UNIVERSITY OF CAPE COAST

ASSESSING GHANA'S BILATERAL EXPORTS POTENTIAL AND GAP

MICHAEL TUTU BOADU

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BY

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DECLARATION

Candidate's Declaration

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

Candidate's Signature………………………………… Date……………………..

Name: Michael Tutu Boadu

Supervisors' Declaration

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

Principal Supervisor's Signature …………………………… Date………………..

Name: Dr. Camara K. Obeng

Co-Supervisor's Signature ……………………………… Date……………..........

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ABSTRACT

Nations continue to explore ways and means of increasing and optimising their export flows with other nations across the world. Eliminating supply-side constraints in the export industry is a way to maintain and promote international demand for a country's exports. To achieve this goal, it is important for every country to be fully aware of its export potential and gaps as well as the inefficiencies that confront their exports. In this regard, the study employed the stochastic frontier gravity model to assess Ghana's bilateral export potential and gap for a panel of 61 countries over the period 2000-2017. The objective of this study was to assess Ghana's export potential and gap and explore the inefficiencies accounting for these gaps. The frontier results show that Ghana's bilateral exports are positively influenced by importer income level, the population of both trading partners and common colonial ties whiles geographic distance and landlocked reduce bilateral export flows. The study also found a huge export potential and gap among all trading partners selected for the study, but the export gap is greatest among the ECOWAS region of about USD 5.9 billion. The results also indicated that the 'behind the border' constraints such as poor infrastructure and tax burden are responsible for a considerable gap between Ghana's potential and actual exports. The tax burden of both trading partners and poor infrastructure of Ghana increases technical inefficiency. It is, therefore, recommended that the government and policymakers increase investment in trade-related infrastructure and also negotiate effectively with trading partners to eliminate all forms of tariff and non-tariff barriers that impede the export potential of Ghana.

KEY WORDS

Bilateral Export

Export Gap

Potential Export

Stochastic Frontier Gravity Model

Technical Efficiency

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DEDICATION

In memory of my father, Mr. Edwin Yaw Mensah, and my beloved sister, Elizabeth Dufie.

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LIST OF ACRONYMS/ABBREVIATIONS

ACP	Africa, Caribbean, and Pacific
AFTA	Asian Free Trade Area
AGOA	Africa Growth and Opportunity Act
APEC	Asian -Pacific Economic Cooperation
BTA	Bilateral Trade Agreements
CAP	Common Agricultural Policy
CEEC	Central and Eastern European Countries
COMESA	Common Market of Eastern and Southern Africa
DOLS	Dynamic Ordinary Least Square
EAC	East Asian Community
ECI	Economic Complexity Index
ECOWAS	Economic Community of West African States
EEC	European Economic Community
EFTA	European Free Trade Area
ERP	Economic Recovery Program
EU	European Union
FEM	Fixed Effect Model
FMOLS	Fully Modified Ordinary Least Square
FDI	Foreign Direct Investment
GAFTA	Greater Arab Free Trade Area
GEPA	Ghana Export Promotion Authority

GDP	Gross Domestic Product
GMM	Generalized Method of Moment
HS	Harmonized System
ISSER	Institute of Statistical, Social and Economic Research
IMF	International Monetary Fund
LDCs	Least Developed Countries
NAFTA	North American Free Trade Agreement
OECD	Organisation of Economic Cooperation and Development
OLS	Ordinary Least Square
SAARC	South Asian Association for Regional Corporation
SADC	South African Development Community
SAP	Structural Adjustment Program
SSA	Sub Saharan Africa
SFGM	Stochastic Frontier Gravity Model
TCI	Trade Conformity Index
TGM	Traditional Gravity Model
WTO	World Trade Organization

CHAPTER ONE

INTRODUCTION

This chapter contains the background to the study, statement of the problem, purpose of the study, and research hypotheses. It also includes the significance of the study as well as the organization of the various chapters. This research is important because, for Ghana to promote and sustain growth in the export sector, there is the need to know its export performance to trading partners as well as the factors that are obstacles to its export flows.

Background to the Study

Exports are a key component of a country's economy, as their contribution to a country's gross output is enormous. Export is one of the oldest forms of economic transfer, taking place on a large scale between nations with fewer trade restrictions, such as tariffs or subsidies. Countries advocate export promotion because of their ability to generate foreign exchange that can help solve trade deficits, create new markets or expand existing markets for local firms, and create jobs to raise citizens' living standards.

In 1969, Ghana established the Ghana Export Promotion Authority (GEPA) as part of reforms to turn Ghana's economic fortunes from import-dependent to export-led state. The authority's mission is to ensure that the export trade of the nation leads to accelerated economic growth by strategic aggressive marketing in the dynamic global economy of Made-in-Ghana goods. The country has also adopted a national export strategy with the goal of exploiting the capacity of the non-traditional export sector (NTE) to make a maximum contribution to GDP growth and national development in order to consolidate and enhance Ghana's middle-income status, build formal decent job prospects that translate into better living standards and people's welfare.

Ghana embraced the export-led development model as part of a number of economic and structural reforms implemented in the wake of the economic woes of the early 1980s. These policies became necessary to change the country’s trade policies from a highly restricted and import-substitution industrialisation regime in the 1960s and 1970s to a more liberalised export-led regime characterised by the reduction of high import tariffs and quantitative constraints.

Exports from Ghana are traditionally dominated by a few primary products such as, cocoa, timber, and unprocessed mineral resources while imports are dominated by capital goods, foodstuffs, and fuels (GEPA, 2017). Ghana is the 70th largest export economy in the world and the 111th most complex economy, according to the Economic Complexity Index (ECI). In 2017, Ghana exported $17.1 billion and imported $13.2 billion, resulting in a positive trade balance of $3.9 billion. According to the 1992 revision of the HS (Harmonized System) classification, the top exports of Ghana are Gold ($8.35b), crude petroleum ($2.97b), cocoa beans ($1.77b), cocoa paste ($538m) and coconuts, Brazil nuts, and cashews ($325m). However, the most recent exports of Ghana are led by gold which represents 48.7% of the total exports of Ghana, followed by crude petroleum, which accounts for 17.3 % of the total exports (Comtrade, 2017).

In terms of export destination, the 28 states of the European Union collectively represent the leading destination for Ghanaian exports and the second-largest source of Ghana's imports. Exports comprise mostly raw materials, while imports from the European Union include machinery, farm equipment, and mineral fuels. Countries within the bloc such as the Germany, France, Netherlands, Italy, and the United Kingdom have consistently featured in the top Export Promotion in Ghana's major export destinations (Comtrade, 2017). The top export destinations of Ghana in the year 2017 are India (US$5. 09b), China (US$1. 9b), Switzerland (US$1. 84b), South Africa (US$918m) and the Netherlands ($911b) (Comtrade, 2017). However, countries such as Japan, Spain, Belgium, and Nigeria, which featured quite prominently in Ghana's export destination 10 years ago, have all fallen off, giving way to emerging economies such as China, Turkey, India, and Portugal. This is mostly a promising development since these countries present an enormous market opportunity by the sheer size of their populations and growing middle classes with increased purchasing power. The skewed nature of Ghana's export market makes it highly vulnerable to the economic cycle of these countries. Therefore, it is important to diversify the export market, both in terms of destinations and products, to reach the potential level of export in aggregate terms.

The exports of Ghana to the ECOWAS region has not seen any significant improvement despite her membership to the ECOWAS. This may be because the countries in the ECOWAS have similar comparative advantage. The share of Ghana's exports to the ECOWAS region declined from 32.87% in 2011 to 10.55% in 2016. Nigeria, which represents over half of the region's population, is a diminishing export destination for Ghana's exports, with exports to Nigeria declining from US$101. 1 million in 2010 to US$63. 2 million in 2017 according to UN Comtrade data. Ghana Export Promotion Authority (GEPA) attributes this decline mainly to Nigeria's ban on the importation of over 150 products in 2013, from abroad or the ECOWAS sub-region, in spite of various trade liberalisation policies in the sub-region.

The products with the greatest export potential from Ghana to the World are Cocoa beans, Cashew nuts, and Cocoa paste. Cocoa beans shows the largest absolute difference between potential and actual exports in value terms, leaving room to realise additional exports worth $1.7 billion (GEPA, 2017). These potentialities in the non-traditional exports of the country give Ghana the opportunity to expand its bilateral exports. However, Ghana's ability to export depends on some socio-economic and political institutional factors in her trading partner countries.

Export potential is considered as the maximum level of exports that could be achieved at the frontier with open and frictionless trade, given the current level of trade, institutional technologies and transport (Miankhel, Thangavelu, & Kalirajan, 2009). The extant literature shows that the export production capacity of a country, usually, proxied with GDP affects bilateral exports positively. Another factor that has been found to affect bilateral exports is the level of demand for exports by the importing country. Empirical evidence has also confirmed that distance between trading partners, language, landlocked, economic freedom, membership of trade agreement, the cost of doing business, trade facilitation, availability of credit, infrastructure, institutional quality, and corruption affect bilateral exports (Ebaidalla & Mustafa, 2018; Hassan, 2017; Deluna Jr & Cruz, 2013; Drysdale, Huang & Kalirajan, 2012). The implication of the above is that, in reality countries are unable to achieve the optimum in export trade or the potential level. Existing empirical literature points to varying levels of bilateral export efficiency for countries (Ebaidalla & Mustafa, 2018; Hassan, 2017; Deluna Jr & Cruz, 2013; Drysdale, Huang & Kalirajan, 2012). Knowledge of how well a country is doing in terms of exports will help in negotiating new trade agreements and diversifying export destinations. Achieving this goal includes a thorough knowledge of the export gap between the country's actual observed and potential exports, as well as identifying factors that limit the country's exports from achieving its potential levels, which are either the country's institutional and infrastructural rigidity (behind the border) or its trading partners' rigidity (beyond the border).

To sum up, this study would enable the country to identify those countries that are increasingly demanding more of her exports in order to expand exports to those countries. It would also enable the country to identify the factors that may be responsible for the inefficiencies in its exports so that it can negotiate new trade agreements with trading partners. In the long term, this will assist the country to attain the needed growth in the export industry which would translate into the ultimate growth of the economy. This backdrop motivated this study to assess Ghana's exports potential and the gap with its trading partners within the stochastic frontier gravity model.

Statement of the Problem

Increasing the export capacity of developing countries to industrialised countries ' markets has long been regarded as an essential mechanism for promoting sustainable development, reducing the level of poverty, and benefiting the developing world of potential globalisation (Gil-Pareja, Llorca-Vivero, & Martínez-Serrano, 2014)

It is important to note that over the years, researchers have studied export potential around the world. Studies such as (Deluna Jr & Cruz, 2013; Hassan, 2017; Ebaidalla & Mustafa, 2018) employed the stochastic frontier gravity model to investigate the export potential and identified the behind the border constraints that limit exports from reaching its potential level. However, among these studies, only Deluna Jr and Cruz (2013) explored the drivers of technical inefficiency for Philippines export flows.

Country specific study of export potential and gap with a more advanced methodology (stochastic frontier gravity model) is hard to find in the literature for the case of Ghana. Related studies identified include (Kumah, 2017; Adam & Tweneboah, 2008; Bonuedi, 2013; Asante-Nimako, 2016). Kumah (2017) studied the level of trade integration in the WAMZ zone. The author employed the SFGM to investigate the export efficiencies of the member countries of WAMZ, which included Ghana. Given that Ghana's trading partners spanned beyond five countries, it is important to expand the study to cover more trading partners for a better policy recommendation. In the case of the Adam and Tweneboah (2008), the authors employed the traditional gravity model to predict the trade potential of

Ghana’s trading partners. Bonuedi (2013) and Asante-Nimako (2016) also employed the traditional gravity model to examine the internal and external determinants of Ghana’s bilateral export flows. However, the methodology used by Adam and Tweneboah (2008), Bonuedi (2013) and Asante-Nimako (2016) is noted to have major weaknesses in controlling trade resistances (Kalirajan, 2008; Ravishankar & Stack, 2014; Bhattacharya & Das, 2014).

The difference between the previous studies and this current research is that the current study would explore the determinants of Ghana's bilateral export inefficiency and also estimate the export gap with each trading partner. Therefore, this current study would attempt to estimate the gap that exists between the actual bilateral exports and the potential exports of Ghana. It would also identify the factors that are responsible for Ghana’s bilateral export inefficiencies which were neglected by earlier studies such as Kumah (2017) and Adam and Tweneboah (2008). It would again predict the level of technical efficiency of Ghana’s bilateral exports. In this regard, the study utilized current dataset to assess Ghana’s bilateral export potential and gap for 61 major export destination countries over the period 2000-2017 within the stochastic frontier gravity model. The choice of the stochastic frontier gravity model over the traditional gravity model is that the SFGM helps to identify the biases from the ‘behind the border’ measures that the traditional gravity model does not address. The SFGM also allows assessing the export potential and the technical efficiency of each trading partner. Again, the use of the SFGM approach in estimating export potentials is more consistent with the theory of trade potential, as it adequately and sufficiently controls for multilateral trade resistance terms (Kalirajan, 2008; Ravishankar & Stack, 2014; Bhattacharya & Das, 2014).

Purpose of the Study

The main purpose of the study was to assess Ghana's bilateral exports potential and gap.

Objectives of the Study

The study will specifically address the following objectives:

i. Examine the drivers and impediments to Ghana's bilateral exports potential and gap.

ii. Estimate export efficiencies between Ghana and her trading partners.

iii. Estimate Ghana's bilateral export gap.

Hypothesis of the Study

The study seeks to test the following hypotheses;

H_O: There are no impediments to Ghana's bilateral exports potential and gap.

H_1: There are impediments to Ghana's bilateral exports potential and gap.

H_O: Ghana's bilateral export with its trading partners is not efficient.

H_1: Ghana's bilateral export with its trading partners is efficient.

Significance of the Study

In spite of the profuse evidence of strong empirical success in the study of the export potential of countries, little has been done in explaining the export potential of Ghana with trading partners. Since Ghana seeks to expand its export base to improve the economic growth and also to improve the status of the country, the findings of this study will provide empirical evidence on factors that better enhance or impede export flows of Ghana. The study will also bring to light which trading partners Ghana has unexploited export potential with and which partners it has exhausted its export potential with. This will enable the country to properly target those partners it has unexploited export potential with and expand its exports to them accordingly so that the country can realize the potential growth of the export sector as well as the entire economy.

Delimitations

The study was delimited to some selected trading partners of Ghana. Specifically, the study focused on 61 trading partners of Ghana. The study used bilateral exports of Ghana in the form of the value of merchandised exports disaggregate according to Ghana's primary trading partners. Thus, merchandised imports from trading partners were not considered. The SFGM approach was applied to the data since this approach in estimating export potentials is more consistent with the theory of trade potential, as it adequately and sufficiently controls for multilateral resistance terms.

Limitations

Due to the unavailability of data for some countries, the study could not include all trading partners of Ghana. Ghana's key trading partners are more than 61 countries, and these bilateral exports have spanned beyond 17 years. Moreover, the limited availability of data on bilateral export flows and other variables for all the countries imposed a constraint on the number of trading partners selected for the study. For instance, few Sub-Saharan African countries were included due to missing values and no data on bilateral exports. If more SSA countries were included in the study, more precise conclusions could have been drawn to know the countries in Sub-Saharan Africa that Ghana has great export potential with.

Definition of Terms

Export potential: This refers to the maximum level of exports a country can attain given the level of technology, all available resources of the country and when all barriers to trade are removed (Miankhel, Thangavelu, & Kalirajan, 2009).

Bilateral exports: It refers to the total value of export from a country to a specific trading partner at a given time.

Exports efficiency: It is the proportion of the potential export that is currently being exploited. It measures the relative success or failure of the efforts of a country to sell domestically-produced goods and services in other nations. In other words, export efficiency is the measure of the performance of a country's exports to its trading partners.

Exports gap: This refers to the difference between the amount of good and services a country has been able to export to its trading partner (actual exports) and the potential level of exports (Hassan, 2017). There would always be a gap in a country's exports to other partners since there are factors in the partner country that may be beyond the control of the exporting country.

Organisation of the Study

The study is organised in five Chapters. Chapter one deals with the introduction of the study, problem statement, purpose of the study and the significance of the study. The second chapter reviews the literature on models of international trade preferences available to less developed countries and empirical literature relating to export efficiencies of countries. The third chapter presents the research design, the model and the methods employed in the study. It also covers the description of data and their sources. In the fourth chapter, descriptive statistics and results of the estimations regarding the study are presented. The fifth and final chapter summarises the results, concludes and presents relevant policy recommendations. It also presents a limitation of the study and directions for future research.

CHAPTER TWO

LITERATURE REVIEW

Introduction

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

Theoretical Review

Under this subsection, the study would review the literature on some of the theoretical development of the gravity model. The review is grouped under three headings, the first part focused on the development of the gravity model from the 1960s to 1970s. The second part concentrates on how the general equilibrium model was used to develop the gravity equation and the last review also looked at the recent development of the gravity model. This section also provides theoretical justification for the use of the gravity model of international trade.

