumed to be

Expected Results

Per the specifications of the trade gravity model, it is anticipated that the signs Υ_{it}, Υ_{jt}, P_{it} and P_{jt} will be positive. The reason is that both Υ and P are, respectively, used in the model to represent income and market size. Geographical distance stands-in for economic distance and, therefore, a negative sign is expected in the estimation of d_{ij}. Economic theory expects that depreciation of a country's currency relative to its trading partner will boost exports and therefore ExR_{ij} is expected to be positively correlated to X_{ijt}. Since tariffs impede exports, a negative sign is anticipated for the estimation of AvT_j. The sign for $DPTA_{ij}$ should be positive since PTAs generally facilitate increased exports. Since countries that are members of the EU and COMESA are traditionally among Kenya's major export destinations, the signs for the dummy variables $DEuro_j$ and $DComesa_j$ which capture country *j*'s membership to these two regional blocs is likely to be positive. Finally, $Year_{ijt}$ is expected to be positive implying positive 'technological' change in exports per year.

3.4 DATA AND MEASUREMENT OF VARIABLES

This study will use a panel data of Kenya's exports to its top 20 export markets from the year 2008 to 2017. Kenya's top twenty (20) export destinations in the year 2017 were selected as the representation of the country's export markets globally and were considered to be representative of critical groups. These include: regional economies with strong bilateral and regional trade ties (e.g. EAC countries), traditional markets with strong historical and institutional ties(e.g. the Netherlands and the United Kingdom represent), non-traditional markets in countries with limited institutional, cultural and historical links with Kenya (e.g. Pakistan), and distant non-traditional markets with huge economic weight and significant institutional ties with Kenya (e.g. the United States).

identically distributed and the second step involved specification of a regression model for the 'predicted' technical inefficiency effects. This two-step approach contradicted the assumption of identically distributed inefficiency effects in the stochastic frontier. Consequently, Battese & Coelli (1995) proposed that the maximum likelihood method would provide a better method for simultaneous estimation of both the parameters of the stochastic frontier as well as the technical inefficiency effects model. The proposed likelihood function, expressed in terms of the variance parameters, is $\sigma_v^2 + \sigma^2$ and $\gamma \equiv \sigma^2/\sigma_s^2$. The technical efficiency of production for the i^{th} firm at the t^{th} observation is defined by the equation: $TE_{it} = exp(-U_{it}) = exp(-z_{it}\delta - W_{it})$.

TABLE 5: DATA AND DATA SOURCES

Data	Description	Source
1. Export destinations	Top 20 Export Destinations in the year 2017	World Bank WITS database (2019)
2. Total Exports[3]	Total Exports (FOB) from Kenya to sample countries in US$ (millions)	IMF Direction of Trade (DOTS) Database (2019)
3. GDP	Kenya and Country j GDP in Constant 2010 US$ (millions)	World Bank Group, World Development Indicators (WDI) Database (2019)
4. Population	Total Population in Kenya and trading partner country j at time period t (millions)	World Bank Group, World Development Indicators (WDI) Database (2019)
5. Geographical Distance	Geodesic distances calculated following the great circle formula, which uses latitudes and longitudes of the geographic coordinates of the capital cities and also incorporates internal distances (kilometres)	CEPII GeoDist database, Mayer & Zignago (2011)
6. Average Tariff Rates[4]	Applied, simple mean, all products (%)	World Bank Group, World Development Indicators (WDI)[5] Database (2019)
7. Exchange Rates	Average rate of currency of trading partner j, at time t, per Kshs	IMF International Financial Statistics (IFS) database (2019)
8. Preferential Trade Agreements	Membership of sample countries to the European Union, COMESA, EAC and AGOA	World Trade Organisation (WTO) Regional Trade Agreements (RTA) database (2019) and WTO Database on Preferential Trade Arrangements (2019)

Source: Author's compilation (All sources included in the table)

[3] Data for the Sudan and the Republic of South Sudan commences after South Sudan's independence in 2011. To avoid bias and duplication, pre-2011 data for both countries is omitted.

[4] Annual country-specific data for Exchange Rates and Average Tariffs which are not available are computed using an average of the preceding three years.

[5] Average Tariffs for Somalia are represented by the Sub-Saharan Africa average due to unavailability of country specific data

3.5 ESTIMATION PROCEDURE

The stochastic frontier trade gravity model captured in equation (10) and the trade inefficiency model presented in equation (11) were estimated using the Battese and Coelli (1995) simultaneous estimation approach.

The degree of the deviations from the gravity model frontier that are explained by the inefficiency component were estimated using the 'goodness-of-fit' measurement proposed by Aigner, Lovell, & Schmidt (1977). This "goodness-of-fit" measurement confirms the applicability or otherwise of the stochastic frontier gravity model.

CHAPTER FOUR: PRESENTATION AND DISCUSSION OF RESULTS

4.1 INTRODUCTION

This Chapter will present the empirical results and an analytical interpretation of the results. Descriptive statistics will be presented at the beginning, followed by the diagnostic tests outlined in the previous Chapter. Results of the econometric estimation of the Stochastic Frontier Gravity Model and a discussion of the results will conclude the Chapter.

4.2 SUMMARY STATISTICS

Data was collected from the top twenty (20) export destinations for Kenyan exports in the year 2017, according to the World Integrated Trade Solution (World Bank, 2017). A full list is provided in Annex (1) of this paper. Table (6) provides a statistical summary of the data used in this paper.