Theoretical developments of the gravity model (the 1960s–1970s)

The gravity equation of trade first emerged in the empirical literature without any extensive effort to theoretically prove its use. Tinbergen (1962) and Pöyhönen (1963) were the first authors to conduct a study on trade flows using the gravity equation. However, the authors did not provide a sound theoretical justification for the use of the gravity model of international trade. Linnemann (1966) by providing theoretical justification for the use of the gravity model in trade, introduced more variables and proposed a theoretical basis for a Walrasian general equilibrium model. However, the Walrasian model appeared to include too many independent variables so that each of the trade flows can easily reduce to the gravity equation. Deriving from a transaction probability model, Leamer and Stern (1970) followed Savage and Deutsch (1960). They observed that bilateral trade is indeterminate in the lack of transportation cost, presuming that nations are basically drawing their trading partners 'out of a hat' according to different probabilities.

The Ricardian model and the Heckscher-Ohlin (HO) model were among the leading international trade models of this period. In a multi-country environment, these models did not comment much on aggregate bilateral trade flows (Bergstrand & Egger, 2010). It was therefore thought that standard Ricardian and HO models could not provide a basis for the gravity model (Piermartini & Teh, 2005). Leamer (1974) used both the gravity equation and the HO model to motivate independent variables in a trade flow regression analysis, but the two methods were not theoretically incorporated.

General equilibrium models, 1979- 2003

Inference of trade cost from trade flows using gravity equations

Unmeasurable costs of trade, mainly in the form of gravity equations, were deduced from bilateral trade flows via international economics models. Trade economists have been using gravity models for nearly five decades to describe the effect of trade barriers on global trade flows (Bergstrand & Egger, 2013). Making inference from the standard gravity model used by Tinbergen (1962) to describe flows between two countries, two key theoretical approaches arose in global trade literature, namely the conditional and unconditional general equilibrium paradigm.

The major difference between these two methods, as per Bergstrand and Egger (2013), was the assumption made about the 'separability' of production and consumption decisions from bilateral trade decisions The conditional general equilibrium approach, being an endowment-based model, assumed production and therefore consumer decisions as specified and that each country was entirely specialized in producing its own products. The general equilibrium approach also presume that there is one good generated exogenously for each country. Through making the roles of technology and market structure more clear, the unconditional general equilibrium approach acknowledged the lack of separability of production and consumption decisions from bilateral trade decisions (Bergstrand & Egger, 2013).

Two key variants of the conditional general equilibrium gravity equation are generally calculated, namely the versions 'conventional' and 'theory-based'. The conventional gravity formula resulting from Tinbergen (1962) and Anderson (1979) to infer non-observable trade costs is of the form:

$$EX_{ij} = \delta_1 y_i + \delta_2 y_j + \sum_{n=1}^{N} \beta_m ln\left(G_{ij}^n\right) + \omega_{ij} \tag{1}$$

Where EX_{ij} is the log of exports from country i to j, y_i and y_j are the log of GDP of the exporting and importing countries respectively, G_{ij}^n $(n = 1, \ldots, N)$ is a collection of observables associated with bilateral trade barriers and ω_{ij} is the random disturbance term. The basic assumption in deriving equation (1) was that prices across products are uniform, suggesting consistency in the cost of trade. Because of the existence of asymmetric trade costs, Bergstrand (1985) attempted to include prices in equation (1) and found that price indexes had an effect on bilateral trade flows (Bergstrand & Egger, 2013).

Per the findings of McCallum's (1995), Anderson and van Wincoop (2003) made a consequent theoretical dynamism of equation (1). McCallum (1995) derived a modification of equation (1) with two n variables for U.S. states and provinces of Canada (bilateral distance and a dummy variable equal to 1 if the two regions are located in the same country and equal to zero otherwise). After McCallum (1995) controlled for distance and size, the author discovered that trade between provinces within Canada was 22 times greater than trade between United States and Canada provinces, implying that there is a higher trade cost across the borders of United States – Canada.

Anderson and van Wincoop (2003) claimed that the significantly overestimated effect on bilateral trade of national borders observed by McCallum was due to the failure of the conventional gravity model to compensate for the effects of multilateral trade resistance on bilateral trade costs. Therefore, Anderson and van Wincoop (2003) were inspired to provide a theoretical refining of the traditional gravity model (the 'theory-based' gravity model) to include multilateral variables of trade resistance.

The various studies that have made use of the theory-based gravity model (an enhanced conditional general equilibrium model) have estimated in different ways the gravity equation of the form: The different studies using the theory-based gravity model (an improved conditional general equilibrium model) estimated the gravity equation in various ways as specified in equation (2) and (3):

$$EX_{ij} = \frac{GDP_i GDP_j}{GDP^W} \left(\frac{TC_{ij}}{\vartheta_i P_j} \right)^{1-\theta} \tag{2}$$

Where;

$$TC_{ij} = \sum_{n=1}^{N} \left(G_{ij}^n \right)^{\propto n} \tag{3}$$

Where EX_{ij} is nominal exports from country i to j, GDP_i and GDP_j is the nominal GDP of the expoter and the importer respectively, GDP^W is the nominal income for the world. $TC_{ij}$is the bilateral trade costs,$\propto$ is the elasticity of substitution among goods, $\vartheta_i$and P_j are outward and inward multilateral resistance variables respectively. G_{ij}^n $(n = 1, \dots, N)$ is a set of observables to which bilateral trade barriers are related and θ is the elasticity of substitution among goods or between varieties.

The elasticity of substitution among goods or between varieties measures the extent to which products are differentiated and this determines the relative impact of trade costs on trade flows (Turkson, 2012). As noted by Chaney (2008), when the elasticity of substitution between categories of products is high, trade barriers turn to have a stronger impact on trade flows. When goods are more distinguished and therefore the elasticity of substitution is low buyers are even more willing to buy foreign varieties, which means that trade barriers have little effect on bilateral trade flows (Turkson, 2012).

In calculating the trade cost factor, the choice of a value for the elasticity of substitution (θ) is very significant. In Anderson and van Wincoop (2004), survey estimates suggest that θ generally falls within the range of 5 to 10. Novy (2012) made reference to Anderson and van Wincoop (2004) and set θ to 8, implying that it corresponds to the Frechet and productivity distribution parameters of Eaton and Kortum (2002) and Chaney (2008) respectively.

Versions of conventional and theoretical gravity equations have been applied in many studies to calculate the different parts of global trade costs, in particular trade barrier costs and environmental costs. While some studies have attempted to quantify the overall cost of trade barriers, most of these studies have focused on the different components of trade costs. For example, Head and Ries (2001), Eaton and Kortum (2002), Anderson and Van Wincoop (2004) and Novy (2012) computed different versions of the theoretical gravity equation in various ways to calculate the total cost of trade barriers.

Costs of trade barriers was classified under two main components by Anderson and van Wincoop (2004): costs associated with cross-border trading (also known as border-related barrier costs) and costs of natural trade friction. Costs associated with border trade barriers include: non-tariff policies (customs unions and/or regional trade agreements), currency, contract compliance and information, interaction and language barriers. Costs of natural trade friction relate to geographical friction such as distance, adjacency, time and landlocked. In a country or region, trading networks, procedures and logistics are also often included as border costs. The main distinction is that whereas the former relates to differences in policies, procedures or structures between trading partners (hence border-related), the latter arise from natural characteristics (and may affect trading costs in a country equally) (Turkson, 2012).

The recent development of the gravity models – Firm heterogeneity of trade, 2003 onwards

A striking issue that has gained much consideration across both theoretical and empirical literature on the gravity model of trade is the proof that half of all nation pairs do not trade with each other and that bilateral trade is not symmetrical (Anderson & Wincoop, 2004; Evenett & Venables, 2002; Haveman & Hummels, 2004). Helpman, Melitz, and Rubinstein (2008) argue in his paper that by ignoring non-trading nations, prior studies provide significant information contained in the data, resulting in biased estimates. They also contend that standard specifications of the gravity equation impose symmetry that is inconsistent with the data, therefore biases the results. To address these biases, Helpman *et al*. (2008) designed a theory that forecasts both favourable and zeroes trade flows between nations and use the theory to obtain estimation processes that harness the information contained in trading and non-trading data sets. Their model is one of international trade in differentiated goods and heterogeneous firms, where firms face fixed and variable export costs. By introducing heterogeneity in productivity, they can disintegrate the effect of trade costs on trade flows into an intensive (trade volume per firm) and extensive (number of exporting firms) margin. Zero trade occurs between countries i and j when the productivity of all firms in the country, says i, is below the threshold that would make exporting to country j lucrative. Countrywide differences in trade costs and strong heterogeneity also account for asymmetries between export volumes from i to j and from j to i. Equation 3 shows their gravity equation.

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

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

In summary, the research line mentioned in this chapter indicates that the new product differentiation-based trade theory should be seen as a complement to traditional methods rather than a replacement. In explaining trade flows, traditional methods (Ricardian, HO) continue to play a significant role. The equation of gravity can emerge from a broad spectrum of standard and new theories of trade. Usually, they are offered as theoretical substitutes and the choice of the equation depends on the preferred set of assumptions and models (Baier & Bergstrand, 2001). However, there are some variations in the underlying assumptions and models, and such variations could likely explain the different literature, specifications and the diversity of empirical outcomes (Martínez-Zarzoso & Nowak-Lehmann, 2003).

While the theoretical foundation is no longer in doubt, the focus is now on ensuring that its empirical applications are well rooted on its theoretical ground and can be connected to any of the theoretical frameworks available and relevant. Regardless of the theoretical structure taken, however, the majority of subsequent gravity equation justifications are versions of the one first obtained in Anderson (1979).

Theoretical justification of the gravity model

Even though the gravity model was commonly used due to its empirical achievement in explaining bilateral trade flows, the model falls short of theoretical proof and was criticised for being ill-conceived for a long time (Bonuedi, 2013). This critique had cast aspersion on the gravity model of trade being respectable (Frankel et al., 1997). With the growing significance of geographical variables in international trade theory, however, the gravity model began to receive a revival of attention in the late 1970s in order to provide theoretical justification. Anderson (1979), Bergstrand (1985), Bergstrand (1989), Helpman and Krugman (1985), Deardorff (1998), and Anderson and van Wincoop (2003) are among the works that significantly contributed to the development of a theoretical basis for the gravity model. These publications have shown that the gravity model can be generated from a number of distinct trade models, such as the Ricardian model, the Heckscher-Ohlin model and new trade theories of economies of scale, monopolistic competition and intra-industry trade Bonuedi (2013).

At Anderson (1979) work, which was based on the premise of Armington's (1969) work (the country of origin differentiated goods). Anderson made the first attempt to provide the gravity model with a theoretical basis. He assumed that cross-countries preferences for trading goods (identical homothetic preferences across countries) are identical. The constant elasticity of substitution (CES) utility function was developed. That is, irrespective of the revenue in trade between nations, at least each nation consumes some of the goods at a given price from each partner. The national income will be the sum of domestic and foreign demand for the traded goods that each nation creates uniquely. Therefore, more imports and exports from advanced nations (Bacchetta & Van Wincoop, 2000)

In order to explain the gravity model, Bergstrand (1985) used a microeconomic basis of simple monopolistic competition models. Bergstrand (1985) took on a more flexible utility function that enabled him to discover proof that imports were closer substitutes for each of the domestic goods he called his equation a generalised model of gravity as it also included cost factors (Frankel, Stein, & Wei, 1997; Rahman, 2009; Thai, 2006).

Helpman's (1987) and Helpman and Krugman's (1985) works provide the best-known theoretical reasoning for the concept that bilateral trade relies on GDP. According to the authors, as in Frankel et al. (1997), under the imperfect substitute model, where each firm produces a product that is an imperfect substitute for another product and has monopoly power in its own product, consumers prefer the variety of goods they consume (Bonuedi, 2013). Once the size of the domestic economy proxy by population doubles, consumers increase their usefulness, not in the form of larger quantities but more variety. International trade can have the same impact by enhancing the chance for customers to become even more diverse

(Bonuedi, 2013). Hence, if two nations have comparable technologies and preferences, they will obviously trade more with one another to boost the number of consumer choices available**.** Frankel et al (1997) asserted that the classical H-O theory does not have this property, as it does in the gravity model that bilateral trade depends on income products.

Deardorff (1995) proved, on the contrary, that the simple gravity model could be derived from the hypothesis of Heckscher–Ohlin, Staffan Linder and Helpman–Krugman. Consumers and producers are indifferent in their trade from the (HO) model and other models based exclusively on comparative advantage and perfect competition, hence the lack of all trade barriers in homogeneous products. Deardorff has come up with two anticipated trade flows from this premise that is connected to the frictionless gravity model equation whenever there are identical preferences (Makochekanwa, Jordaan, & Kemegue, 2012). Deardorff defines each trade transaction as a selection of a worldwide product pool where producers place their products first and customers choose their products accordingly from this pool. The second situation is the presence of the (impediment) trade barrier. It is presumed that each product is produced by one nation only, therefore there are differentiated commodities with bilateral trade patterns in the HO model (Deardorff, 1998).

Whereas deriving a proportionate relationship between trade flows and country size is an important foundation, Helpman's theories (1987) and most of the above-mentioned writers do not include a distance role and therefore cannot appropriately be called the basis of the complete gravity model (Frankel et al., 1997). But, some literature works on the theoretical basis of the gravity equation have pointed to the fact that both relative and absolute distance issues related to bilateral trade flows (Sohn, 2005). These include Bergstrand (1985) edition of the imperfect-substitute theory which integrated a distance to proxy shipping cost. In this regard, the input of Anderson and van Wincoop's (2003) article was particularly important, showing that controlling relative trade costs are essential for a well-specified gravity model. They argued that trade between the two regions is declining in their bilateral trade barrier relative to the two regions' average trade barrier with all their partners. This average trade barrier is called "multilateral resistance". If a nation has a comparatively large average trade barrier, it will trade more with a nation with a small bilateral barrier. The logic is that ceteris paribus, two nations encircled by other big trading economies, will trade less among themselves than if they were bordered by oceans (or large expanses of deserts and mountains) (Bacchetta & Wincoop, 2000). Anderson and van Wincoop argued that multilateral resistance cannot be measured using remoteness variables depending on distance measurements because this does not capture border impacts, but rather the gravity model must be resolved by taking into consideration the effect of obstacles on prices (Bonuedi, 2013).

Empirical Literature Review

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

Determinants of trade within the framework of traditional gravity model and the augmented gravity model

The gravity model has been widely used as an empirical mechanism to analyze the determinants and patterns of global trade between Europe, Asia, and Latin America. The aim of this sub-section is to undertake a thorough examination of the available literature of certain studies, which will actually serve as a guide in the selection of a suitable model and variables in this research work**.**

Tinbergen (1962) was the first to pursue econometric research using an international trade flow gravity model. His first research was carried out in 1958, using data from 18 nations to determine the association between income, distance and common border effects on the impact of international trade. Among the trade resistance measures, he included the geographical distance between them, the adjacency dummy (common borders) and the British Commonwealth and Benelux membership dummies. Tinbergen discovered that both income and distance had their expected signs and were statistically significant. Tinbergen also found that the trade flow with a country's membership in the British Commonwealth (Benelux FTA) and the distance between trading partners are 5% and 2% greater respectively (Bonuedi, 2013).

The augmented version of the gravity equation was used by Bergstrand (1985) to evaluate the determinants of bilateral exports between 15 OECD countries in 1976. In addition to the conventional gravity variables proposed by Tinbergen, Bergstrand included exchange rates, export, and import price indices, GDP deflators in both nations and dummies for adjacency, membership of the European Economic Community (EEC) and the European Free Trade Area (EFTA) in the augmented gravity equation. Bergstrand discovered the variables, the import price index, the economic size of the countries, the adjacency and membership of EFTA had a positive effect on exports between a country and its trading partners, but the geographical distance between the countries had a negative impact on the export quantity of the countries concerned. The exchange rate and other variables were found to be statistically insignificant.

In a similar fashion, Rahman (2009) also employed the augmented gravity model to analyse Australia's international trade flows with 57 trading partners utilizing data from 1972-2006. The study included variables such as Australia's per capita GDP and those of its trading partners, Australia's per capita GDP differential and those of its trading partners, language dummies, the Regional Trade Agreement (RTA) and the openness of its trading partners. The results indicated that Australia has the trade potential with the USA, Canada, Japan, Mexico, Pakistan, Argentina, Brazil, Uruguay, Austria, New Zealand, Turkey, Chile, Hungary, India, Nepal, Hong Kong, Kenya, Peru, and South Africa. Furthermore, the study mentioned that bilateral trade in Australia is positively influenced by income, common language, free RTA and partners ' openness. However, the distance between Australia and her trading partners and the GDP per capita differentials negatively affect Australia's bilateral trade.

The augmented gravity model was again employed by Roy and Rayhan (2011) to investigate the prime determinants of Bangladesh's trade flow. The study included a maximum of 14 countries including Bangladesh and other 13 countries, which have a bilateral trade agreement with Bangladesh, including the South Asian Regional Cooperation Association (SAARC). The researchers used data spanning from 1991 to 2007 in their study. Based on their preliminary results, both basic and extended gravity models were created, which obviously indicated that variables such as the size of Bangladesh's economy and that of its partners, the openness of the partner's economy and the exchange rate greatly determined the trade flows in Bangladesh. The study also revealed that membership of SAARC and borders are significant factors that influence Bangladesh's trade flows.

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

In an attempt to investigate Ethiopia's export determinants, Yishak (2009) adopted the gravity model using the Generalized Two Stages Least Squares (G2SLS) technique on the panel data from 1995 to 2007. The study divides export performance of Ethiopia into inner supply-side contributions (macroeconomic environment, real exchange rate, institutional quality, foreign direct investment, and infrastructure) and conditions for external market access (geographical distance, transport costs, tariffs, and non-tariffs). The variables introduced into the model are GDP of Ethiopia and its importers, real exchange rates, the environmental performance index, foreign direct investment (FDI), internal transport, the index of international trade policy and the geographic distance between Ethiopia and its export destination. The result clearly showed however that the export volume of Ethiopia was substantially determined by an increase in GDP, infrastructure and efficient institutional quality in Ethiopia. There is no measurable impact on real exchange rates and FDI on their exports. The export volume of Ethiopia is also affected by geographical distance and import barriers from trading partners.

Within the framework of the gravity model, Gani (2008) examined the determinants of Fiji's international trade and its Asian trading partners using panel data from 1985 to 2002 on a cross-section of Asian nations where Gani produced import models for all seven nations, including India, Japan, China, Singapore, Thailand, Hong Kong, and Indonesia, as well as five export models in China, Hong Kong, Japan, Singapore, and Malaysia. The variables included in his model are the geographical distance between trading partners, GDP of both trading partners, exchange rate, population, and infrastructure. Gani's results from the panel showed that the population and infrastructure of Asian nations and the distance between their port and the exporting countries in Asia had a tremendous impact on Fiji's imports from its Asian trading partners. His research revealed that GDP is insignificant for both exporting and importing countries.

Sohn (2005) conducted a study in Korea to determine the extent to which the gravity model suits Korea's bilateral trade flows and the ramifications of Korea's trade policy. In his document, new explanatory variables, such as the Trade Conformity Index (TCI) and the Asia-Pacific Economic Cooperation (APEC) membership, were also introduced to examine the peculiarity of Korea's trade patterns - whether they conform to the Heckscher-Ohlin model or the differentiated product model - and to assess the impact of regional economic partnership with Korea's bilateral trade. Sohn's work was based on 1995 cross-section data on bilateral flows between Korea and its 30 major trading partners, their GDPs, per capita GDPs, and distance. Based on the outcomes of the regression, Korea's bilateral trade patterns have been found to fit well with the basic gravity model. The author's results revealed a positive and significant coefficient for the trade structure (TCI) of Korea. Based on these results, he concluded that inter-industry trade is prevalent in Korea's international trade, as explained in the Heckscher-Ohlin model. Membership of APEC was also found to have a significant positive influence on the volume of trade in Korea. Sohn concluded that Korea has a huge untapped trade potential with Japan and China.

In the particular scenario in Ghana, the literature on the gravity model for estimating trade flows is comparatively limited. Márquez-Ramos (2007) used the augmented gravity model to determine the variables that affect the pattern and volume of bilateral trade flow in Ghana and South Africa. For the writer to efficiently handle sector heterogeneity, he estimated a gravity equation using disaggregated data to evaluate trade determinants of these countries. In addition to traditional gravity variables, Marques-Ramos included other explanatory factors such as tariff rate and technological innovation in the importing country and trade imbalances between trading partners in the export model. The author found that South Africa, which is a developed African nation, will significantly increase its exports to other African nations, while Ghana, which is a developing nation, exports more to nations of high economic freedom, such as the EU. It has also been proven lowering transport costs has no important impact on African countries' exports. Results indicate that the impact of multilateral liberalisation on global trade is negative and substantial for South Africa, and regional integration (ECOWAS) does not encourage exports from Ghana. Importers' income was found to be important in championing global trade, but the tariff effect was found to differ between the countries.

The determinants of Ghana's bilateral trade flows were investigated by Bonuedi (2013) within the framework of the gravity model. He used panel data which covered 25 trading partners of Ghana from 1995 to 2011. Panel integration, as well as conventional fixed and random effects, were used to establish an estimate the run relationship between total bilateral trade and exports of Ghana and its respective determinants. The empirical results show that the upturn in Ghana's GDP and that of its partners, the growth of the foreign population and the depreciation of the real bilateral exchange rate, the increased freedom of trade between partners and the inflow of foreign direct investment are robust positive and important determinants of Ghana's bilateral exports and total trade. It is also discovered that the institutional quality of Ghana and the sharing of the language with its partners have a positive but statistically insignificant impact on the bilateral trade flows of the nation.

Another study was conducted by Asante-Nimako (2016) to examine the determinants of Ghana's bilateral export flows using the gravity model. The emphasis was on whether exchange rate variability in Ghana really matters in Ghana's bilateral export flow since Ghana's external value was volatile and the depreciation against significant currencies has steadily increased over the past two decades. Asante used panel data for Ghana's 20 trading partners from 1995 to 2014. The techniques used to estimate the model were the augmented gravity model and panel data estimation techniques such as POLS, fixed effects and random effects estimation techniques. Asante-Nimako found that GDP is positive and highly significant, while real bilateral exchange rates are negative. Commercial openness, infrastructure and foreign direct investment (FDI) are all positive, but not statistically significant, with the total export trade. Distance, language and population had a negative relationship with the total bilateral export flow of Ghana.

From the review above, the first eminent study of trade flows is credited to Tinbergen (1962). He assumed that based on Newton's gravitational law, which is indicated as trade between two nations can depend on their economic size and their distance. However, the real world scenario is not so simple that such a few factors are the determinants of trade flow. Ferwerda, Kattenberg, Chang, Unger, Groot and Bikker (2013) claimed that the traditional gravity model was rejected by two basic problems. According to the authors, substitutions between trade flows cannot be described by the TGM and it also lacks a cogent theoretical basis. He also observed that the traditional gravity model largely overestimates the impact of international trade determinants owing to the strong substitution of trade flows, thus decreasing the original gravitational impact. To overcome these weaknesses led to the development of the extended gravity model to. Over the years, many scholars developed Tinbergen's basic gravity model (1962) using other real or dummy variables that formed the basis for extending the traditional gravity model. For example, Linnemann (1966) extended the gravity model and introduced both the exporting and importing countries' population size as well as the factor of artificial trade resistance.

In addition, Frankel et al. (1997) expanded the fundamental gravity to include income (GDP per capita). As a variable affecting trade flows between countries, Pfaffermayr (1994) added foreign direct investment to further enrich the gravity model. Chen and Wall (as cited in Rasoulinezhad, 2017) included the index of trade policy, bilateral exchange rates, and regional trade preferences. Anderson and Wincoop (2003) expanded the fundamental gravity model by including multilateral resistance variables (MRFs) such as language, remoteness, etc. But there are other real and dummy variables such as regional trade preferences, common language, remoteness, both partners' population, per capita GDP, trade policy indexes, bilateral exchange rates, economic openness, and FDI are very significant determinants of trade flow between nations.

The strength of the Stochastic Frontier Gravity Model (SFGM) over the Traditional Gravity Model (TGM) in estimating trade potentials of countries

Since its advent by Tinbergen (1962), the traditional gravity model has been used to answer countless research questions. It was only in the 1990s, however, that the gravity model was used to calculate the trade potential of nations as well as regions. Some of the earlier studies were (Wang &Winters, 1992; Hamilton & Winters, 1992; Baldwin, 1994; Gros & Gonciarz, 1996; Nilsson, 2000). All of them concentrated mostly on the European Union (EU) and Central and Eastern European (CEEC) countries. In general, these studies were intended to project the expected growth in trade between CEECs and EU countries against the background of the breakdown of the Iron Curtain that led to the liberalization of the CEEC economies for trade with European countries.

Two methods have been used in previous research to calculate trade potential using the gravity model, as stated by Egger (2002). One approach was called out of the projection sample and the other approach is the in the projection sample. The out sample approach involved estimating the gravity equation for EU countries or OECD countries and then using the estimated parameters to project trade volumes between EU countries and CEECs. The basic assumption of this approach was that the EU countries already traded at their potential levels so that the estimated gravity equation parameters reflected potential trade projections. Under the in the sampling approach, the countries of Central and Eastern Europe were included in the gravity equation assessment. The residues of the estimated gravity equation were interpreted as the difference between actual and potential trade (Egger, 2002).

Nilsson (2000) seeks to measure the degree of commercial integration between the CEECs and Cyprus and EU countries in its quest to evaluate the willingness of the CEECs and Cyprus to satisfy the economic criteria for their entry into the EU. The economic criteria stated that CEECs and Cyprus should be able to cope with competitive pressure and market forces in the EU in the medium term before they joined the EU Nilsson (2000). He calculated the trade potential between the chosen countries and also the EU countries, where Nilsson then compared to the actual trade flows in order to ascertain their level of market integration. What Nilsson (2000) obviously tried to do was to discover a baseline in terms of trade flows to compare actual trade flows in determining the CEEC and Cyprus countries' level of integration with the EU Member States. However, he discovered that the CEECs and Cyprus were willing to join the EU on the basis of the empirical results showing that their actual trade flows were close to potential trade flows.

In his criticism of the pioneering studies in their use of the gravity equation to assess trade potential, in specifically the in-sample strategy, Egger (2002) stressed the significance of adequate specification and estimator selection in terms of the gravity equation parameter consistency and efficiency. Egger (2002) stated that the cross-sectional specification framework, including the use of an OLS estimator, could produce inconsistent and ineffective estimates given the absence of direct control over non-observable bilateral impacts. Finally, Egger (2002) found that the so-called enormous untapped trade potential obtained from some other studies on EU nations and CEECs using the in-sample method was due to model misspecifications and estimation issues. In his study, he applied six different panel estimators and used the trade projection approach, in -sample to estimate the trade potential of the countries used in his study in order to produce consistent and efficient estimator. He confirmed that the consistent and efficient estimator in his application was the Hausman and Taylor, AR (1) estimator because it generated trade projections, which did not vary wildly from the trade flows observed.

From the study of De Benedictis and Vicarelli (2005), they calculated the trade potential of 32 trading partners using the gravity model for each of the 11 founding countries of the European Union. The gravity equation for each of the 11 countries using 32 importing countries individually (each EU country serving as an exporting country) was estimated. Three gravity equation specifications were used in their study. These included a static linear specification, a static linear with fixed effects and a dynamic fixed effect specification. The three different specifications were estimated by using OLS and the General Method of Moments (GMM) estimators. The study's main priority was to determine the robustness of the in-sample approach of estimating trade potential by using different estimators. De Benedictis and Vicarelli (2005) found that various estimators generated different outcomes of trade potential. The dynamic specification with estimated fixed effects using GMM systems produced fitted close trade flows to the observed trade flows. According to De Benedictis and Vicarelli (2005), GMM was the most reliable estimator in its application. They acknowledged that due to the high sensitivity of the trade potential projections in the in-sample to the choice of the estimator, extreme caution must be exerted in drawing policy conclusions based on the empirical results of some of this research.

Out of sample gravity, projection and panel data framework was used by Ferrarini (2014) to estimate Myanmar's export potential. The gravity equation used in the measurement of Myanmar's trade potential was estimated using the bilateral export flows of six South East Asian Nations Association (ASEAN) countries for the period 2000- 2010. In Ferrarini's assessment of the gravity equation, he used a pseudo-fixed effect (PSEUDOFE). The author asserted that unlike most of the properly fixed estimator, which makes it impossible to estimate time-invariant trade determinants such as the distance factor in gravity estimation, the PSEUDOFE allows the estimation of time-invariant trade determinants in gravity estimation. Ferrarini (2014) argued that the coefficient estimates of time-invariant variables are important in the use of the gravity equation to estimate trade potential and that their exclusion leads to inaccurate estimates of trade potential. The reliability of its gravity regression results was checked using three other estimators: a generalized least squares estimator for random effects, a feasible generalised least squares estimator and an unconditional fixed effects Tobit estimator. His results were robust to different estimators. He discovered that 15 percent of Myanmar's trade potential was traded.

The disparities between observed values and anticipated values were estimated in previous research using the gravity equation through OLS estimates as potential trade (Baldwin, 1994; Nilsson, 2000) between a pair of countries. The method of estimating OLS produces estimates that represent the central values of the data set. However, potential trade implies free trade without constraints on trade. Therefore, it is logical for policy reasons to describe potential trade as the highest possible trade between any two countries that have most liberalised trade restrictions, given the determinants of trade Miankhel et al. (2009). It means that estimating potential trade requires a process that represents the upper boundaries of the data and not the centralised values of the data set (Kalirajan, 2000, 2007). The stochastic frontier gravity model is able to predict potential trade close to the frontier level by using the maximum likelihood estimation method. The reliable strength of the stochastic frontier gravity model over traditional models in estimating trade potential has led to an increasing body of literature assessing trade potential between nations and regions.

The use of Stochastic Frontier Gravity Model (SFGM) in the estimation of trade potential.

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

Through multilateral trade resistance, Anderson and van Wincoop (2003) suggested that trade flows between a pair of countries depend not only on trade resistance between the two countries but also on trade resistance between the two countries and all their various trading partners. For example, the trade volume between Ghana and Nigeria depends not only on the trade resistance (economic distance) between Ghana and Nigeria but also on each country's trade resistance with all its various trading partners. If, as a result of a successful bilateral trade agreement, trade resistance between Ghana and Nigeria or any of its trading partners other than the USA is reduced, Ghana's multilateral resistance will be reduced, which will facilitate trade between Ghana and Nigeria and reduce trade between the USA and Ghana. The multilateral resistance factor exposes a substitutability element in international trade (Starck, 2012).

This resistance term has attained such affirmation in the literature of trade. According to Baldwin and Taglioni (2006), failure to control for this multilateral resistance terms in any estimation of the gravity model leads to the commitment of a gold medal error in the gravity estimate.

The word multilateral resistance is mainly unnoticeable and difficult to assess, according to Miankhel et al. (2009). Inability to control "economic distance" properly and by extension, of multilateral gravity estimation resistance results in inconsistent and inefficient parameters. According to the writers, in the traditional gravity model estimated with OLS, wrongful control or omission leads to a violation of the normality assumption of the error term and generates heteroscedasticity in the often-unknown error term. The conventional gravity model is estimated in a linear log form and according to Silva and Tenreyro (2006), log-linearization in the presence of heteroscedasticity produces inconsistent estimates. "The reason is that a random variable's anticipated logarithm value depends completely on its distribution at moments of greater order" (p. 653).

Many methods were created and implemented in the literature to regulate the estimation of the gravity of multilateral resistance terms. Multilateral trade resistance factors were addressed in terms of observed trade price determinants by Anderson and van Wincoop (2003) and a tailored non-linear least square estimator was used to obtain coherent parameter estimates. With their strategy, the primary downside is that it is very complex (Baier & Bergstrand, 2009). It also contributes to reduced efficiency. Multilateral resistance with country-specific fixed effects are less taxable and often used the technique (Feenstra, 2015). This method produces consistent estimates of parameters, but the partial impacts of many potentially useful explanatory variables cannot be estimated immediately due to their ideal collinearity with country-specific effects (Baier & Bergstrand, 2009). Kalirajan (2008) also argued that the fixed effects strategy is not based on economic theory.

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

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

The following advantages in the use of the SFGM in estimating trade potential were recognised by (Kalirajan, 2008; Mikankhel et al., 2009). First, the use of SFGM is not affected by efficiency losses. The combined impacts of the word "economic distance" ('behind the border' variables) can also be estimated, which results in heteroscedasticity and non-normality and isolates it from the term of statistical error. The investigator can effectively evaluate the bias term factors. The SFGM again offer trade estimates close to free trade estimates as it represents the highest information volumes from those countries with the most liberalized trade constraints. Finally, it has important trade consequences and theoretical consequences. In other words, it offers theoretical and policy suggestions on how to support socio-political-institutional free trade considerations (Bhattacharya & Das, 2014). Although SFGM is not so prevalent in the empirical literature, it has been used in several types of research to calculate the trade potential of nations. Kang and Fratianni (2006) used the SFGM strategy to assess trade efficiencies for several nations, ten geographic areas, and eleven regional trade agreements. Their trade efficiency estimates for the nations were extremely small. They asserted that “the use of stochastic frontier estimates is justified when the equation of trade gravity is considered as the consequence of cost decrease’ (p. 5).

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

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

The Stochastic frontier gravity model was also adopted by Ravishankar and Stack (2014) to calculate trade efficiency scores for ten Eastern European countries (new European Union members) with seventeen Western European countries.

Ravishankar and Stack (2014) estimated the model of importing nations with 10 new members from Eastern Europe using the export flows of the 17 existing members of the European Union. Panel estimation approach of 1994- 2007 was used by the authors. Their research showed high-efficiency scores, indicating a high degree of trade inclusion over the period under research between the ten Eastern European nations and their Western European trading associates.

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

To determine the extent to which trade arrangements will help India minimise its balance of trade deficit with the counterpart country, China, Kalirajan, and Paudel (2015) applied the SFGM framework to undertake a counterfactual analysis of India’s free trade agreement or preferential trade arrangement with China. The authors designed Panel data to cover export data from 1995 to 2010 in accordance with the stochastic gravity equation for China and as well as India.

Kalirajan and Paudel did find that 68 percent of Indian export potential with China has been exploited with the present tariff systems and exchange rate, while 86 percent of China's export potential with India has been achieved. They carried out a simulative hypothetical decrease of 50% in the simple average tariff, which amounted to about 7.7% for China and 11.5% for India in 2010. The counter-factual free trade assessment between India and China disclosed a 20% increase in India's export potential to China, while China will assist to boost India's export potential by 28%. Given their simulation exercise outcomes, they advised that India must first achieve its export potential with China by reducing its “behind the border” trade-resistant factors before trying either to establish a preferential trade agreement or a free trade agreement with China.