TABLE 6: SUMMARY STATISTICS

Variable	Obs	Mean	Std.Dev.	Min	Max
X_ijt	191	217.178	175.465	17.756	845.196
Y_i	191	46499.56	7271.407	35717.36	58108.88
Y_j	191	1900000	3790000	1038.101	1.73e+07
P_i	191	45.111	3.338	39.792	50.221
P_j	191	139.588	295.757	7.089	1386.395
d_ij	191	4108.699	3249.979	506.059	12152.02
AvT_j	191	8.482	4.806	2.09	18.66
ExR_ij	191	34.614	47.347	.002	149.997

Created using asdoc, a STATA program written by Shah(2018)

Data for the Sudan and the Republic of South Sudan commences after South Sudan's independence in 2011. To avoid bias and duplication, pre-2011 data for both countries are omitted. This explains the count of 191 observations from the expected 200. During the period under review, Kenya's GDP increased from $35,717 million US dollars to $58,109 million US dollars. The population grew from 39.7 million in 20078 to 50.2 million in 2017. Export destinations ranged from small-sized economies of $1,038 million U.S. dollars in GDP to large economies of up to 1.73 trillion U.S. dollar in GDP. The average distance ranged from neighbouring countries whose trade capitals are 506 kilometres away, up to countries that were

12,152 kilometres away. The lowest average tariff charged on imports at any of the selected markets was 2.09%, while the highest average tariff charged was 18.66%.

4.3 STOCHASTIC FRONTIER GRAVITY MODEL ESTIMATES

4.3.1 Maximum Likelihood Estimates

The results of the econometric estimation of the Battese and Coelli (1995) Inefficiency Effects Model (truncated-normal) are presented below:

TABLE 7: MAXIMUM LIKELIHOOD ESTIMATES

VARIABLES	(1) Frontier	(2) Mu	(3) Usigma	(4) Vsigma
lnY_it	6.160			
	(4.819)			
lnY_jt	0.251***			
	(0.0434)			
lnP_it	-26.84***			
	(9.944)			
lnP_jt	-0.526***			
	(0.0811)			
lnD_ij	0.00223			
	(0.101)			
lnExR_ij	-0.162***			
	(0.0283)			
Year	0.402***			
	(0.00703)			
lnAvT_j		-1.611***		
		(0.298)		
D_AGOA		-6.734**		
		(3.302)		
DEuro_j		-2.233***		
		(0.355)		
DComesa_j		0.599***		
		(0.230)		
Constant	-767.8	4.662***	-0.453***	-3.733***
	(0)	(0.575)	(0.162)	(0.570)
Observations	191	191	191	191
Number of Country_n	20	20	20	20

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table (7): Maximum Likelihood Estimates …Cont'd

Inefficiency effects model (truncated-normal)	Number of obs	=	191
Group variable: Country_n	Number of groups	=	20
Time variable: Year	Obs per group: min	=	5
	avg =	9.6	
	max =	10	
	Sigma_u (σ_μ)	=	0.7975052
	Sigma_v (σ_v)	=	0.1546812
	Prob > chi2	=	0.0000
Log likelihood = -189.2419	Wald chi2(6)	=	5716.07

Summary of the Stochastic Frontier Trade Gravity Model Estimates

The study found that the coefficient for time (Year), log of the GDP in the importing country (lnY_jt), Populations in both countries (lnP_it and lnP_jt), distance (lnD_ij) and exchange rate (lnExR_ij) are significant in explaining Kenya's exports.

The "Year' coefficient in the stochastic frontier trade gravity model reveals small but significant increases in exports over the sample period that may result from neutral technological change or man-made efficiencies that contribute to increase in trade over time. In line with the previous studies [See, Miankhel, Thangavelu, & Kalirajan (2009); Hassan, (2017); Daluna Jr. & Cruz (2014), etc.] and also in line with the standard gravity model, the estimated parameters of lnY_it and lnY_jt were both found to be positive.

The estimated parameters for population in the home economy (lnP_it) and the export market (lnP_jt), which are used as proxies for market size, were found to be negative which contradicts the trade gravity model theory. This may be explained by the recent trend of Kenya's exports which seem to be declining even as the home market size and the partner country's market size increases. Previous studies on this area, including Mahona & Mjema, (2014); Daluna Jr. & Cruz (2014); and Hassan (2017), found population to be trade enhancing. Miankhel, Thangavelu, & Kalirajan (2009) found population increase to be insignificant.

In the trade gravity model, the 'distance' variable acts as a proxy to the cost of doing trade, including the cost of communication and transportation and is therefore expected to have adverse effect on exports. The estimated coefficient of the distance parameter (lnD_ij) in this study were however found to be positive and not significant. This may imply that geographical distance is a poor proxy for economic distance in the case of Kenya. In some instances, it may

be less costly for exporters to trade with economies that are further away from Kenya compared to those in Kenya's proximity.

The estimated exchange rate elasticity (lnExR_ij) was found to be low at -0.162. This implies therefore that, contrary to standard economic theory, the percentage change of exports due to a relative increase in exchange rate (a relative depreciation of the Kenya shilling) is -0.162.

Summary of the Inefficiency Model Estimates

The results of the export inefficiency model (equation 11) are also captured in table (7) above. The results show that, other than the coefficient of the COMESA dummy variable, all the coefficients related to preferential trade agreements are statistically significant and positive as expected by the trade gravity theory. It is important to note that the coefficients in this equation capture the inefficiency effects and therefore the negative signs indicated for the AGOA membership dummy variable (D_AGOA), the European Union membership dummy variable (DEuro_j) imply lower inefficiency compared to the countries in the sample that are not members of the respective trade association. Holding other factors constant therefore, Kenya's exports to its AGOA partner was more efficient by 6.734 compared to exports to other countries in the sample, while exports to countries that are part of the EU were found to be 2.233 more efficient than exports to non-EU countries in the sample. Exports to COMESA member countries were however revealed to have greater inefficiency of 0.599 compared to other countries in the sample, a finding that is backed by actual export figures in the same period.