An assessment of Pakistan trade potential was carried out by Gul (2006) within the stochastic frontier gravity framework. Analysis of the panel data for the period 1981-2005 is used across 42 nations. The coefficients acquired from the model are then used to predict the trade potential of the country globally as well as within particular trading blocs. Their results revealed that Pakistan’s trade potential is highest with countries in the Asia-Pacific region (the Association of Southeast Asian Nations (ASEAN), the European Union (EU), the Middle East, Latin America, and North America. Specifically, the maximum potential exists with Japan, Sri Lanka, Bangladesh, Malaysia, the Philippines, New Zealand, Norway, Sweden, Italy, and Denmark, therefore, suggested that Pakistan should explore methods and means of further improving its trade ties with the nations involved, as well as focusing on ASEAN, the Middle East, and the EU to boost their market share as far as possible. They found that, despite the existence of significant potential, the volume of trade between Pakistan and other South Asian Association for Regional Cooperation (SAARC) and Economic Cooperation Organization (ECO) members is very low.

The primary barriers to this end, according to Gul (2006), are the political and cultural tensions between neighboring nations, especially between Pakistan and India, which are SAARC's key partners.

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

Following the theoretical orientation of production function, (Ebaidalla & Mustafa, 2018) uses the Stochastic frontier Gravity Model (SFGM) to explore intra-Arab trade efficiency and potential over the period 1998-2015. The main focus of these researchers was to examine the existence of restrictions on trade flow between Arab countries, specifically, behind and beyond the border restrictions. Their study revealed that the limitations of 'behind the border' was accountable for a significant gap between potential and actual trade between Arab countries. Their results again revealed that the influence of 'behind the border' constraints on trade flows have been decreasing over time among the Arab countries. In addition, Ebaidalla and Mustafa disclosed that intra-Arab trade efficiency scores show a comparatively small degree of trade inclusion among Arab countries, confirming the presence of rigidities against intra-Arab trade both 'behind the border' and 'beyond the border'.

Hassan (2017) introduced a stochastic frontier gravity model approach using panel data to examine the main factors and limitations of Bangladesh's export sector and its ability to improve its trading position in relation to its top 40 trading partners. Hassan's research disclosed that the primary determinants of export volume for Bangladesh were a gross national product (GDP), population, distance, average tariff, trade arrangements, and exchange rates. However, tariff rates and distance between Bangladesh and its partner nations have been discovered to have a negative impact on trade. The research also finds that social-political-institutional limitations such as customs procedures, port inefficiencies, and corruption, "behind the border," restrict trade. Hassan found that there are wide variations in export rates, even among nations within the same trading blocks, which implies that a large level of untapped export potential can be found by eliminating behind the -border constraints and assimilating more efficiently with the global market.

The application of the gravity model to estimate the export potential of only Ghana, either with the other Member States or with other trading partners in general, is limited in the literature. In a study focusing on Ghana, Adam and Tweneboah (2009) used the gravity equation to model Ghana's bilateral trade flows with their main trading partners, including the remaining five WAMZ members. They discovered that there is potential trade growth in Ghana with Nigeria and Guinea, but exhausted trade flows from Ghana with the other WAMZ members. Adam and Tweneboah advised that the success of the suggested common currency depends on the countries' proper intraregional integration. However, there are some intrinsic flaws in Adam and Tweneboah (2009) research using the standard gravity model with an OLS estimate to calculate trade potential. This implies that their trade flows are measured as average trade flows rather than freezing or optimising trade flows. In addition, their study did not control non-observed trade resistance and multilateral trade resistance between Ghana and its trading partners, which raises alarms about the consistency and efficiency of the gravity model's regression results.

More recently, Kumah (2017) introduced the stochastic frontier model to evaluate trade potential between Western African Monetary Zone nations in order to address the possible limitation of the standard gravity model used by Adam and Tweneboah (2009) in estimating WAMZ countries' trade potential To evaluate the level of trade inclusion between WAMZ nations, Kumah established an export frontier for each WAMZ nation using aggregate country export data for at least 45 nations over the period 2000-2014. The author has applied both the Battese and Coelli model (1992) and the Kumbhakar model (1990) to estimate the efficiency scores for each member of the WAMZ. His results concluded that the estimates of trade efficiency between WAMZ countries showed different degrees of trade integration and therefore, the region is poorly integrated from a trade point of view.

Conclusion

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

Despite the intense and varied empirical literature on the investigation of various countries' export potential with their trading partners, Ghana's export potential and gap have been ignored. Most of the previous studies that featured

Ghana (Adam & Tweneboah, 2008; Kumah, 2017) concentrated on a potential trade with special focus on WAMZ. It is also noted that these studies reviewed overlooked the limitations of “behind the border” and “beyond the border” constraints, which could generate inefficiencies in trade or export flows. With the deficiencies in mind, the distinctive feature of this research is to use the stochastic frontier gravity model to evaluate the bilateral export potential and gap of Ghana with 61 chosen trading partners.

CHAPTER THREE

RESEARCH METHODS

Introduction

The purpose of this chapter is to present the methodology of the study. First research design and a brief overview of the weaknesses of the traditional gravity model and the linear panel Fixed and Random Effect model in the estimation of export potential are presented. It again presents an overview of the theoretical foundations of the Stochastic Frontier Gravity Model. It continues to present specification of the model, justification, and measurement of the variables, sources of data, estimation techniques and the post-estimation tests. Finally, the chapter will discuss major econometric issues regarding panel regression.

Research Design

In view of the purpose and objectives of this study, the quantitative research design was used to assess the export potential of Ghana and the gap with its selected trading partners. The quantitative research design allows the researcher to maximise objectivity, generalise the results and replicate other researchers' findings. This research design appears to be either descriptive when the subject is measured once in nature or experimental when the subject is measured before and after treatment. This study, which attempts to analyse the export potential and gap in Ghana, is descriptive in nature since it is measured once. Therefore, the variables relevant to the stated objectives of the study are valid and accurately presented.

Theoretical Model Specification

This sub-section will start with a short overview of the traditional gravity model's weaknesses and fixed and random effect models of the linear panel. This is accompanied by the stochastic frontier models' theoretical formulation and the stochastic frontier gravity model's empirical specification. It also discussed the source of data and research estimation techniques.

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

While many empirical studies have been successful in estimating trade flows using the standard gravity model and the linear panel fixed and random effect model, the standard gravity model has however been criticised for the absence of theoretical basis.

The common techniques used in the estimation of panel data are the estimation of fixed and random effects. The choice of these two techniques depends on what they assume. The random effect assumes that the explanatory variables do not correlate with the unseen heterogeneity (individual effects) while the fixed effect model assumes that the unseen heterogeneity is correlated with the error term. Acceptance of the zero correlation hypothesis implies that the effect is efficient at random; both are consistent, but the effect at random is more consistent than the fixed effect. However, the fixed effect is consistent with a situation where the null hypothesis is rejected and the random effect is neither efficient nor consistent. The issues associated with the fixed effect model are that the dummy variables such as geographical distance, land area, the common language and bilateral trade agreement (BTA) are not estimated in the fixed effects model (FEM) at all-time invariants. In other words, invariant variables are always dropped from the fixed effect model, which then implies that the fixed effect model excludes some vital theoretical variables which are essential for the estimation of the gravity model.

Egger (2002) also noted that the use of random effect estimators has a high frequency of producing estimates which are inconsistent and inefficient, and attributed this to the fact that it is very unlikely that the orthogonality assumption exists between the independent variables and the unnoticed effect.

Early gravity models estimated gravity equations using the ordinary least squares (OLS) techniques to log the model linearly. Their assertion was that in order to be valid, the log-linear gravity model depends on the homoscedastic assumption since the error term and the log must be statistically independent of the regressors. That practice was criticised by Silva and Tenreyro (2006). Their position is that due to the nature of the trade data intrinsic to heteroscedasticity and general zero trade observation, it is problematic to linearise the gravity equation and then to apply OLS.

The first major problem identified by Silva and Tenreyro (2006) is that the normal practice of log linearising and estimating the gravity equation with OLS is inappropriate, as the expected value of the linearised error term depends on the regression covariates. The use of OLS as the estimation technique is therefore not consistent, even if the observations of the dependent variables are positive. The reason for this is that the logging of the linear gravity model alters the properties of the term. Silva and Tenreyro (2006) contend that the linear transformation of the gravity model into biased and inefficient estimates is inherent to heteroscedasticity and that OLS results are used. Silva and Tenreyro (2006) again expressed concern about the presence of zero trade flows in the trade matrix and the correct estimation procedure. According to them, bilateral trade flows have frequent zero values and the estimation of the linear gravity model in the presence of these zero trades flows leads to theoretical and methodological problems, particularly in situations where there are many zero values. Consequently, estimating linear regression with zero trade flows in the data means that these observations must either be dropped or replaced by an arbitrary positive value, leading to sample selection bias and information loss. The remedy suggested in the empirical literature to solve this zero trading flow record is the use of the censoring or truncation method before the linear estimation techniques are applied. The truncation method drops the value of zero while the censoring method chooses an arbitrary positive value instead of zero. The issue here is that these two methods have no powerful theoretical and empirical support and can, therefore, affect the results of the estimate, resulting in inconsistent estimates (Flowerdew & Aitkin, 1982; Eichengreen & Irwin, 1998; Linders & De Groot, 2006).

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

However, this study will adopt the Stochastic Frontier Gravity Model (SFGM) to overcome some of these problems with the methodology and estimation. The SFGM approach is an improvement over traditional gravity and linear panel models of Fixed Effect and Random Effect in the sense that the error term is divided into two parts: this symbolises all the- border constraints; and the random error term, which captures the effects of all other unnoticed or omitted variables and errors of measurement. However, the fixed and random effect linear panel models and the traditional gravity models only capture the random error term. You cannot capture the term of non- negative error that captures the inefficiency.

Pioneers of the Stochastic Frontier Gravity Model (SFGM) believed that it controls the multilateral trade resistance factors properly (Kalirajan, 2008; Miankhel et al., 2009; Ravishankar & Stack, 2014). They argue that, in view of the determinants of trade, the SFGM allows the direct estimation of non- observable trade barriers which prevent the trade flow between a pair of countries from reaching its maximum limit. In estimating trade potential, the use of SFGM is more consistent with the theory of trade potential as suggested by (Kalirajan, 2008; Ravishankar & Stack, 2014; Bhattacharya & Das, 2014). This informed its development as an alternative and improved method to the traditional gravity approach and the fixed and random effect linear panel method. The traditional method of gravity estimates the trade potential using the average effect of the determinants. However, according to theory, the potential of trade must be the maximum level of trade flow given both the determinants and the least trade resistance. To do so, it is important to estimate the upper limits of the set of data. The SFGM makes it possible to estimate the upper limit of the data by using the maximum likelihood estimation method, which makes the theory of trade potential more consistent with empirical estimation. However, the application of the traditional gravity model using OLS only estimates the data centered limit that is inconsistent with empirical estimates. Finally, a key strength of the SFGM over the TGM is its ability to decompose the error term into two parts, specifically, the non-negative error term which represents the 'behind the border' inefficiencies that restrict trade from reaching its potential, and the random error term which captures all other disturbances including 'beyond the border'.

Stochastic Frontier Production Function (SFPF)

A working horse in the literature on productivity and efficiency was the Stochastic Frontier Production Function (SFPF), created independently by Aigner et al. (1977) and Meeusen and Van den Broeck (1977). The SFPF refers to the peak output from the given amount of input and technology to a structural part of the production function and a decomposed disturbance term. The Stochastic Frontier Gravity Model is a blend of both the conventional Gravity Model and the Stochastic Frontier Production Function Model originally attributed to Kalirajan (2000) in order to address the weaknesses imposed by the conventional gravity trade model and to estimate potential trade flows between countries that can be written as;

$$y_{it} = f(x_{it}; \beta) + v_{it} - u_{it\,,\, i=1,2,\ldots\ldots,n.;t=1,\ldots\ldots,T_i} \tag{5}$$

Where y_{it} represents the logarithm of the output of firm i at time t, x_{it} is vector logarithm of inputs of firm i at time t, β is a vector of unknown parameters, $f(.)$ is a known production frontier function (e.g., Cobb-Douglas or Translog), v_{it} is a two-sided symmetric random disturbance representing factors that are beyond the firm's control such as weather, topography, machine performance, etc. $\mathrm{u_{it}} \geq 0$, is a one-sided disturbance representing technical inefficiency. It is assumed thatv_{it}~$\mathrm{i.i.d\ N}(0, {\sigma_v}^2)$, u_{it}~$i.i.d\ N^+(0, {\sigma_u}^2)$, where N^+ (...) denotes a half-normal distribution. Finally, it is assumed that v_{it} *and* u_{it} are independent and both errors are independent of x_{it}. From equation (5), zero value of u_{it} indicates that the firm is fully efficient (no production inefficiencies). On the other hand, any positive value of u_{it} indicates that the firm is operating below the frontier, implying that there exists productive inefficiency within the production process of the firm.

The Stochastic Frontier Gravity Model (SFGM)

The Gravity Model is one of the most widely adopted frameworks for empirical work in international economics. The Gravity Model is based on the Newtonian Universal Law of Gravitation, which states that the force of gravity between objects is proportional to the masses of objects and inversely related to the square distance between objects (Newton, 1848). Tinbergen (1962) introduced the TGM to empirical economic literature.

The model predicts that the amount of trade flows between a pair of nations is proportionally related to the two countries' scales, which are primarily represented by the two countries' gross national products and vice versa by the geographical distance between the two nations, which is a proxy primarily for the transport costs of the goods. The stochastic frontier gravity model (SFGM) has become an improved alternative framework for the assessment of trade potential. In general, the SFGM version of the TGM is based primarily on the stochastic frontier production model (SFPM) concept in equation (5) and can be stated as:

$$EX_{ijt} = f\left(w_{ijt}; \beta\right) + v_{ijt} - u_{ijt}, \tag{6}$$

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

Empirical Model Specification

The study embraces the stochastic frontier gravity model of Armstrong (2007). Armstrong's suggested model specification comprises of two phases of estimation. The first stage includes a trade frontier estimate. The second stage includes estimating the determinants in the unilateral error term explaining the variation. Armstrong (2007) proposed that gross domestic products (GDPs), relative distance ($dist_{ij}$), border effects and other determinants such as Language as the basic elements for the estimation of the trade frontier.

Trade flow resistances between country i and j is specified in equation (7).

$$TR_{ij} = f\left(dist_{ij},\ other\ factors\right) \tag{7}$$

Natural trade flow resistances are barriers to trade that are not policy-oriented whereas man-made trade barriers are instituted for the purpose of policy. By including both the natural and manmade resistances, equation 7 can be rewritten as

$$TR_{ij} = f\left(trade\ \ resist_{ij}\right) = \ p\left(natural_{ij}\right)q\left(manmade_{ij}\right) \tag{8}$$

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

$$p\left(natural_{ij}\right) = RDist_{ij}{}^{\varphi_1}\exp(border_{ij}{}^{\varphi_2} + landlocked_{ij}{}^{\varphi_3} + lang_{ij}{}^{\varphi_4} \dots) \tag{9}$$

$$q(Manmade_{ij}) = q(TA_{ij}, pol\ dist_{ij}\ regional\ blocs, institutions, \dots) \quad (10)$$

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

Taking the log of equation (8) yields:

$$lnTR_{ij} = lnp(natural) + q(manmade) \quad (11)$$

Equation (12) captures all the trade flow resistances between country i and country j. The standard gravity equation proposed by Armstrong (2007) is given by:

$$lnT_{ijt} = \psi_0 + \psi_1 lny_{it} + \psi_2 lny_{jt} + \psi_3 lnb(natural) + \sum_m \psi_m lnp_m + v_{ijt} - u_{ij} \quad (12)$$

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

Measurement of Export Potential, Efficiency and Gap

More appropriately, export potential refers to the export level achieved at the frontier where free and frictionless trade takes place between two countries (Hassan, 2017). But in the real world, this is difficult to achieve. In this regard, the export potential of a country would be the maximum achievable export level with the given level of trade determinants and the least restrictive level in the current system (Drysdale, Huang & Kalirajan, 2000; Armstrong, 2007). This means that the potential level of trade is where the countries concerned have minimum restrictions, but not under free trade conditions. The gap between actual exports and potential exports suggests the efficiency loss in the system that the stochastic frontier model can estimate (Kalirajan & Finlay, 2005). It is essential to remember that the trade gap is determined not only by the primary export determinants but also by natural and man-made variables that influence trade between nations.

Based on this argument, after the parameter estimates, the point estimate of the technical efficiency of a country can be measured by the following equation in the stochastic frontier model developed by (Battese & Coelli, 1988).

$$TE_i = \frac{\ln f(w_i;\beta)exp(-u_i+v_i)}{lnf(w_i;\beta)exp(v_i)} = exp(-u_i) \tag{13}$$

The estimates of technical efficiency range from zero to one. A zero technical efficiency value shows the need to raise actual export levels, while a technical efficiency value of one suggests that the real and potential export rates are the same.

According to Hassan (2017), the potential export can be measured by the following formula;

$$PE_i = \frac{Actual\ Export}{\exp(-u_i)} \tag{14}$$

Where TE_i represent the technical efficiency for Ghana, PE_i is the export potential for Ghana, w_i are the determinants of potential bilateral export, u_i represents the inefficiency term, or the behind-the-border constraints, v_i represents the random error term and β is an unknown parameter.