The coefficient for average tariff elasticity of exports in the inefficiency model was found to be -1.611; indicating that general increases in average tariffs in the sample countries seems to reduce inefficiency of Kenya's exports by the same factor. Though counterintuitive to the trade gravity model, a credible explanation could be that institutional trading arrangements in the sample countries provide preferential access for Kenyan goods even as average tariffs in the importing country increase.

In summary, the study found that population growth, exchange rates and membership to COMESA contribute to trade inefficiency while Kenya's trade efficiency is enhanced by the GDP of the importing nation, membership to the European Union and membership to AGOA. The time trend was also found to be statistically significant. It can therefore be added to the model as a proxy for man-made efficiencies that contribute to increase in trade over time.

4.3.2 Export Efficiency Estimates Per Country

Equation (9) shows the calculation of Export Efficiency (EE). Since Export Efficiency (EE) is presented as a ratio of actual to potential exports and its value expressed as a percentage, its range is restricted between 0% - 100%.

Table (8) presents a tabulation of the estimated average trade efficiency. The resultant estimates are further used to rank Kenya's top 20 export partners in the order of their estimated export efficiency for the 2008 to 2017 period.

TABLE 8: EXPORT EFFICIENCY ESTIMATES PER COUNTRY, 2008-2017

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Ave.TE
United States	87.73	78.86	81.19	82.73	87.19	88.98	89.78	86.72	89.71	90.13	86.30
United Kingdom	91.50	90.57	86.01	87.13	84.53	76.77	82.76	78.45	55.25	51.96	78.49
Pakistan	66.89	67.24	66.09	68.31	79.97	76.03	80.80	76.58	84.37	94.01	76.03
Uganda	78.73	80.28	75.42	87.03	85.54	81.64	65.82	58.06	56.39	52.15	72.11
Egypt, Arab Rep.	66.11	50.95	62.85	70.85	69.98	52.11	51.97	47.57	42.56	33.84	54.88
Tanzania	64.13	63.12	57.18	62.01	73.45	62.21	53.08	46.87	36.14	27.60	54.58
Netherlands	49.73	48.14	40.76	44.04	44.56	44.03	60.16	54.86	40.88	38.14	46.53
South Sudan	.	.	.	.	.	45.56	51.18	37.80	22.11	19.81	35.29
Congo, Dem Rep.	33.00	34.45	31.43	38.03	42.74	41.24	36.22	33.08	31.22	26.00	34.74
China	18.92	20.21	16.65	21.72	32.71	23.78	33.01	30.40	37.72	34.40	26.95
Ethiopia	32.64	29.53	23.75	22.34	22.62	22.26	32.13	29.64	24.65	19.48	25.90
Somalia	83.80	16.74	16.25	18.31	23.17	20.68	15.67	14.26	15.57	15.72	24.02
U.A.E	9.69	13.51	20.52	19.09	28.84	23.70	20.51	18.87	20.39	16.41	19.15
Germany	19.59	22.73	19.08	16.83	22.91	18.32	17.38	15.39	18.34	16.78	18.73
Rwanda	16.31	16.55	14.96	16.76	21.14	16.84	17.40	15.94	14.79	13.30	16.40
Sudan	.	.	.	.	21.86	19.37	17.05	14.02	11.07	13.23	16.10
France	15.11	12.82	12.60	12.45	11.62	11.97	12.17	10.93	10.18	11.28	12.11
Russian Federation	10.12	10.29	10.37	11.77	14.17	13.63	12.55	10.63	8.80	9.43	11.18
Burundi	6.71	8.59	8.39	8.10	7.78	7.69	9.78	9.32	7.33	6.98	8.07
Saudi Arabia	3.22	3.03	3.17	3.74	5.55	5.07	10.45	10.17	7.65	8.34	6.04
	Total Average Export Trade Efficiency between 2008-2017 (Percentage)										36.18

The mean trade efficiency was 36% . The least efficiency recorded during the period was 3.03% recorded in Saudi Arabia in the year 2009 while the highest efficiency was 94.01% with reference to Kenya's exports to Pakistan in the year 2017.

During the period under review, Kenya traded most efficiently with the United States where a TE of 86.3% was recorded. This efficiency is arguably attributable to the benefits of AGOA utilization by Kenyan exporters and is in conformity with recent trade figures. Kenya's exports to the United Kingdom were equally characterized by high efficiency with an average of 78.49% recorded during the period. According to these estimates, Kenya could have increased

its exports to the UK by an average of 21.51% during the period under review (2008-2017) through the removal of trade restrictions between the two countries. It is however notable that the trend of Kenya's trade efficiency with the United Kingdom has been on a steady downward trend since the year 2007 achieving a high efficiency level of 91.5% in 2008 and a low efficiency level of 51.96% in the year 2017.

For clarity purposes, this study classified Kenya's export efficiency in the following categories:

Ave. Trade Efficiency	Category	Countries
70-90%	High	United States, United Kingdom, Pakistan, Uganda
45-55%	Moderate	Egypt, Tanzania, Netherlands
20-40%	Low	South Sudan, DRC, China, Ethiopia, Somalia
10-20%	Very Low	U.A.E., Germany, Rwanda, Sudan, France, Russia
0-10%	Extreme Low	Burundi, Saudi Arabia

The ranking and classification reveals that Kenya's trade efficiency with most of its trading partners was less than 40%. The lowest average efficiency level is revealed in Kenya's exports to Saudi Arabia (6.04%), and with Burundi (8.07%), these were the only markets where Kenya had export efficiency estimates of less than 10%. In 14 out of the 20 sampled countries (70%), Kenya's export efficiency ranged between 10% - 55%.

4.3.3 Export Efficiency Estimates by Region

In general, this study finds low average estimates of Kenya's export efficiency when efficiency is evaluated by its key trading regions (i.e. where Kenya has an active preferential trade arrangement). Estimates from all key regions ranged between 30% - 40%, as shown in table (9):

TABLE 9: TECHNICAL EFFICIENCY ESTIMATES PER REGION, 2008-2017

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Ave. TE
EAC	41.47	42.14	38.99	43.48	46.98	42.79	39.45	33.60	27.35	23.97	37.29
COMESA	38.92	36.73	36.13	40.52	38.81	34.45	32.91	29.66	26.86	23.57	32.60
Africa	47.68	37.53	36.28	40.43	40.92	36.96	35.03	30.65	26.18	22.81	34.21
EU	43.98	43.57	39.61	40.11	40.90	37.77	43.12	39.90	31.16	29.54	38.97
Others	32.76	32.19	33.00	34.56	41.41	38.53	41.18	38.90	41.44	42.12	37.61
Total Ave.	**41.89**	**37.09**	**35.93**	**38.40**	**41.07**	**37.59**	**38.49**	**34.98**	**31.76**	**29.95**	**36.18**

The results indicate escalating annual export inefficiency across all key trading regions. This is captured well by the decreasing efficiency estimates in the EAC, COMESA, Africa (generalized) and the European Union between 2008 -2017.

4.3.4 Export Potential Estimates Per Country

Table (10) shows Kenya's estimated mean potential exports and the resultant estimated export gap with its top 20 export partners. The calculations are obtained using the efficiency coefficients of the trade gravity model imposed on the mean of the actual observed trade per country.

TABLE 10: EXPORT POTENTIAL ESTIMATES PER COUNTRY

	Mean Actual Exports (millions USD)	Average Efficiency (%)	Mean Potential Exports (millions USD)	Export Gap (millions USD)
Country				
U.A.E.	$239.96	19.15	$1,252.86	$1,012.89
Rwanda	$154.71	16.40	$943.46	$788.75
Uganda	$660.66	72.11	$916.22	$255.56
Netherlands	$405.84	46.53	$872.20	$466.37
Burundi	$67.87	8.07	$841.31	$773.44
Saudi Arabia	$46.57	6.04	$770.99	$724.42
Tanzania	$412.52	54.58	$755.82	$343.30
Somalia	$175.39	24.02	$730.29	$554.90
Russian Federation	$66.74	11.18	$597.14	$530.40
United Kingdom	$468.64	78.49	$597.05	$128.41
France	$65.02	12.11	$536.84	$471.82
Congo, Dem Rep.	$183.55	34.74	$528.32	$344.78
Germany	$97.79	18.73	$521.96	$424.18
South Sudan	$183.16	35.29	$519.00	$335.84
Sudan	$67.18	16.10	$417.27	$350.09
Pakistan	$304.79	76.03	$400.88	$96.09
United States	$333.47	86.30	$386.40	$52.93
Egypt, Arab Rep.	$208.71	54.88	$380.31	$171.60
Ethiopia	$65.57	25.90	$253.11	$187.55
China	$58.42	26.95	$216.78	$158.35
	$4,266.55		$12,438.21	$8,171.67

Table (9) reveals that Kenya has high unexploited potential in the Middle East. The United Arab Emirates was found to have the highest export potential ($1,252.86) and the highest

unutilized export gap ($1,012.89) according to the stochastic frontier gravity model estimates. Saudi Arabia was also found to poses high potential ($770.99) and a substantially high export gap ($724.42). The study also revealed high underutilized export potential in Rwanda ($943.46) and Burundi ($841.31) and a high export gap primarily due to the current low trade efficiency of Kenya's trade with these two EAC members.

The study finds that, other than Uganda, where Kenya's export efficiency is high, there is vast unexploited potential within the neighbouring countries. Rwanda, Burundi and Somalia are among the top 5 markets with the highest unexploited export gaps according to the estimations of the stochastic frontier gravity model. Additionally, there are vast unutilized opportunities in the non-traditional export markets in the Middle East (i.e. United Arab Emirates and Saudi Arabia) and Europe (i.e. Russia and France).The study shows that Kenya is operating near the frontier with respect to its trade with the United States and Pakistan and found limited opportunity for trade with China despite its vast economic size.

4.4 DIAGNOSTIC TESTING

4.4.1 Goodness-of-Fit Test for Stochastic Frontier Models

This study used the ML functions proposed by Aigner, Lovell, & Schmidt (1977) to calculate two specific variance parameters, i.e. sigma squared $\sigma_T^2 = \sigma_\mu^2 + \sigma_v^2$ and gamma $\gamma = \sigma_\mu^2/\sigma_T^2$, which confirm the applicability of the stochastic frontier gravity model [See Table (7) cont'd]. Gamma (γ) accounts for the proportion of total output/exports that is accounted for by technical inefficiency (μ) and lies between 1 and 0; where 0 indicates that all deviations from the frontier come from noise effect while 1 indicates that all the deviations from the frontier are due to inefficiency effects.

In this study, Gamma $(\gamma) = \sigma_\mu^2/\sigma_T^2 = 0.9636441$ accounts for over 96.36% of the deviations from the frontier, which provides sufficient justification for the stochastic frontier gravity model.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This concluding chapter presents a summary of the findings, conclusions, the policy implications of the study, its limitations, and recommendations for further research.