According to Hassan (2017) and Deluna Jr & Cruz (2013), the export gap is measured or computed as the difference between actual exports and potential export. Drawing from Hassan (2017) and Deluna Jr & Cruz (2013), the study calculates the gap in Ghana's bilateral export flow as the difference between the potential export computed in equation (14) and the actual observed bilateral exports.

Using Armstrong's (2007) methodology, the stochastic frontier gravity model in equation (12) can be rewritten as equation (15) to assess the determinants of Ghana's bilateral export flows.

$$lnBEXP_{ijt} = \beta_o + \beta_1 lnGDPX_{it} + \beta_2 lnGDPM_{jt} + \beta_3 lnPOP_{it} + \beta_4 lnPOP_{jt} + \beta_5 lnDIST_{ij} + \beta_6 Landlocked_j + \beta_7 Comcol_{ijt} - u_{ij} + v_{ij} \tag{15}$$

Where $lnBEXP_{ijt}$ is the logarithm of the bilateral export flows to each of the 61 trading partners, $lnGDPX_{it}$ is the logarithm of the value of the gross domestic product of the exporting country (Ghana) at time t. $lnGDPM_{jt}$ is the logarithm of the value of the gross domestic product of the importing country at time t. $lnPOP_{it}(lnPOP_{jt})$, is the logarithm of the total population of Ghana and the total population of the trading partner respectively. $lnDIST_{ij}$, represents the logarithm of the absolute distance between the capital cities of bilateral trading partners.

$Landlocked_{jt}$ is a dummy variable; 1 if the country, j, is landlocked and 0 if otherwise. $Comcol_{ijt}$ is a dummy variable; 1 if the countries i and j are ever in a colonial relationship and 0 others. u_{ij} is a single-sided error for the combined effects of inherent economic distance bias or "behind the border", constraints, which is specific to the exporting country with respect to the particular importing country, which create the difference between actual and potential bilateral trade. Lastly, v_{ij} is the conventional error term that control, statistical errors and omitted variables.

The inefficiency effect model, is specified in equation (16) captures significant factors that contribute to Ghana's bilateral export inefficiency.

$$\begin{aligned} u_{ij} = \alpha_0 + \alpha_1 ECOWAS_{ij} + \alpha_2 APEC_j + \alpha_3 LANG_j + \alpha_4 FFC_i + \alpha_5 FFC_j \\ + \alpha_6 TRF_i + \alpha_7 TRF_j + \alpha_8 TAXB_i + \alpha_9 TAXB_j + \alpha_{10} lnINS_i \\ + \alpha_{11} lnINS_j + \alpha_{12} lnINFRAS_i + \alpha_{13} lnINFRAS_j + \alpha_{14} DCTPS_i \\ + \alpha_{15} DCTPS_j + \omega_{ijt} \end{aligned} \tag{16}$$

Where, u_{ijt} measures the performance or the degree to which actual export falls short of potential export given by the stochastic frontier equation. Therefore, equation (16) represents "inefficiency" of a country (Ghana) in its foreign trade, which is as a result of the countries' lack of proper infrastructure or managerial expertise (Kang & Fratianni, 2006). This model assumes that there are restricting factors in both the home and the importing country that affect the home country's (Ghana's) export. ECOWAS is a dummy variable for a regional trade agreement and it is equal to 1 if a country is a member of the Economic Community of West African States (ECOWAS) and 0 if otherwise. $APEC_j$, is a dummy variable that takes the value of 1 if country j is a member of the Asian Pacific Economic Corporation and 0, otherwise. $lANG_j$, is a dummy variable, it takes a value of 1 if the country j's language is English and 0 otherwise. $FFC_i(FFC_j)$, Freedom from corruption index of country, i and j, respectively. $TRF_i(TRF_j)$, is Trade Freedom index of country, i and j, respectively. $TAXB_i(TAXB_j)$, is Tax burden of the country, i and j, respectively. $INS_i(INS_j)$, it represents the institutional quality of the country, i and j respectively. $INFRAS_{it}(INFRAS_{jt})$, represents the internal infrastructure of both countries, i and j, respectively. Finally, $DCTPS_i(DCTPS_j)$ represents the domestic credit to the private sector of both countries, I and j, respectively.

Measurement and Justification of Inclusion of Variables

In assessing Ghana's Bilateral Export potential and the gap with its trading partners, the study made use of annual data over the period 2000 to 2017; containing eight variables, which comprise one dummy variable. The variables include bilateral export to the trading partners ($BEXP_{ijt}$), Gross Domestic Product for both exporting and importing countries ($GDPX_{it}$ and $GDPM_{jt}$), the population of the exporting and importing country (Pop_{it} and Pop_{jt}), the distance between the exporting and importing country ($Dist_{ijt}$), landlocked of the importing country ($landlocked_j$). Common colony between the exporting and the importing country ($Comcol_{ij}$). Membership of Economic Community of West African State of the exporting and the importing country (ECOWAS), Membership of Asian Pacific Economic Corporation of the importing country (APEC), Freedom from corruption index of the exporting and importing country (FFC_i, FFC_j), Trade Freedom index for exporting and importing country (TRF_i, TRF_j), tax burden for both exporting and importing country ($TAXB_i, TAXB_j$), Institutional quality for both exporting and importing country (INS_i, INS_j), Internal infrastructure for both trading partners ($INFRAS_{it}$, $INFRAS_{jt}$).

Dependent Variable

Bilateral export ($BEXP_{ijt}$)

This is measured by the total value of export from Ghana to a specific trading partner at a time t, usually measured in US dollars**.** It also represents the total value of import of the trading partners from Ghana. This, therefore, comprises of total exports of goods from Ghana to the trading partners. The bilateral export statistics are sourced from the International Monetary Fund Direction of Trade Statistics (DOTS).

Inefficiency (u_{ijt})

This measures the efficiency or the degree to which real exports fall short of the potential exports provided by the stochastic frontier equation. It reflects a country's (Ghana) "inefficiency" in its external trade, which is due to the country's absence of adequate infrastructure or managerial knowledge. It measures the "behind the border constraints" in the exporting country (home country). This implies that there exists an influential effect of behind the border factors in restricting the export of Ghana. This variable is predicted from the coefficients of the stochastic frontier estimates.

Independent Variables

The main independent variable of interest in the gravity equation is Gross Domestic Product for both exporting and importing countries, however the study has other control variables such as population for both exporting and importing countries, the distance between the exporting and importing country, landlocked of the importing country, colonial history between the exporting and importing country**.** The primary variable of concern in the inefficiency model is also institutional quality. Other control variables include membership of ECOWAS, Membership of Asian Pacific Economic Cooperation, common language, and freedom of corruption for both trading partners, freedom of trade for both exporting and importing countries, the tax burden for both trading partners, internal infrastructure for both exporting and importing countries, and domestic credit to the private sector for both trading partners.

Gross Domestic Product (GDPs)

The gross domestic product is the market value of all goods and services produced in a country over a given period of time which is usually one year. The study uses the real GDP, which is measured in real terms at current 2000 US$ which account for inflation. Data for Ghana's GDP and GDPs of the selected trading partners were sourced from the World Bank's, World Development Indicators

(WDI) online database (2018). The GDP of Ghana as well as the selected trading partners are expected to have a positive effect on Ghana's Bilateral export, hence β_1, $\beta_2 > 0$.

Population (Pop)

The population is simply the total number of residents in a particular country, regardless of the legal status or citizenship and excluding refuges that have not permanently settled in the country refuge. The study included both the total population of Ghana and the total population of the selected trading partner in the estimation. The population is used as a measure of the economic size of the exporting and importing country in this study. Theoretical literature regarding the expected coefficient of this variable in the gravity trade equation is ambiguous. According to Bergstrand (1989), the interpretation is that a positive coefficient for an exporting country indicates that exports are labor-intensive while a negative coefficient indicates that exports are capital-intensive. Glick and Rose (2002) also explain that a negative coefficient indicates that there is a large domestic market for the local produce hence fewer exports. Hence $\beta_3, \beta_4 \lesseqgtr 0$. The population variable was sourced from the World Development Indicators (WDI) and it is measured in millions.

Distance ($Dist_{ijt}$)

This is a time-invariant variable measuring the geographical distance between the capital city of Ghana (i) and the selected trading partners (j) which is measured in kilometers (km). Distance is often used to proxy the cost of transportation. The computation of distance follows the great circle formula which uses longitudes and latitudes of centers to capture the weighted distance measure. The distance variable is expected to have a negative coefficient, hence $\beta_5 < 0$. This is because of the wider the geographic distance between the trading partners, the higher the cost of transportation. This is in line with the studies done by Deluna Jr and Cruz (2013), Didia et al. (2015) and Baah (2015). However, a study by Xue-bin LIU Ming-xue and Yi-ying (2007) refute this expected sign using innovations and technology. The data for the distance variable is obtained from the CEPII gravity database on distance measurement.

Landlocked ($\boldsymbol{Landlocked_j}$):

This is a dummy variable, which assumes a value 1 if the country j is landlocked and 0 otherwise. The landlocked variable is expected to have a negative coefficient. This is because countries that are landlocked are likely to trade less since they have to incur a higher cost in transporting goods from neighboring countries where they can access port. Hence$\beta_6 < 0$. The data for the landlocked was obtained from the CEPII gravity database.

Common colony ($\boldsymbol{Comcol_{ijt}}$)

This is a dummy variable, which assumes a value 1 if the country, i and j have a colonial tie and 0 otherwise. A positive coefficient is expected for this variable. This is because countries with common colonial ties tend to face fewer trade hurdles, hence their ability to import more from their trading partner. Hence $\beta_7 > 0$. This data is sourced from the CEP II gravity database.

ECOWAS

This is a dummy variable for a regional trade agreement and it is equal to 1 if a country is a member of the Economic Community of West African States (ECOWAS) and 0 if otherwise. The information on ECOWAS membership was obtained from the Community's website. A negative coefficient is expected for this variable since countries belonging to the same regional trade agreement are likely to trade more and hence reduction in inefficiencies.

Freedom from Corruption Index (FFC_i, FFC_j)

Freedom from corruption index of the country, i and j, respectively, which is formulated by the Corruption Perception Index (CPI) of Transparency International. The FFC score of each partner country, i and j, is from 0 to 100, the higher the score shows little corruption. Corruption freedom score of 100 indicates that the country is totally free from corruption and thus signify a conducive environment for export. Therefore, a negative coefficient is expected $(\alpha_4, \alpha_5 > 0)$. Data on freedom from corruption was taken from the database of the World Heritage Foundation.

Trade Freedom index (TRF_i, TRF_j)

The trade freedom index of the exporting and importing country, which is a composite measure of the absence of tariff and non-tariff barriers that affect imports and exports of goods and services. It is incorporated to capture the degree of openness of trade partners to the flow of goods and services from around the world and the citizen's ability to interact freely as a buyer or seller in the international marketplace. The index ranges from 0 to 100. A trade freedom score of 100 indicates that the country imposes zero tariffs and nontariff barriers and thus signifies a friendly environment for export. Hence a negative coefficient is expected (α_6, α_7). Data on trade freedom was sourced from the database of the World Heritage Foundation.

Tax Burden $(TAXB_i, TAXB_j)$

The tax burden of the country, i and j, respectively. The tax burden is a measure of the tax burden imposed by the government, which includes direct taxes, in terms of the top marginal tax rates on individual and corporate incomes, and overall taxes, including all forms of direct and indirect taxation at all levels of government, as a percentage of GDP. It measures whether country, i and j are burdened or faced with excessive taxes. A positive coefficient is expected for this variable. This is because, when business and individuals in both countries are burdened with higher taxes, it will reduce their ability to trade more and hence increase the country's export inefficiencies. $(\alpha_8, \alpha_9 > 0)$. Data on tax burden was sourced from the database of the World Heritage Foundation.

Institutional Quality (INS_i, INS_j)

Institutional Quality which is proxied by Government Effectiveness reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. This governance indicator is measured in units ranging from about -2.5 to 2.5, with higher values corresponding to better governance outcomes. Better institutional quality is expected to boost export and reduce export efficiencies. Therefore, a negative coefficient is expected ($\alpha_{10}, \alpha_{11} < 0$). Data on these institutional quality indicators was sourced from The World Bank's Worldwide Governance Indicators online database.

Internal Infrastructure ($INFRAS_{it},\ INFRAS_{jt}$)

The internal infrastructure of both exporting and importing countries refers to the stock and quality of roads, streets, and highways, rail lines, airports and airways, ports and harbors, waterways and other transit systems to facilitate the movement of goods and enable people to access internal and global markets. This is proxied by electricity production. A higher rating indicates a better infrastructure. Better infrastructure should lead to higher trade and therefore more exports from Ghana, which then lead to a fall in Ghana's bilateral export inefficiencies. Hence, a negative coefficient is expected ($\alpha_{12}, \alpha_{13} < 0$). Data on electricity production for both countries was sourced from the World Bank, World Development Indicators online database.

Domestic Credit to Private Sector

Domestic credit to private sector refers to financial resources provided to the private sector, such as through loans, purchases of non-equity securities, and trade credits and other accounts receivable, that establish a claim for repayment all measured as a percent of GDP. Domestic credit to the private sector is another variable that seems to be positively associated with exports of a country. A higher share of domestic credit to the private sector will provide financial strength to individuals and businesses to trade more with other countries. Given the positive effect of a higher share of domestic credit to the private sector on export, relaxing credit constraints can play a positive role in fostering export growth and decreasing export inefficiencies. Hence a negative coefficient is expected, $(\alpha_{14}, \alpha_{15} < 0)$. Data on the percentage of paved roads in Ghana was sourced from the World Bank, World Development Indicators online database.

Sources of Data

This study uses panel data of Ghana's 61 trading partners, based on the annual bilateral export value covering a period of 17 years (2000–2017). Data used for the study were obtained from different sources. Data on Bilateral Exports were sourced from the International Monetary Fund Direction of Trade (IMF, DoT). Data on Gross Domestic Products (measured as constant US $) for both the importer and exporter, Population (POP), Internal Infrastructure (INFRAS) and Domestic credit to the private sector (DCTPS) for both the importer and exporter was sourced from the World Bank's World Development Indicators database (WDI). Data on Bilateral

Distance (DIST), Landlocked, Common colony (Comcol) and Common Language (LANG) were sourced from the CEP II. Data on the dummy variable of ECOWAS and APEC were obtained from the Economic Community of the West African States and the Asian Pacific Economic Corporation websites, respectively. Also, data on Corruption freedom, Tax burden, and Trade freedom of both trading partners were sourced from the database of the World Heritage Foundation. Data on the institutional quality indicator was sourced from The World Bank's Worldwide Governance Indicators online database.

Estimation Techniques

The research used the Maximum Likelihood Estimation (MLE) adopted by Aigner et al. (1977) to evaluate the impacts of "behind the border" restrictions on potential exports to estimate the stochastic frontier model.

For the purpose of this study, the MLE technique is used to estimate the Stochastic Frontier Gravity Model because of its relative strength in SFGM estimation. Theory suggests that trade potential must be the maximum level of trade flow, which means that the upper limits of the data must be estimated. The Maximum Likelihood Estimation technique has the ability to estimate the upper limits, making the SFGM more appropriate for this study compared to the conventional gravity model, which adopt the OLS technique. The Maximum Likelihood Estimation method was found to be significantly better than the Corrected Ordinary Least Square (COLS), where the contribution of the inefficiency effects of the total variance is large and wherever possible the preferred estimation technique (Coelli, Rao, & Battese 1998).

The reason for choosing the panel data estimation technique is that it is widely used in the analysis of the gravity model in most modern research. Another reason for the use of the panel data estimation technique for this study is its precision in controlling individual heterogeneity because it includes time-invariant variables and the inclusion of specific effects. Moreover, the panel data estimation technique provides informative and efficient data, there is less correlation between the variables and also more freedom due to its ability to combine time- series and cross-sectional observations. Finally, the technique of panel estimate is the preferred technique for studying dynamic changes.

Post-estimation Techniques

Using the joint density functions of u_{ij} and v_{ij}, the maximum likelihood estimation will be used to estimate the coefficients, $\beta_o \dots \beta_{13}$ along with the total variance and the parameter γ, which is the ratio of the variance of 'behind the border' constraints to the total variance of exports as indicated in equation (17).

$$\gamma = \frac{\sigma_u{}^2}{(\sigma_u{}^2 + \sigma_v{}^2)} \tag{17}$$

That is, the gamma coefficient helps to understand the nature of variation in potential export. It measures the total variations in export which is as a result of the influence of the socio-political-institutional factors. Thus, γ indicates whether 'behind the border' constraints are one of the determinants of Ghana's bilateral export, and also serves as a robustness test for the stochastic frontier gravity model given in equation (15). When γ is significant, it means that 'behind the border' constraints are important determinants of Ghana's exports. In other words, the significant gamma signifies that the effect of behind the border constraints is responsible for the gap between potential and actual export.

In addition to the gamma as a robustness test, Kumbhakar, Wang, and Horncastle (2015), indicated that we conduct a likelihood ratio test in which we estimate two models $L(H_0)$ and $L(H_1)$. Where $L(H_0)$ represents unrestricted model which is strictly Cobb Douglas and $L(H_1)$ is the restricted model.