5.2 SUMMARY OF FINDINGS

Gravity Model Variables: GDP, Population, Distance and Exchange Rates

The results of the stochastic frontier gravity model found GDP in both the exporting country (Kenya) and the importing country (Country *j*) to be positive; a finding that is consistent with the expectations of trade gravity model theory. However, the study found contradictory results in regard to the effect of population (which is assumed to represent market size in this study).

The study found that increases in population in both the exporting and importing countries have a negative effect on exports, which is an unexpected finding. This could also mean that increases in domestic population and the corresponding increase in domestic market size has an adverse effect on the type of agricultural exports that dominate Kenya's export basket through increase of local consumption. Distance was found to be insignificant, which perhaps captures the decreasing economic distance in global trade due to new forms of communication and added efficiencies in the transportation sector.

In summary, Kenya's exports were found to increase with increases in GDP in both countries but decrease with increase in population in both domestic and importing countries.

The Inefficiency Effects Model: Average Tariffs and Preferential Trade Agreements

The general effect of Preferential Trade Agreements (PTAs) was found to be positive as predicted by the trade gravity model. Membership by the trade partner to the European Union and AGOA was found to have significant positive effects on Kenya's exports. However, membership to COMESA was not found to have the expected positive impact. These findings correspond to the actual observed trade statistics of Kenya's exports to these regions.

An increase in average tariffs in the trading partners market was found to increase Kenya's exports. This could be considered as additional proof of the benefits accrued from preferential trade agreements which provide Kenya's exports with secure market access on preferential terms and shield its exports from the increases in tariffs.

Export Efficiency/Trade Efficiency

Kenya's export efficiency with most of the sampled countries was found to be below 40%. The mean trade efficiency was 36%, which implies that Kenya could have increased its exports by 64% during the sample period through removal of inefficiencies that exist in its bilateral trade frameworks, e.g. by negotiating better trade agreements. The least efficiency during the study period was recorded in Kenya's trade with Saudi Arabia (6.04%) in the year 2009, and the highest efficiency (94.01%) was found in Kenya's trade with Pakistan in the year 2017. The markets where Kenya was found to achieve the highest efficiencies were the United States, the United Kingdom, Pakistan, Uganda and Egypt. Trade with non-traditional export markets such as Saudi Arabia, France and Russia, as well as trade with regional neighbours such as Rwanda, Burundi and the Sudan, was found to have the least efficiency scores.

Export Potential/Trade Potential

This study reveals that most of Kenya's underutilized export potential lies in the non-traditional markets, particularly in the Middle East. Regional markets, particularly Rwanda, Burundi and Somalia were also found to poses high underexploited trade potential. Opportunities to expand exports also exist in non-traditional European markets such as Russia and France.

The study also revealed that Kenya is trading close to the frontier of its trade gravity function with respect to trade with the United States and Pakistan. Despite having a vast economic size, the study revealed limited export potential with respect to Kenya's trade with China.

5.3 CONCLUSIONS OF THE STUDY

This study began by providing a background of Kenya's external trade profile. It was pointed out that Kenya's trade volumes with what is considered to be its traditional bilateral trade partners, where historical ties and preferential trade arrangements had been established for a substantial duration, was on the decline. On the other hand, trade to "non-traditional" markets was increasing. A notable decline in exports to neighbouring countries was also highlighted. This study consequently sought to analyse Kenya's export trade with the objective of providing critical insight into the efficiency of the country's export sector and estimating the potential level of exports in its main export markets.

Drawing from the recent trends, this study further sought to review the impact of region-specific trade agreements on export performance. It was pointed out that previous studies in this area {see Ngugi (2016) and Mahona & Mjema (2014)} had drawn inconclusive and contradictory findings, especially with regard to the impact of RECs on Kenya's exports.

The study employed the stochastic frontier gravity model approach, attributed to Kalirajan (2000), in conjunction with the Battese and Coelli (1995) estimation method, to conduct simultaneous measurement of a prescribed trade gravity function and an inefficiency/efficiency model representing factors that constrain Kenya's exports. The study determined that growth of GDP in both the home and export market had a positive impact on Kenya's exports. Contrary to expectation, the study did not find population increase to have a positive effect on exports. Distance was revealed to be insignificant. The study further revealed that access to the European Union markets and access to AGOA preferential terms had a positive impact on Kenya's exports. Notably, access to the COMESA markets, was generally not found to be trade-enhancing. The highest efficiency estimates were found to exist in Kenya's trade with the United States, the United Kingdom, Pakistan, Uganda and Egypt. The study further deduced that Kenya's most substantial export gaps were in the non-traditional markets, particularly in the Middle East i.e. the United Arab Emirates and Saudi Arabia, and in Europe i.e. Russia, France and Germany. The study also revealed substantial underutilized potential within the regional markets, particularly in Rwanda, Burundi and Somalia.

While recent export statistics seem to contradict the assertion by Ngugi (2016) that the Linder Hypothesis is applicable to the Kenyan context, the results of this study, and the consequent ranking of Kenya's trading partners on the basis of potential export, agrees with the Linder proposition. This study revealed the highest export potential to exist mainly in Kenya's regional trading partners, where a case of overlapping demands can be made. In addition to Linder's theory, the heavy presence of industrialized countries in Kenya's top 20 export markets also provides support for the relevance of the factor-endowment assertions of the H-O theory.

5.4 POLICY RECOMMENDATIONS

The findings of this study call for a review of the current tactical approach to Kenya's trade negotiations. The empirical findings of this study imply that securing the preferential market access terms offered by the European Union and the United States through the EPA and AGOA respectively, should remain among the key trade policy priorities. It is important to note here that AGOA expires in the year 2025 and the EAC-EU EPA is yet to be concluded. The cost implications of the reciprocal requirements of concluding any future trade agreements with the EU and the US should be evaluated against the backdrop of the benefits offered and gains secured in these two markets.

The revelation that substantial export potential exists in non-traditional markets implies that more effort should be put towards negotiating new enabling trade agreements with countries in the Middle East and in the non-English speaking major economies in Europe. Growth of exports in the U.A.E., Saudi Arabia, Russia, France and Germany should become the key focus of all official engagements between Kenya and these countries and should also become the main assignment issued to Kenya's Diplomatic Missions in these countries. Focus should also be put towards removing non-tariff trade barriers that prohibit regional trade from attaining its actual potential. The platforms offered by Kenya's membership to the EAC and the AfCFTA should be put to better use to attain this objective.

5.5 LIMITATIONS OF THE STUDY

Firstly, according to Bezat (2009), the model and variable specification greatly affect the estimates obtained from stochastic frontier models. It is difficult to ascertain all the variables that affect export trade and exclusion of an important variable may result in biased results.

Secondly, though the model specification in this paper mirrors previous studies conducted in other jurisdictions [see, Daluna & Cruz (2014), Hassan (2017), Kang & Fratianni (2006)}and is chosen for the specific objectives of this study, it evident that some key institutional factors that may affect Kenya's export trade e.g. customs processes, ease of doing business, corruption indices, etc. have been omitted. These were assumed to be contained within the regional-specific trading blocs and were represented in this study, albeit loosely, by the RECs themselves.

Thirdly, a key limitation of this study is the use of aggregated data. This is a common challenge in country-level trade analysis. It is arguable that decisions regarding exports are often made at industry or firm level hence aggregation at country level may result into specification errors that may be transmitted to the results of final efficiency scores.

Finally, as noted by Li et al. (2017), empirical test statistics to measure the plausibility of parametric stochastic frontier functions are scarce. Li et al. (2017) note that though SFA models have grown in recent popularity in the area of productivity and efficiency analysis, primarily due to established theoretical grounding and the relative ease of computation and interpretation, there is limited analysis of the specification testing for SFA models compared to conventional regression models. This was a key challenge in the conduct of this research project.

5.6 RESEARCH GAP AND PROPOSALS FOR FUTURE RESEARCH

A vibrant export sector is critical for the attainment of accelerated economic growth, emergence of strong manufacturing sectors, employment creation, and poverty alleviation (SDT, 2018). Research work to ascertain the finest and most viable tactical approaches to increase efficiency in the export sector will therefore continue to be important. To improve upon this study, a disaggregation of the data and level of analysis is proposed in order explore the efficiency and potential of Kenya's exports from an industry perspective. A series of studies focusing on one industry at a time would immensely contribute to studies in this area. For instance, the key growth areas identified in both the Big Four Agenda and the Vision 2030 blueprint, including textile and apparels, horticulture, leather products and footwear, and tourism, could offer great opportunities for industry-specific stochastic frontier gravity model analysis.

REFERENCES

Aigner, D., Lovell, C. A., & Schmidt, P. (1977, July). Formulation and Estimation of Stochastic Frontier Production Function Models. *Journal of Econometrics, Vol. 6* (Issue 1), 21-37.

Anderson, J. E. (1979, March). A Theoretical Foundation for the Gravity Equation. *The American Economic Review, 69*(1), 106-116.

Assefa, M. (2017, April). Unlocking Export Potentail and the Influence of Country-Specific characteristics: Evidence from Ethiopia. *African Journal of Business and Economic Research (AJBER), 12*(1), 49-79.

Battese, G. E., & Coelli, T. J. (1995, June). A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data. *Empirical Economics, Vol. 20* (Issue 2), pp. 325-332.

Bezat, A. (2009). Comparison of the Deterministic and Stochastic Approaches for Estimating Technical Efficiency on the Example of Non-parametric DEA and Parametric SFA Methods. *Metody Ilościowe w Badaniach Ekonomicznych, Vol. 10* (Issue 1), pp. 20-29.

Carbaugh, R. J. (2009). *International Economics* (12th ed.). Mason, Ohio, USA: South-Western Cengage Learning.

Carpenter, M., & Dunung, S. (2012). *Challenges and Opportunities in International Business (v.1.0).* Mountain View, California: Creative Commons by 3.0 licence. Retrieved from https://2012books.lardbucket.org/books/challenges-and-opportunities-in-international-business/s06-01-what-is-international-trade-th.html

Ciuriak, D., Lapham, B., & Wolfe, R. (2011, April). New-New Trade Policy. *Queen's Economics Department Working Paper No. 1263*.

Daluna Jr., R. S., & Cruz, E. D. (2014, July). *Philippine Export Efficiency and Potential: An Application of Stochastic Frontier Gravity Model.* Retrieved from Munich Personal RePEc Archive (MPRA): https://mpra.ub.uni-muenchen.de/51677/

Daluna, R. J. (2013, April 30). *Trade Performance and Potential of the Philippines: An Application of Stochastic Frontier Gravity Model.* Retrieved from Munich Personal RePEc Archive (MPRA): https://mpra.ub.uni-muenchen.de/51677/

Drysdale, P., Huang, Y., & Kalirajan, K. (2012). China's Trade Efficiency: Measurement and Determinants. In P. Drysdale, Z. Yunling, & L. Song (Eds.), *APEC and Liberalisation of the Chinese Economy* (pp. pp. 259-271). ANU Press.

Greene, W. H. (1980, May). Maximum Likelihood Estimation of Econometric Frontier Functions. *Journal of Econometrics, 13*(1), 27-56.

Hassan, T. M. (2017). An analysis of prime determinants and constraints of Bangladesh's export market: Stochastic frontier gravity model approach. *World Customs Journal, 11(2)*, 77-92.