Due to the suggestions of Kumbhakar et al. (2015), a series of formal hypothesis tests are conducted to determine the distribution of the random variables associated with the existence of technical inefficiency and the residual error term. These are tested through imposing restrictions on the model and using the generalized likelihood-ratio statistic (λ) to determine the significance of the restriction. The generalised likelihood ratio statistic is defined by

$$\lambda = -2\{ln[L(H_o)] - ln[L(H_1)]\} \quad (18)$$

Where $[L(H_o)]$ and $[L(H_1)]$ are the values of the log-likelihood function for the frontier model under the null and alternative hypotheses, H_O; there are no technical inefficiencies and H_1: there are technical inefficiencies. If the null hypothesis involves $\gamma = 0$, indicating that the technical inefficiency effects are not present in the model, then, λ has mixed chi-square distribution with the number of degrees of freedom given by the number of restrictions imposed because $\gamma = 0$ is a value on the boundary of the parameter space for γ (Battese & Coelli, 1992).

Conclusion

Briefly, the positivist philosophy is the research design used. Regarding this, both theoretical and empirical models were formulated. The chapter has elaborated on some theoretical foundation and justification for the use of the gravity model in international trade flows. The study as well adopted the stochastic frontier gravity model which has been identified to be resourceful in examining trade flows between countries.

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

This chapter presents the empirical results and discussions. The chapter is divided into three sections: the first section presents the estimation results of the SFGM pertaining to the determinants of bilateral export between Ghana and its selected trading partners, using maximum likelihood esstimation (MLE). The second section presents the results of the drivers of Ghana's bilateral export inefficiencies. Finally, the last section outlines the technical efficiency scores as well as the gap of bilateral exports among the trading partners. These presentations are in relation to the objectives and hypotheses of the study.

Descriptive Statistics

This section of the study briefly discusses the basic statistical characteristics of the non - binary variables used in the model for the period under study (2000 – 2017). The descriptive statistics examined include the means, minimum, maximum and the standard deviation.

Table 1*: Summary Statistics of Variables, 2000 - 2017*

Variables	Mean	Std. Dev	Min	Max
Bilateral Export	1.03.08	3.48E8	17	4.59E+09
GDP of Exporter	2.62E+10	1.52e+10	4.98E+09	4.78E+10
GDP of Importer	8.50E+11	2.18E+2	4.87E+08	1.94E+13
Population of Exporter	2.37E+07	3054197	1.89E+07	2.88E+07
Population of Importer	8.56E+07	2.26E+8	1231844	1.39E+09
Distance	5909.696	3800.695	189.9789	15717.05
Domestic credit of Exporter	28.8099	4.311666	21.10397	39.29761
Domestic credit of importer	71.49046	54.35297	-10.9789	233.211
Trade Freedom of Exporter	63.31111	3.867551	55.4	67.8
Trade Freedom of Importer	73.41029	13.82438	0	95
Corruption Freedom of Exporter	39.38889	4.658526	33	48
Corruption Freedom of Importer	49.74044	24.22827	10	99
Tax Burden of Exporter	80.45	4.628511	73	86
Tax burden of Importer	69.7827	15.06233	0	99.9
Infrastructure of Exporter	1.193375	0.263614	0.617633	1.658615
Infrastructure of Importer	1.58e+07	4.10e+07	11234	3.68e+08
Institution of Exporter	-0.092951	0.173816	- 0.45	0.13
Institution of Importer	0.194508	1.006456	-1.98	1.8

Source: Author’s calculation (2019)

Note: Std. Dev. represents Standard Deviation

From Table 1, there are 1,098 observations for the study. Over the period under study, however, total bilateral exports from Ghana to its trading partners averaged approximately US$1. 03 million with a maximum and minimum value of approximately US$ 4.59 billion and US$ 17 million respectively. This implies that from its bilateral total export flows; Ghana's highest earnings are about $ 4.95 billion, while lower earnings are about $ 17 million. Both domestic and foreign infrastructures averaged around 1.1934 units and, respectively, 24.7991 units. The maximum values for both domestic and foreign infrastructures are approximately 1.6586 units and 3.6800 units with minimum values of 0.6176 units and 11234 units respectively. The GDP of Ghana for the period averaged about 2.62 billion US dollars while that of the partner country for the period averaged approximately 8.50 billion US dollars. The maximum and minimum values of exporter's GDP is 47.8 billion US dollars and 4.98 billion US dollars respectively whiles maximum and minimum values of the partner's GDP is approximately 1.9 trillion US dollars and 4.87 billion US dollars respectively.

In addition, the domestic country's population and the population of the partner countries averaged 2.37E+07 and 8.56E+07 respectively. Export of Ghana traveled on an average distance of 5909.696 km to the partner countries. The tax burden of the exporting country average of 80.45. The maximum tax burden was 86 as against its minimum value of 73. With regard to standard deviations, the GDP of the importing countries has the highest value ($2.18 trillion) followed by GDP of the exporting countries ($1.52 billion) with the lowest standard deviation value of 0.2636 units for the infrastructure of the exporting country. The lower the standard deviation, however, shows lower gain disparities in domestic and foreign countries.

Empirical Results and Discussions

The empirical results for the Stochastic Frontier Gravity Model as well as the inefficiency model are presented in this sub-section. The results for the efficiency scores, export potential and gap for Ghana are also presented here.

Results of the stochastic frontier gravity model

Based on the usual stochastic frontier production function using MLE, the stochastic frontier gravity model in equation 15 and the inefficiency model in equation 16 were estimated simultaneously. The model parameter estimates of frontier and inefficiency are reported in Tables 2 and 3 respectively. Generally, most variable estimates have the expected signs and are statistically significant.

Table 2***:*** *Stochastic Frontier Gravity Model Estimates*

Dependent Variable: Log of Bilateral Export				
Independent Variable	Coefficient	Std. Err	T-ratio	P-value
LnGDPX	0.062	0.293	0.21	0.831
lnGDPM	0.478***	0 .110	4.33	0.000
LnPopulation of exporter	4.529**	1.767	2.56	0.010
LnPopulation of importer	0 .341***	0.078	4.37	0.000
Ln*Distance*	-2.421***	0.216	-11.23	0.000
Common colony	0.474**	0.197	2.41	0.016
Landlocked	-0.873***	0.270	-3.23	0.001
Constant	- 57.603**	23.809	-2.42	0.016

Source: Author’s calculation (2019)

Note: ***, ** and * signify statistically significant at 1%, 5% and 10% respectively.

Findings based on the Frontier estimate in Table 2 indicate that all the estimated parameters are in line with the theory and carry their expected signs and they are statistically significant except the GDP of the exporting country. Specifically, the GDP variable as a proxy to the income of the exporting country turns out insignificant. Thus, it implies that income changes in the exporting country have no impact on export from Ghana. In addition, the importer's GDP estimates, which control the scales of Ghana's trading partners, are positive and statistically significant at the 1 percent level of significance. This is in line with the a priori expectations. This means a percentage increase in trading partners' national income increased Ghana's bilateral export by 0.478 percent. The intuition is that as their economies expand, Ghana's trading partners import more from Ghana. It also means that partner countries' income levels influence domestic export demand, which confirms the findings of (Gani, 2008; Rahman, 2009; Yishak, 2009; Kumah 2017; Bonuedi, 2013).

Again, expectedly, the results reveal that the impact of population size in both Ghana and her trading partner was found to be positive and statistically significant, which implies that the population size of both countries has a positive effect on Ghana's bilateral export flow. More precisely, a percentage increase in Ghana's population caused its bilateral exports to increase by 4.529 percent, which is significant at the 5 percent level of significance. On the other hand, the results show that the impact of the partner country's population size is positive and statistically significant at the 1 percent level, suggesting that the partner country's population size has a positive influence on Ghana's bilateral export flow.

It indicates that a percentage increase in the partner countries' population causes Ghana's bilateral export to increase by 0.341 percent and this is highly significant at the 1 percent level. This confirms our expectations beforehand. Intuitively, the exporting country's population has a beneficial effect on bilateral export flows, showing that as a consequence the greater the population the greater the production and exports. In addition, the need for imported products may also be increased by a greater population. This actually stimulates Ghana's bilateral export supply as a result of its trading partners' rising import demand. This result is consistent with the findings of (Ebaidalla & Mustafa, 2018; Deluna Jr & Cruz, 2013; Hassan, 2017).

In addition, the highly significant and negative coefficient for distance variable suggests that the greater the distance between the two countries, the less likely they will trade. The distance variable proxies mainly for transportation costs where, due to higher transportation costs involved in the movement of goods and services, a country trades less with far distant countries. The negative sign of the coefficient of distance suggests that Ghana is trading less with countries geographically distant from her. It implies distance is a major barrier to export flows in Ghana. Ghana's distance estimates are elastic, suggesting a more severe distance restrictive force on its exports. This means that a small percentage change in the bilateral distance between Ghana and her trading partner will result in a larger percentage change in Ghana's bilateral export to her trading partner.

To be precise, a percentage increase in the bilateral distance between Ghana and her trading partner will decrease the bilateral export of Ghana by 2.421 percent, which was found to be significant at the 1 percent significance level. This finding confirms the results of previous studies such as (Hassan, 2017; Ravishankar & Stack, 2014; Bhattacharya & Das, 2014).

The common colony dummy variable estimate has a positive effect on the bilateral export flows of Ghana. The estimated coefficient is positive and highly significant, indicating that countries with common colonial ties tend to face fewer trade hurdles, hence their ability to import more from their trading partner. This means that if the trading partner has a colonial tie with Ghana it will increase Ghana's bilateral export flow by 0.475 units compared to countries without colonial relationship. This is significant at the 5 percent level of significance.

Expectedly, the result of a landlocked dummy is negative and significant at 1 percent significance level. This implies that if the trading partner is a landlocked country, Ghana's bilateral export will be reduced by 0.873 units compared to a non-landlocked country. The geographic feature of being landlocked lowers trade primarily because of the lack of access to the sea tends to increase the cost of transport. This finding confirmed the findings of Ravishankar and Stack (2014). These authors employed SFGM to calculate trade efficiency scores for ten Eastern European countries with seventeen Western European countries. Their study found that geographic characteristic of being landlocked affect trade negatively.

Results of the technical inefficiency model

There are two approaches for estimating models of inefficiency. These can be estimated either by a one- or two-step process. The Stochastic Frontier first estimates for the two-step procedure and each trading partner's technical efficiency are derived. Subsequently, these are regressed on a set of variables, inefficiency factors, which are assumed to influence the export efficiency of the partner. A problem with the two-stage procedure is the incoherence in the inefficiency distribution assumptions. In the first stage, to estimate their value, the inefficiencies are assumed to be distributed independently and identically.

In the second stage, however, the estimated inefficiencies are assumed to be a function of a number of country-specific factors and are therefore not distributed identically unless all the factor coefficients are equal to zero at the same time (Coelli, Rao & Battese, 1998). In order to overcome this inconsistency, the conditional mean method used by Battese and Coelli (1995) is used to estimate all parameters in one step. The effects of inefficiency are defined as a function of country-specific factors (as in the two-stage approach) but are then directly incorporated into the MLE. The results of equation 15 are presented in Table 3.

Table 3***:*** *Determinants of Technical Inefficiency*

Dependent Variable: MU (Technical Inefficiency)				
Independent variable	Coefficient	Std. Err	t-ratio	P-value
ECOWAS	-3.064***	0.612	-5.01	0.000
APEC	-5.237***	1.177	-4.45	0.000
LANG	-0.989***	0.300	-3.30	0.001
Freedom from Corruption of Exporter	-0.019	0.037	-0.53	0.599
Freedom from Corruption of Importer	-0.025***	0.008	-3.01	0.003
Trade Freedom of Exporter	-0.073 *	0.041	-1.79	0.074
Trade Freedom of Importer	-0.004	0.010	-0.41	0.685
Tax Burden of Exporter	0.194***	0.040	4.83	0.000
Tax Burden of Importer	0.019**	0.008	2.30	0.022
Log Institution of Exporter	-1.792**	0.835	-2.14	0.032
Log Institution of Importer	-0.599***	0.169	-3.54	0.000
Log Infrastructure of Exporter	0.903*	0.496	1.82	0.069
Log Infrastructure of Importer	-0. 740***	0.096	-7.67	0.000
Domestic credit to the private sector of the Exporter	-1.872***	0.626	-2.99	0.003
Domestic credit to the private sector of the Importer	-0.443***	0.160	-2.77	0.006
$\text{sigma} - \text{square}\ (\sigma^2)$	1.749***	0.074	23.53	0.000
$\text{Gamma} = \gamma = \frac{{\sigma_u}^2}{{\sigma_u}^2 + {\sigma_v}^2}$	0.791***	0.260	3.05	0.002
Log Likelihood ratio	-2338.3117			
LR test of one-sided error	380.618***			
Wald chi2(7)	461.01			
Number of observations	1, 098			

Source: Author's calculation (2019)

Note: ***, ** and * signify significance at 1%, 5% and 10%, respectively

The model includes ECOWAS and APEC to capture the impact of Ghana and trading partners' regional trade agreements. The negative and significant coefficient estimates for the ECOWAS and APEC dummy confirms the trade-enhancing effect of regional integration. The result reveals that Ghana's membership of ECOWAS reduces technical inefficiency (increase technical efficiency) of Ghana's export flow to trading partners. Specifically, Ghana's membership of ECOWAS increases its Bilateral Export efficiency or decrease its bilateral export inefficiencies by 3.064 units as compared to non-ECOWAS member countries and this variable is significant at 1 percent significance level. Ghana's export to APEC member countries also increases technical efficiency and reduces Ghana's bilateral export inefficiency. This implies that, if Ghana exports to the APEC member countries, the bilateral export efficiency will improve by 5.237 units, which is significant at 1 percent significance level. This result is consistent with the findings of Deluna Jr and Cruz (2013) with their study of the trade potential and performance of the Philippines during the period of 2009 to 2012. Using the Stochastic Frontier Gravity Model, these authors found that the Philippines membership to APEC decreases technical inefficiency of the Philippine export flow to trading partners.

The study also included specific characteristics of trading partners such as language, which was found to be a significant factor that increases export efficiency and decreases Ghana's bilateral export inefficiency. The negative sign of the estimate suggests that exports from Ghana to English-speaking countries boost their export efficiencies compared to non-English-speaking countries. In other words, Ghana's export to English-speaking countries increase its export efficiency by around 0.989 units and was highly significant at 1 percent significance level.

Language's negative and statistically significant estimate implies that language reduces barriers to communication between bilateral trading partners and thus increases the efficiency of bilateral export flows. This is in line with findings of Ravishankar and Stack (2014) who concluded in their study that common language significantly enhances bilateral trade flows. Contrary, Deluna Jr and Cruz (2013) in their study of the trade potential and performance of the Philippines found that language has no effect on technical inefficiency

The effect of both the exporting and importing country's freedom from corruption reduces the gap between the actual and potential export flows of the exporting country. Corruption is expected to impose trade costs and therefore we expect Ghana's export volume to be enhanced by freedom from corruption. The negative impact of freedom from corruption on trade is mostly observed in customs, and if both partner country's customs are free of corruption, it will play a significant role in reducing the export inefficiencies of the exporting country, Ghana, which would have a positive impact on the efficiency of Ghana's bilateral exports flow.

Precisely, the result found that if Ghana's port and customs are free from corrupt practices, it would reduce its bilateral export inefficiency by 0.019 units. However, this is not statistically significant. Contrarily, the result found that the importing country's freedom from corruption has a significant effect in promoting Ghana's bilateral export efficiency. From the results, freedom from corruption in the importing country will significantly reduce Ghana's bilateral export inefficiency by 0.025 units and this is at the 1 percent level of Significance**.** This is consistent with the findings of Deluna Jr and Cruz (2013) and Hassan (2017).

In their study of the trade potential and performance of Philippine and Bangladesh respectively. The two studies found that freedom from corruption by trading partners of Philippine and Bangladesh significantly decreases export inefficiency of their respective countries. They concluded that the impact of freedom from corruption reduces the gap between the actual and potential trade flows of the Philippines and Bangladesh.

To also examine the impact of market openness of both trading partners on Ghana's export inefficiency, trade freedom was included in the inefficiency model. Trade freedom aims to determine whether the exporting and the importing country is free of excessive tariffs and import quotas or health or safety regulatory barriers. The negative coefficients of trade freedom imply that, when the exporting and the importing countries are free from excessive tariffs, quotas and other barriers restricting trade, it will reduce the inefficiency and increase the efficiency of Ghana's bilateral exports flow. Precisely, trade freedom by the exporting and the importing countries will reduce export inefficiency of Ghana by 0.073 and 0.004 units, respectively. However, it is only the exporting country's trade freedom was found to be significant at a 10 percent significance level. This is consistent with the findings of Deluna Jr and Cruz (2013). He sorts to determine the drivers of the Philippines' bilateral export inefficiencies and found that trade freedom significantly reduces bilateral export inefficiencies of Philippine.

This study decomposed the components of economic freedom to incorporate the impact of country-specific macroeconomic stability indicators, the role of government and corporate sector in business and international trade policies.

The study included the tax burden of both the exporting and the importing country to investigate its impact on the export inefficiency of Ghana. The results of the estimate revealed that tax burden which is a measure of the tax burden imposed by government, which includes direct taxes, in terms of the top marginal tax rates on individual and corporate incomes, and overall taxes, including all forms of direct and indirect taxation at all levels of government, as a percentage of GDP. The result indicates that the tax burden of both partners significantly increases export inefficiency and reduces the export efficiency of Ghana. Explicitly, when business and individuals are burdened with higher taxes in Ghana, it will increase Ghana's bilateral export inefficiency by 0.194 units and this is highly significant at 1 percent significance level.