IMF. (2019). *Direction of Trade Statistics (DOTS)*. Retrieved September 18, 2019, from International Monetary Fund (IMF): https://data.imf.org/?sk=9D6028D4-F14A-464C-A2F2-59B2CD424B85

IMF. (2019). *International Financial Statistics (IFS)*. Retrieved September 18, 2019, from IMF Data: https://data.imf.org/?sk=4C514D48-B6BA-49ED-8AB9-52B0C1A0179B

Irwin, D. A. (1992, May). Strategic Trade Policy and Mercantilist Trade Rivalries. *The American Economic Review, Vol. 82* (No. 2), pp. 134-139. Retrieved from Dartmouth College.

Kalirajan, K. (2000). Indian Ocean Rim Association for Regional Cooperation (IOR-ARC): Impact on Australia's Trade. *Journal of Economic Integration, 15(4),* 533-547.

Kalirajan, K. (2007, May 14). Regional Cooperation and Bilateral Trade Flows: An Empirical Measurement of Resistance. *The International Trade Journal, 21*(2), 85-107.

Kalirajan, K. P., & Jayasuriya, S. K. (1991). Simultaneous testing of regression disturbances for heteroscedasticity and non-normality. *Journal of Applied Statistics, 18*(3), pp. 307-312.

Kalirajan, K., & Anbumozhi, V. (2014). Regional Cooperation Toward Green Asia: Trade in Low Carbon Goods. *The International Trade Journal, 28(4),* 344-362.

Kang, H., & Fratianni, M. (2006). *International Trade Efficiency, the Gravity Equation and the Stochastic Frontier.* Bloomington: Kelly School of Business, Indiana University.

KNBS. (2007). *Economic Survey.* Nairobi: GOK.

KNBS. (2017). *Economic Survey.* Nairobi: GOK.

Li, G.-R., McAleer, M., & Wong, W.-K. (2017). *Specification Testing of Production in a Stochastic Frontier Model.* Universidad Complutense Madrid. Madrid: ICAE.

Mahona, B. K., & Mjema, G. D. (2014). Determinants of Tanzania & Kenya Trade in the East African Community: A Gravity Model Approach. *Journal of Economic & Sustainable Development, Vol. 5* (No. 4), pp. 13-23.

Mayer, T., & Zignago, S. (2011, December). Notes on CEPII's Distances Measures: The GeoDist Database. *CEPII Working Paper*(No 2011-25). Retrieved from http://www.cepii.fr/CEPII/en/bdd_modele/bdd_modele.asp

Medin, H. (2014). *New Trade Theory: Implications for Industrial Policy.* Oslo: Norwegian Institute of International Affairs (NUPI).

Melitz, M. J. (2003, November). The Impact of Trade on Intrad-Industry Reallocations and Aggregate Industry Productivity. *Econometrica, 71*(No. 6), 1695-1725.

Miankhel, A. K., Thangavelu, S., & Kalirajan, K. (2009). On Modeling and Measuring Potential Trade. Mumbai: IGIDR.

Ngugi, J. W. (2016, October). Determinants of Kenya's Bilateral Trade Flows. *International Journal of Economics, Commerce & Management, Vol. IV* (No. 10), pp. 159-198.

Orindi, M. N. (2011). Determinants of Kenyan Exports: A Gravity Model Approach. *International Journal of Economics and Political Integration, Vol. 1* (No. 1), pp. 3-14.

Ouma, D. (2016). *Intra-Industry Trade Between Kenya and EAC Member Countries.* Saarbrucken: LAP Lambert Academic Publishing.

Ravishankar, G., & Stack, M. (2014). The Gravity Model and Trade Efficiency: A Stochastic Frontier Analysis of Eastern European Countries' Potential. *The World Economy, 37*(5), 690-704.

Salvatore, D. (2016). *International Economics* (Vol. 12). New Jersey, Hoboken: Wiley & Sons.

SDT. (2017). *National Trade Policy: Transforming Kenya into a Competitive Export-Led and Efficient Domestic Economy.* Nairobi: Ministry of Trade and Cooperatives, State Department for Trade.

SDT. (2018). *Integrated National Export Development and Promotion Strategy.* Nairobi: MoITC.

Shepherd, B. (2010). *Trade Performance of the East African Community: Gravity Model Evidence.* New York: Developing Trade Consultants (DTC).

Smyth, D. (1997). A Critique of the Leontief Paradox. *Student Economic Review 1997, 1*(1), 171-180.

Suranovic, S. M. (2015). *International Trade: Theory and Policy.* Washington, D.C: IESC.

Tamini, L. D., Chebbi, H. E., & Abbassi, A. (2016, September). Trade Performance and Potential of North African Countries: An Application of a Stochastic Frontier Gravity Model. *AGRODEP*.

Tinbergen, J. (1962). *Shaping the World Economy: Suggestions for an International Economic Policy.* New York: Twentieth Century Fund.