Similarly, when importers are faced with excessive taxes at the port of their home country, it will decrease Ghana's export efficiency by 0.019 units. This is significant at the 5 percent level of significance. The underlying idea is that higher taxation not only interferes with the ability of individuals and businesses to pursue their goals in the marketplace, it may also reduce the incentive to work, save, invest, or take risks. In other words, higher tax rates and borrowing by government reduce individuals and firms' ability to pursue their market goals and thereby decrease the level of overall private-sector activity, thus decreasing the export of trading partners including Ghana.

Again, in order to determine the impact of institutional quality of both trading partners on Ghana's bilateral export inefficiency, the study proxied institutional quality by government effectiveness. Government effectiveness reflects perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. The economic reasoning for these variables to be included is simple. Better institutional framework quality reduces uncertainty about enforcement of contracts and overall economic governance. This directly reduces transaction costs by increasing property security and indirectly by increasing the level of trust in the economic transaction process. From the results obtained, the impact of institutional quality proxied by government effectiveness in both trading partners is found to be negative and significant, consistent with empirical studies. That is, government effectiveness of both trading partners reduces bilateral export inefficiencies of Ghana.

Precisely, better quality of the exporting country's public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies quality would reduce Ghana's export in efficiency by 1.792 units and it is significant at the 5 percent level of significance. In a similar fashion, better institutional quality of the importing country would decrease Ghana's bilateral export inefficiency by 0.599 units and is highly significant at the 1 percent level. This result is contrary to the findings of Ebaidalla and Mustafa (2018) whose study on Intra Arab trade integration found that the impact of institutional quality in both reporting and trading partners reduces bilateral trade.

They attributed this to distorted political and institutional situations in Arab countries and also the fact that most of the largest trading partners in the region lacked democracy and institutional quality.

In addition, the results included the infrastructure of both trading partners that is proxied by electricity production to examine its impact on Ghana's export inefficiency. The study reveals that the impact of Ghana's infrastructure on inefficiency is positive and highly significant, contradicting empirical studies. This implies that Ghana's infrastructure increases bilateral export inefficiency or reduces Ghana's export flow to her trading partners. Particularly, poor infrastructure in Ghana increases its export in efficiency by 0.903 percent, which is significant at the 10 percent level of significance. Intuitively, this result points to the negative impact on export flow in Ghana and most African countries due to poor trade-related infrastructural development. The instability associated with power outages and blackouts affects production.

Conditions of infrastructure in Ghana have a significant impact on companies' ability to competitively produce and export goods and services. Comparatively poor infrastructure conditions place many Ghanaian producers and exporters of goods and services at a severe disadvantage in regional and international export markets, raising costs and undermining product quality, making both merchandise and service exports less competitive vis-à-vis exporters that may not be similarly disadvantaged. Electricity infrastructure is largely deficient, unreliable, and underdeveloped, especially in rural areas, necessitating producers to depend on more costly on-site power plants, further raising the cost of production in Ghana, thus dampening the volume and intensity of export flows with the rest of the world. This finding is in line with the findings of Bonuedi (2013) who found a negative and significant impact of internal infrastructure to bilateral export of Ghana. Contrary, and as expected, the impact of the trading partner' infrastructure on Ghana's export inefficiency was found to be negative and highly significant. This implies that trading partner' infrastructure plays a significant role in reducing Ghana's export inefficiency. Precisely, a percent increase in trading partner' infrastructure causes a 0.740 percent decrease in Ghana's bilateral export inefficiency and this is highly significant at 1 percent. This result is consistent with the finding of Ebaidalla and Mustafa (2018) and Yishak (2009) who found that the impact of trading partners' infrastructure facilitates bilateral trade among Arab countries and Ethiopia, respectively.

Finally, domestic credit to private-sector pertains to financial resources offered by financial corporations to the private sector, such as through loans, non-equity securities purchases, and trade credits and other receivable accounts, which establish a claim for repayment. Expectedly, the results reveal that the impact of domestic credit to the private sector in both reporting and trading partners is found to be negative and statistically significant at the 1 percent level of significance. In both trading partner countries, a percentage increase in the proportion of domestic credit to the private sector would reduce Ghana's bilateral export inefficiencies by 1.872 percent and 0.443 percent. Intuitively, by making enough financial resources accessible to private companies and people at a required interest rate, government and banks will boost their capacity to expand production, which will boost their competitiveness on the world market. They would be able to export more at the end. Similarly, the financial resources accessible to the private industries of the importing nation would allow them to export more to other nations and in exchange, they would also request products and services from the exporting country (Ghana).

The Gamma (γ) Coefficient

$$\left(\gamma = \frac{{\sigma_u}^2}{\sigma^2{}_u + \sigma^2{}_v}\right) \tag{17}$$

The gamma (γ) parameter is defined per equation (17). Where ${\sigma_u}^2$ represent the variation in the one-sided error term or the variance of the inefficiency error term whiles the $\sigma^2{}_v$ represent the variance of the double-sided random error term or beyond-the- border factors. The gamma parameter value ranges from zero to one and if the gamma coefficient is close to 1 it means that a great deal of variation is due to technical inefficiencies and therefore the use of the SFGM is justified. The gamma coefficient explains the variation in the composite error term that is due to "behind the border" trade constraints for which the one-sided error term controls. A positive and statistically significant gamma coefficient confirms that trade restrictions under exporter's control are effective in limiting Ghana's export flows from reaching their potential levels. However, a positive and statistically insignificant gamma coefficient suggests that most of the variation in the composite error term was due to variation in the double-sided error term, which possibly could be coming from "beyond the border" trade resisting factors. In other words, it implies that "beyond the border" factors significantly restrained the exporter's bilateral exports from reaching their potential levels.

The result shows that sigma-squared (σ^2), which measures the mean total variation over time in the model, is statistically significant at the level of significance of 1 percent, suggesting that potential exports of Ghana changed over the period under study. This variation in potential exports between Ghana and its trading partners could be due to random factors or the influence of specific characteristics between Ghana and the trading partner country. Moreover, the gamma (γ) coefficient further explains the nature of the variation by measuring the variation ratio due to country-specific socio-political-institutional factors or, in simple terms, due to the behind-the-border constraints to the total variation. The gamma coefficient, in this case, is 0.7908919, which is very high and significant at the 1 percent level. The coefficient of 0.7908919 means that in Ghana's bilateral export flows, technical inefficiency accounts for about 79.1 percent variation. This implies that behind-the-border constraints have a significant influence and are driving a large proportion of the mean total variation in this case, and therefore the Stochastic Frontier analysis gives meaningful and valid results in this study.

Simply put, the factors that are significantly limiting the bilateral exports flow of Ghana from reaching its potential levels are factors within its control. This result is consistent with the findings of Ebaidalla and Mustafa (2018) who found a positive and significant sigma-square (σ^2) and gamma (γ) coefficient for the Arab countries in their study, which assessed the Intra-Arab trade integration and potential. The result is also in line with the findings of Hassan (2017) who analyzed the prime determinants and constraints of Bangladesh's export market using the SFGM.

His study found a positive and statistically significant coefficient for the sigma-square (σ^2), as well as a positive and significant result for the gamma (γ) coefficient, implying that that "behind-the-border" constraints have a significant influence and are driving a large proportion of the mean total variation of Bangladesh's bilateral exports flow.

Post-estimation Test

According to Kumbhakar, Wang, and Horncastle (2015), however, it is not that relevant to use the gamma (γ) coefficient as a measure to check the validity of SFGM use. They suggest we carry out a likelihood ratio test in which we estimate two models. One is the unrestricted model, $L(H_1)$ and the second one is the restricted model, $L(H_0)$ which are the values of the log-likelihood function for the frontier model under the null and alternative hypotheses; H_0: there are no technical inefficiencies and H_1: there are technical inefficiencies as stated in equation (18).

From the results obtained, the value of lambda (λ) in equation (18) represents the likelihood ratio test of the one-sided error term. The LR test is 380.6184. The value of 380.6184 was compared with the critical values of Kodde and Palm (1986) at one percent with a critical value of 8.273. If the calculated value of the LR test is higher than the critical value of Kodde and Palm (1986), then we reject the null hypothesis of no technical inefficiencies or inappropriate use of the SFGM. From the results, the LR test (λ) is greater than the critical value of Kodde and Palm (1986) at one percent, i.e. 380.6184 > 8.273, hence we fail to accept the null hypothesis of no technical inefficiency.

Therefore, we accept the alternative hypothesis, which states that there are technical inefficiencies in Ghana's bilateral exports. This means that the use of the Stochastic Frontier Gravity Model (SFGM) is sufficiently justified.

Estimating Export Efficiency Scores

The export efficiency estimates were calculated using equation (13), which is developed by Battese and Coelli (1988). Having estimated the SFGM of Ghana's bilateral export, the next step is to derive the trade efficiency scores by applying the coefficients of SFGM estimation of Table 2 to the sample of Ghana and her trading partners, over the period 2000-2017. The technical efficiency scores range between zero and one, where zero efficiency scores mean that the country is totally inefficient while an efficiency value of one implies that the country is 100 percent efficient. High-efficiency scores suggest trade between two countries is close to maximum levels, whereas low-efficiency scores indicate deviations of actual trade from frontier estimates, implying scope for improved export performance.

Table 4 to 14 presents the results for estimated technical efficiency of Ghana Bilateral exports to selected trading blocs. Table 15 presents the results for mean estimated technical efficiency of Ghana Bilateral exports for all the trading blocs selected for the study. Ghana's Bilateral Exports Potential and Gap with trading partners are presented in Table 16.

Table 4: *Technical efficiency (in percent) of Ghana Bilateral Exports to Association of Southern Asian Nations (ASEAN) member countries*

Countries	Indonesia	Malaysia	Philippines	Singapore	Thailand	Overall Mean
2000	42.94	56.20	0.07	54.23	48.61	40.41
2001	35.02	48.26	0.05	49.34	46.76	35.89
2002	32.23	48.63	2.24	52.62	43.25	35.79
2003	36.77	53.33	5.04	59.21	43.27	39.52
2004	39.52	62.29	0.03	60.23	54.87	43.39
2005	38.53	65.74	13.36	62.14	50.31	46.01
2006	49.77	67.87	9.41	61.70	49.09	47.57
2007	33.27	65.97	3.94	57.67	51.46	42.46
2008	33.69	65.67	1.29	61.31	49.15	42.22
2009	50.86	62.09	1.20	56.84	46.61	43.52
2010	36.03	55.32	1.70	58.56	45.67	39.45
2011	44.77	64.85	2.21	64.74	46.03	44.52
2012	43.94	68.08	1.82	55.72	52.60	44.43
2013	44.02	64.03	2.59	59.00	44.69	42.87
2014	43.30	67.24	2.75	61.58	43.22	43.62
2015	36.93	64.88	3.99	61.64	38.66	41.22
2016	21.84	61.68	3.28	60.51	5.61	30.58
2017	28.48	63.77	3.63	56.72	28.79	36.28
Mean Efficiency	38.44	61.44	3.26	58.54	43.81	41.10

Source: Author's calculation (2019)

Table 4 illustrates the technical efficiency of exports from Ghana to ASEAN member countries. The performance of Ghana's exports to ASEAN member countries is remarkable as most countries recorded efficiency scores higher than the ASEAN bloc's average efficiency score (41.10 %) and the overall mean efficiency over the whole study period, which is 28.20 %. Results show that with Malaysia, Singapore, and Thailand, with mean efficiency scores of 61.44%, 58.54% and 43.81% respectively. This means that there are inefficiencies in Ghana's exports to these countries, suggesting that Ghana's exports to these countries are faced with some barriers. However, the average efficiency score for the rest of the member States (Indonesia and Philippine) was below the average technical efficiency of the entire ASEAN bloc and the overall average efficiency over the whole period, indicating that exports from Ghana to these countries are faced with high export constraints.

Despite the relatively high technical efficiency among some ASEAN member countries, Ghana's export to the entire block is relatively low as the collective score of 41.10 percent is below half of the frontier which suggests a gap in Ghana’s export to the entire bloc. Based on the overall mean efficiency, there are few variations in Ghana's export efficiency to ASEAN trading bloc members over the period.

Table 5**:** *Technical efficiency (in percent) of Ghana Bilateral Exports to North American Free Trade Agreement (NAFTA) member countries*

Countries	Canada	United States	Overall Mean Efficiency
2000	56.72	74.49	65.61
2001	51.27	73.20	62.23
2002	54.98	72.93	63.96
2003	58.47	74.51	66.49
2004	60.57	69.83	65.20
2005	64.98	69.63	67.30

Table 5, continued

2006	66.03	67.34	66.69
2007	57.69	66.10	61.90
2008	44.80	64.18	54.49
2009	59.19	63.65	61.42
2010	37.87	63.79	50.83
2011	68.84	67.33	68.08
2012	67.53	65.24	66.38
2013	61.09	64.50	62.80
2014	58.88	62.26	60.57
2015	58.21	52.03	55.12
2016	54.52	46.46	50.49
2017	67.66	53.69	60.67
Mean Efficiency	58.29	65.06	61.68

Source: Author's calculation (2019)

Table 5 displays the technical efficiency of Ghana's bilateral exports to the North American Free Trade Area member countries. NAFTA members recorded very high scores of technical efficiency. Between 2000 and 2003, the United States recorded more than 70% technical efficiency, which means that Ghana's bilateral exports to the United States over these years are very close to the frontier level, given the factors considered in the gravity equation. In the 10-year period from 2004 to 2014, the U.S.A efficiency scores remain almost constant. With regard to the mean efficiency, both countries have recorded higher efficiency scores compared to the overall mean efficiency score of the entire block and the world. In addition, the bloc's mean efficiency score is 61.68 percent, more than twice of the mean efficiency for the world (28.20%). This implies that Ghana's export to the

NAFTA trading bloc is generally high, as nearly all of this region's efficiency scores are close to the frontier level or 100 %. This reflects that the effort made by Ghana and members of this bloc to adopt bilateral and multilateral trade arrangements have resulted in a relative improvement in bilateral trade between them. This confirms that less behind-and beyond-the-border inefficiencies confront these trading partners.

Table 6***:*** *Technical efficiency (in percent) of Ghana Bilateral Exports to East Asian (EA) member countries*

Countries	China	Hong Kong	Japan	South Korea	Overall Mean Efficiency
2000	60.34	60.03	67.29	46.59	58.56
2001	61.89	56.92	66.05	43.30	57.04
2002	56.88	51.54	66.91	42.77	54.52
2003	59.92	51.96	70.45	51.25	58.40
2004	52.40	49.82	67.99	56.40	56.65
2005	58.17	56.92	67.59	54.04	59.18
2006	56.52	54.21	69.24	59.02	59.75
2007	50.25	56.52	67.01	54.95	57.18
2008	56.20	56.03	58.76	46.16	54.29
2009	49.70	40.71	66.99	46.12	50.88
2010	49.44	33.33	61.85	53.28	49.47
2011	61.09	48.82	64.44	56.57	57.73
2012	65.92	51.36	66.01	55.00	59.57
2013	64.80	40.06	63.40	55.99	56.06
2014	65.19	29.30	61.96	53.40	52.46
2015	63.85	29.95	60.08	53.17	51.76
2016	62.43	39.64	60.86	49.10	53.01
2017	64.79	63.74	56.74	48.15	58.36
Mean Eff	58.88	48.38	64.64	51.40	55.83

Source: Author’s calculation (2019)

The technical efficiency of Ghana's bilateral exports to members of the Eastern Asian (EA) bloc is presented in Table 6. The table reveals that there is relatively high technical efficiency over the entire period and that most efficiency scores for individual countries are far above their mean technical efficiency. Ghana exports are relatively efficient with Japan, followed by China and South Korea with average efficiency ratings of 64.64%, 58.88%, and 51.40% respectively. The mean technical efficiency score for Japan and China is relatively higher than the mean efficiency score for the entire East Asian bloc of 55.83 percent and the mean efficiency score of 28.20 percent for the world. This high-efficiency score suggests that exports to these countries from Ghana are relatively efficient and close to the level of potential. This may reflect Ghana's effective trade relations with these countries. Hong Kong's mean technical efficiency (48.38 percent) is below the mean technical efficiency of the entire East Asian bloc, this suggests that there is an immense opportunity for enhancing trade from Ghana to Hong Kong. Based on the mean efficiency, technical efficiency of Ghana to members of an East Asian trading bloc is almost constant within the period of the study. Generally speaking, the overall mean efficiency for the entire EA bloc is 55.83 percent higher than the world's 28.20 percent mean efficiency. This implies that the actual export of Ghana to the countries of East Asia is relatively close to the level of potential. Building on the overall mean efficiency, Ghana's export efficiency to East Asian trading bloc is nearly constant with little variation over the study period.