USTR. (2018, 08 27). *Joint Release By USTR Robert Lighthizer And Kenyan Cabinet Secretary For Industry, Trade And Cooperatives, Peter Munya.* Retrieved 11 12, 2019, from Office of the USTR: https://ustr.gov/about-us/policy-offices/press-office/press-releases/2018/august/joint-release-ustr-robert-lighthizer

World Bank. (2019). *World Development Indicators*. Retrieved September 18, 2019, from World Bank Group Data Catalog: https://datacatalog.worldbank.org/dataset/world-development-indicators

World Bank. (2019). *World Integrated Trade Solution (WITS)*. Retrieved September 18, 2019, from https://wits.worldbank.org/

WTO. (2019). *Database on Preferential Trade Arrangements*. Retrieved September 18, 2019, from World Trade Organization: http://ptadb.wto.org/?lang=1

WTO. (2019). *Regional Trade Agreements Database*. Retrieved September 18, 2019, from World Trade Organization: http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx

ANNEX 1: KENYA'S TOP 40 EXPORT DESTINATIONS (2017)

	Country Destination	% Share of Total Exports
1.	Pakistan	10.7818
2.	Uganda	10.4042
3.	United States	7.9562
4.	Netherlands	7.3876
5.	United Kingdom	6.4889
6.	Tanzania	4.8005
7.	United Arab Emirates	4.4384
8.	Somalia	3.3093
9.	Egypt, Arab Rep.	3.1988
10.	Congo, Dem. Rep.	3.1777
11.	Rwanda	2.8822
12.	South Sudan	2.8196
13.	Germany	1.9762
14.	China	1.6827
15.	France	1.3566
16.	Russian Federation	1.346
17.	Saudi Arabia	1.3205
18.	Burundi	1.2425
19.	Ethiopia(excludes Eritrea)	1.1752
20.	Sudan	1.1625
21.	Hong Kong, China	1.0788
22.	Yemen	1.0751
23.	Belgium	1.0142
24.	India	1.0068
25.	Thailand	0.8417
26.	Japan	0.7582
27.	Zambia	0.6512
28.	Qatar	0.6243
29.	Canada	0.6116
30.	Kazakhstan	0.5778
31.	Italy	0.5737
32.	Switzerland	0.5461
33.	Afghanistan	0.5297
34.	Norway	0.5211
35.	Malawi	0.5003
36.	Spain	0.4987
37.	Sweden	0.4819
38.	South Africa	0.4643
39.	Nigeria	0.4459
40.	Unspecified	0.4168

Source: World Integrated Trade Solution, World Bank (2017)

ANNEX 2: AVERAGE EXPORT TRADE EFFICIENCY ESTIMATES PER COUNTRY AND REGION (2008 - 2017)

Technical Efficiency Estimates per Country and Region, 2008-2017

Country	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Ave, TE
EAC Countries	**41.47**	**42.14**	**38.99**	**43.48**	**46.98**	**42.79**	**39.45**	**33.60**	**27.35**	**23.97**	**37.29**
Uganda	78.73	80.28	75.42	87.03	85.54	81.64	65.82	58.06	56.39	52.15	72.11
Tanzania	64.13	63.12	57.18	62.01	73.45	62.21	53.08	46.87	36.14	27.60	54.58
South Sudan	.	.	.	.	.	45.56	51.18	37.80	22.11	19.81	35.29
Rwanda	16.31	16.55	14.96	16.76	21.14	16.84	17.40	15.94	14.79	13.30	16.40
Burundi	6.71	8.59	8.39	8.10	7.78	7.69	9.78	9.32	7.33	6.98	8.07
COMESA Countries	**38.92**	**36.73**	**36.13**	**40.52**	**38.81**	**34.45**	**32.91**	**29.66**	**26.86**	**23.57**	**32.60**
Egypt, Arab Rep.	66.11	50.95	62.85	70.85	69.98	52.11	51.97	47.57	42.56	33.84	54.88
Congo, Dem Rep.	33.00	34.45	31.43	38.03	42.74	41.24	36.22	33.08	31.22	26.00	34.74
Sudan	.	.	.	.	21.86	19.37	17.05	14.02	11.07	13.23	16.10
Ethiopia	32.64	29.53	23.75	22.34	22.62	22.26	32.13	29.64	24.65	19.48	25.90
Somalia	83.80	16.74	16.25	18.31	23.17	20.68	15.67	14.26	15.57	15.72	24.02
Africa Total	**47.68**	**37.53**	**36.28**	**40.43**	**40.92**	**36.96**	**35.03**	**30.65**	**26.18**	**22.81**	**34.21**
European Union	**43.98**	**43.57**	**39.61**	**40.11**	**40.90**	**37.77**	**43.12**	**39.90**	**31.16**	**29.54**	**38.97**
United Kingdom	91.50	90.57	86.01	87.13	84.53	76.77	82.76	78.45	55.25	51.96	78.49
Netherlands	49.73	48.14	40.76	44.04	44.56	44.03	60.16	54.86	40.88	38.14	46.53
Germany	19.59	22.73	19.08	16.83	22.91	18.32	17.38	15.39	18.34	16.78	18.73
France	15.11	12.82	12.60	12.45	11.62	11.97	12.17	10.93	10.18	11.28	12.11
Others	**32.76**	**32.19**	**33.00**	**34.56**	**41.41**	**38.53**	**41.18**	**38.90**	**41.44**	**42.12**	**37.61**
United States	87.73	78.86	81.19	82.73	87.19	88.98	89.78	86.72	89.71	90.13	86.30
Pakistan	66.89	67.24	66.09	68.31	79.97	76.03	80.80	76.58	84.37	94.01	76.03
China	18.92	20.21	16.65	21.72	32.71	23.78	33.01	30.40	37.72	34.40	26.95
United Arab Emirates	9.69	13.51	20.52	19.09	28.84	23.70	20.51	18.87	20.39	16.41	19.15
Russian Federation	10.12	10.29	10.37	11.77	14.17	13.63	12.55	10.63	8.80	9.43	11.18
Saudi Arabia	3.22	3.03	3.17	3.74	5.55	5.07	10.45	10.17	7.65	8.34	6.04
Total Average Efficiency	**41.89**	**37.09**	**35.93**	**38.40**	**41.07**	**37.59**	**38.49**	**34.98**	**31.76**	**29.95**	**36.18**