Table 7: *Technical efficiency (in percent) of Ghana Bilateral Exports to the European Free Trade Association (EFTA) member countries*

Countries	Norway	Switzerland	Overall Mean Efficiency
2000	24.99	65.19	45.09
2001	20.94	65.54	43.24
2002	18.89	64.34	41.62
2003	21.64	65.31	43.48
2004	12.86	38.65	25.76
2005	22.41	52.83	37.62
2006	29.23	56.69	42.96
2007	14.16	50.77	32.46
2008	5.45	43.66	24.56
2009	11.04	56.09	33.56
2010	15.07	48.11	31.59
2011	32.29	58.69	45.49
2012	11.24	60.94	36.09
2013	3.03	59.17	31.10
2014	1.98	56.97	29.48
2015	2.68	48.69	25.69
2016	1.79	51.37	26.58
2017	1.55	43.46	22.51
Mean Efficiency	14.69	55.47	34.38

Source: Author's calculation (2019)

Table 7 shows the technical efficiency of bilateral exports from Ghana to the two countries of the European Free Trade Area. The table shows that Switzerland recorded very high-efficiency scores over the entire study period, compared to the mean efficiency score for the entire block.

Switzerland reported an average efficiency score of 55.47 percent, which is relatively high compared to the average efficiency score of 34.38 percent for the entire bloc as well as the 28.20 percent world average efficiency score. This high-efficiency score shows that Ghana's export to Switzerland faces less behind and beyond the border constraints, reducing the gap between its actual export and potential export. Such a desirable outcome can be explained in these countries by the efficiency of trade institutions.

Contrary to the high-efficiency scores of Switzerland, Norway registered the lowest efficiency scores and their performance is very low compared with that of the entire bloc and the world. This low-efficiency score reflects the weakness of the trade relationship between Ghana and Norway and also indicating that Ghana has untapped potential with Norway. Based on the mean efficiency, export efficiency of Ghana to members of the EFTA trading bloc has little variations within the period of the study. Overall, the above results suggest that Ghana's export to the EFTA bloc is far from the potential level, as all the efficiency scores for the entire bloc is below half of the frontier level. Benched on the overall mean efficiency, export efficiency of Ghana to members of EFTA region experience little variations within the period of the study.

Table 8: *Technical efficiency (in percent) of Ghana Bilateral Exports to the Greater Arab Free Trade Area (GAFTA) member countries*

Countries	Egypt	Kuwait	Libya	Morocco	Tunisia	Saudi Arabia	Overall Mean Efficiency
2000	5.40	0.89	0.34	1.09	5.33	13.43	4.41
2001	4.05	0.52	0.19	0.90	2.14	5.98	2.30
2002	4.04	0.45	0.12	1.16	0.54	5.96	2.04
2003	6.48	0.55	0.14	1.85	1.96	8.90	3.31
2004	5.21	0.00	0.52	1.31	4.19	3.04	2.38
2005	7.93	0.16	0.28	1.66	0.43	9.40	3.31
2006	6.40	0.39	0.33	0.85	1.87	4.63	2.41
2007	5.69	0.32	0.27	1.52	0.56	5.07	2.24
2008	4.80	0.09	0.37	0.66	0.34	3.27	1.59
2009	3.79	0.13	0.08	1.09	0.09	2.73	1.32
2010	2.98	0.10	0.22	0.47	0.11	1.96	0.97
2011	3.36	0.04	0.08	1.10	1.57	3.22	1.56
2012	2.59	0.93	0.09	1.25	5.24	1.37	1.91
2013	1.04	0.16	0.03	4.13	7.77	1.06	2.36
2014	0.71	0.12	0.03	0.91	7.62	0.82	1.70
2015	0.61	0.16	0.06	1.45	8.50	0.71	1.91
2016	0.32	0.11	0.05	1.92	5.23	0.45	1.35
2017	2.11	0.07	0.05	1.69	4.63	0.74	1.55
Mean Eff.	3.75	0.29	0.18	1.39	3.23	4.04	**2.15**

Source: Author's calculation (2019)

Our results in Table 8 illustrate the fact that the export of Ghana within GAFTA with all members is generally very low. The efficiency scores are far below the frontier for all members of the bloc. Saudi Arabia, Egypt, and Tunisia had mean efficiency scores that were higher than the overall mean efficiency for the entire bloc, while the other members had mean efficiency below the overall mean efficiency of the entire bloc. The mean efficiency for individual countries as well as the entire GAFTA bloc (2.15 percent) over the study period is below the world's meanest efficiency (28.20 percent). This means that Ghana’s actual bilateral export to members of this bloc is far below the potential level and that members of this bloc have large untapped export potential. The reasons for this bloc's low export performance are both economic and political. Tensions persist between members of this bloc and inefficiencies of trade institutions, which could continue to hamper future trade prospects between Ghana and members of this bloc. This does not, of course, imply that there are no prospects for future trade expansion between Ghana and members of this bloc, but this will depend on some kind of political progress to remove the roots of conflict and other trade rigidities between members. Ghana should, therefore, explore ways and means to strengthen its trade relations with these regions/countries. In any event, Ghana will need to improve the quality of its exports and minimize production costs so that it can compete well on the international market. Given the overall mean efficiency, within the study period, Ghana's export efficiency to GAFTA members’ experiences fluctuations.

Table 9: *Technical efficiency (in percent) of Ghana Bilateral Exports to South Asian Association for Regional Cooperation (SAARC) member countries*

Countries	India	Pakistan	Overall Mean Efficiency
2000	31.04	1.02	16.03
2001	45.47	2.04	23.75
2002	40.77	0.74	20.76
2003	25.27	4.01	14.64
2004	19.73	0.04	9.88
2005	32.86	3.49	18.17
2006	35.95	1.03	18.49
2007	30.07	2.78	16.42
2008	40.30	1.88	21.09
2009	23.75	0.23	11.99
2010	19.76	0.58	10.17
2011	47.10	0.72	23.91
2012	35.29	0.86	18.08
2013	32.86	0.72	16.79
2014	41.82	0.62	21.22
2015	54.07	0.62	27.34
2016	41.04	0.41	20.72
2017	43.69	3.31	23.50
Mean Efficiency	35.60	1.39	**18.50**

Source: Author’s calculation (2019)

Table 9 presents the technical efficiency of Ghana’ bilateral export to the South Asian Association for Regional Cooperation (SAARC) member countries. Our results illustrate the fact that Ghana’s trade within SAARC is low, particularly with Pakistan suggesting that Ghana has a huge unexploited potential with Pakistan and the bloc as a whole. Among the two countries, India's average efficiency score of 35.60% is higher than the average efficiency of 18.50% and 28.20% respectively for the entire SAARC bloc and the world. This implies that, compared to Pakistan, Ghana faces less export resistance with India. However, the efficiency scores for the individual countries as well as the entire block are below half the frontier level, except in 2015, where India recorded a 54.07 percent efficiency score. In conclusion, there is a huge gap between the actual bilateral export of Ghana and potential exports to this region, indicating that Ghana has a large untapped export potential with the SAARC trading bloc. Over the period under study, there are also huge variations in efficiency scores.

Table 10: *Technical efficiency (in percent) of Ghana Bilateral Exports to Other countries*

Countries	Brazil	Turkey	Ukraine	Iran	Israel	Cameroon	Overall Mean Efficiency
2000	4.61	23.79	18.58	4.67	29.16	0.52	13.56
2001	0.12	0.48	22.75	0.13	14.46	0.50	6.41
2002	0.42	0.22	23.10	0.17	11.65	0.58	6.02
2003	0.07	0.49	26.99	0.19	6.52	0.57	5.80
2004	0.61	27.37	8.99	2.61	8.22	0.38	8.03
2005	1.87	27.16	23.65	0.40	18.62	0.99	12.12
2006	2.88	28.25	0.38	2.78	14.13	0.57	8.17
2007	2.92	9.48	21.28	1.73	13.24	0.29	8.16
2008	8.09	19.87	29.73	10.58	10.30	0.45	13.17
2009	5.59	16.93	23.01	5.19	5.46	0.40	9.43
2010	1.10	13.24	25.63	6.85	4.50	0.35	8.61
2011	12.80	28.34	28.36	9.07	12.02	0.77	15.23

Table 11, continued

2012	13.52	30.25	15.36	4.70	6.61	1.48	11.99
2013	17.83	19.99	17.37	9.44	4.17	0.53	11.56
2014	22.16	15.25	15.92	8.52	5.30	0.42	11.26
2015	12.65	19.55	16.30	10.67	2.93	0.45	10.42
2016	23.70	16.55	11.57	7.28	2.64	0.29	10.34
2017	21.95	12.71	16.74	15.54	3.56	0.31	11.80
Mean Efficiency	8.49	17.22	19.21	5.58	9.64	0.55	**10.11**

Source: Author's calculation (2019)

Other countries, Ghana's bilateral export efficiency estimates are reported in Table 10. Overall, the average export efficiency estimates are well below the 50 percent mark of the export frontier for the six countries. The export efficiencies of Ghana are highest in Ukraine with a mean efficiency score of 19.21 percent and closely followed by Turkey with a mean efficiency score of 17.22 percent, whiles Cameroon recorded the lowest efficiency scores with a mean efficiency of 0.55 percent over the entire period. The overall mean countrywide efficiency is 10.11 percent, which is below the World's average efficiency of 28.20 percent over the entire study period. This implies that Ghana's exports to these countries are far below the frontier level, indicating a huge gap between actual and potential exports. This confirms that many of Ghana's exports to these countries are confronted behind and beyond border constraints. The efficiency estimates for the countries in question show a fluctuating trend over the period without any significant improvement.

Table 11: *Technical efficiency (in percent) of Ghana Bilateral Exports to the European Union (EU) member countries*

Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008
Belgium	47.27	48.47	52.58	55.69	51.15	55.72	51.92	37.94	33.76
Bulgaria	6.76	0.41	0.00	0.01	1.59	3.99	2.29	0.75	4.84
Denmark	44.45	29.70	30.93	41.88	30.11	53.68	33.28	38.46	36.95
Finland	23.25	9.15	14.92	11.22	18.56	21.95	10.04	15.00	8.19
France	41.17	42.61	41.14	45.74	40.91	45.39	45.22	35.77	31.73
Germany	47.02	37.06	40.64	46.24	29.00	36.86	38.66	29.59	25.93
Greece	17.74	9.37	8.36	12.27	11.85	19.74	20.20	12.97	11.11
Hungary	0.35	1.30	1.76	1.56	21.19	0.12	0.05	1.89	0.46
Ireland	48.46	31.28	32.09	33.12	37.58	38.62	37.08	30.81	31.21
Italy	36.37	36.30	35.63	39.45	27.95	28.64	31.10	16.95	19.77
Poland	8.21	5.78	7.24	11.73	9.25	13.35	26.21	9.54	6.20
Portugal	7.46	11.19	15.15	11.05	5.36	14.66	24.77	7.54	8.53
Spain	32.21	34.18	35.37	34.95	27.66	29.74	28.26	24.64	24.07
Sweden	24.39	8.05	14.37	10.92	3.95	6.95	4.18	1.56	8.35
Netherlands	60.49	55.62	57.41	59.20	59.33	57.69	58.09	54.38	54.10
United Kingdom	54.83	53.66	49.38	48.33	43.08	44.78	46.62	38.40	41.81
Over all Mean	31.28	25.88	27.31	28.96	26.16	29.49	28.62	22.26	**21.69**

Source: Author's calculation (2019)

Table 11, continued

Countries	2009	2010	2011	2012	2013	2014	2015	2016	2017	Mean Efficiency
Belgium	32.56	40.98	52.81	42.17	36.66	35.43	31.26	30.96	35.09	42.91
Bulgaria	3.64	6.68	0.73	0.71	0.01	0.02	0.03	0.02	12.26	2.49
Denmark	28.42	21.75	28.81	30.90	27.03	23.58	21.72	16.68	14.35	30.70
Finland	4.98	13.10	6.42	2.87	0.27	0.09	0.04	0.03	1.50	8.98
France	27.15	26.11	57.33	55.89	47.57	42.83	37.20	25.18	25.78	39.71
Germany	24.20	25.18	34.40	36.15	38.84	27.60	27.15	19.96	22.55	32.61
Greece	7.70	8.41	7.82	16.89	2.89	1.80	2.97	0.76	3.33	9.79
Hungary	0.52	1.06	1.36	0.45	0.50	4.84	0.21	1.30	3.39	2.35
Ireland	30.47	28.88	21.13	24.63	11.35	3.16	1.71	1.28	6.90	24.99
Italy	16.23	14.23	46.61	48.32	40.52	35.61	28.25	20.92	21.26	30.23
Poland	4.47	5.70	8.69	9.75	5.66	3.25	3.46	2.42	10.34	8.40
Portugal	1.95	3.67	7.16	5.44	43.48	33.34	29.24	17.12	14.04	14.51
Spain	20.24	22.25	28.63	35.87	32.83	25.96	28.56	24.41	25.39	28.62
Sweden	22.08	2.21	26.22	5.49	17.93	14.99	20.36	9.70	5.67	11.52
Netherlands	51.73	48.48	55.78	56.52	49.57	47.37	45.01	43.72	50.04	53.58
United Kingdom	39.04	38.84	53.16	49.23	42.72	36.54	37.02	34.78	42.83	44.17
Over all Mean	19.71	19.22	27.32	26.33	24.87	21.03	19.64	15.58	18.42	**24.10**

Source: Author’s calculation (2019)

Performances of Ghana's export to the members of the European Union (EU) were offered in Table 11. With respect to EU members, Ghana's technical efficiency with the Netherlands, the United Kingdom, Belgium, France, Germany, Denmark, and Italy is high with mean efficiency scores above the EU bloc's overall mean efficiency score and the world as a whole. This implies that Ghana's export to these countries is relatively efficient compared to its export efficiency to the entire bloc and the world, suggesting that the constraining impact of country-specific effects on potential exports (i.e. behind-the-border) is declining due to bilateral negotiations. Export efficiency estimates, however, are below the 50 percent mark of the export frontier for all countries within the EU region on average, except for the Netherlands. This indicates that Ghana has enormous untapped potential with members of this bloc as the overall mean efficiency of 24.10% is less than half of the export frontier's 50 percent mark.

It is also important to note that the efficiency parameter of the EU trading bloc, which is Ghana's largest trading bloc, varies widely. In this bloc, the mean technical efficiency in the Netherlands is as high as 53.58% and in Hungary and Bulgaria as low as 2.35% and 2.49% respectively. There are a few variations in the efficiency estimates over the sample period with reference to the overall mean efficiency.

Table 12: *Technical efficiency (in percent) of Ghana Bilateral exports to ECOWAS member countries*

Countries	Burkina Faso	Côte d'Ivoire	The Gambia	Mali	Niger	Nigeria	Senegal	Serra Leon	Togo	Overall Mean
2000	5.64	1.30	4.59	2.70	5.62	0.89	11.51	6.98	2.03	4.59
2001	2.02	1.63	3.96	0.97	1.81	0.57	14.05	4.30	0.81	3.35
2002	1.69	1.85	3.82	0.33	0.09	0.50	17.57	4.60	0.69	3.46
2003	2.09	1.25	7.21	0.42	0.11	0.65	21.04	3.98	0.94	4.19
2004	0.40	0.21	9.57	0.94	0.36	0.26	13.11	2.00	0.61	3.05
2005	0.72	0.75	5.33	0.14	0.10	3.01	17.51	9.56	0.01	4.12
2006	31.55	0.59	4.66	1.99	0.31	1.00	14.47	1.68	0.10	6.26
2007	15.61	0.75	4.58	2.03	0.56	0.74	14.34	11.06	0.18	5.54
2008	11.23	0.84	4.64	3.43	1.25	0.70	12.24	1.71	0.28	4.04
2009	16.53	1.16	5.28	4.44	0.59	0.59	9.80	4.07	0.70	4.80
2010	8.37	0.56	9.86	20.89	2.07	0.48	8.49	2.06	0.68	5.94
2011	22.31	3.97	8.92	7.37	2.41	0.67	11.67	5.54	9.94	8.09
2012	19.70	1.26	5.68	12.46	2.29	0.65	10.87	3.75	3.39	6.67
2013	17.73	0.51	3.10	22.93	5.08	0.15	11.85	1.19	1.45	7.11
2014	15.59	0.40	2.54	22.87	4.51	0.10	12.47	0.89	0.99	6.71
2015	17.21	0.58	2.49	26.37	4.09	0.12	15.55	1.26	1.18	7.65
2016	13.10	0.40	1.61	19.90	2.79	0.08	19.48	0.89	0.93	6.58
2017	13.72	0.66	3.90	6.65	3.38	0.11	10.44	1.12	0.69	4.52
Mean Efficiency	11.96	1.04	5.10	8.71	2.08	0.62	13.69	3.70	1.42	**5.37**

Source: Author’s calculation (2019)

Table 12 highlights that the technical efficiency scores for all ECOWAS trading bloc members are far below the frontier level or 100 %, implying that the actual bilateral export between Ghana and ECOWAS member countries is below the frontier. This is due to similarities in comparative advantage between Ghana and ECOWAS member countries. The overall mean efficiency for the entire block is 5.37%, which is very low and also below the overall mean efficiency of 28.20% for the entire sample period. This efficiency score of 5.37% also implies that the inefficiency level in Ghana's export to ECOWAS is about 95.63%. Only Senegal, Burkina Faso and Mali had mean efficiency scores that were higher than the mean efficiency of the whole ECOWAS bloc. These scores, however, remain below the overall mean efficiency of 28.20% throughout the study period.

One striking result is that Senegal, despite its distance from Ghana, has relatively higher efficiency scores compared to Togo, Burkina Faso, and Côte d'Ivoire, which are much closer to Ghana. This suggests that Senegal faces the least behind and beyond the border rigidities; it also reflects Senegal and Ghana's effective trade relations. Despite the distance and trade agreement that Ghana has with members of this bloc, the technical efficiency score for all countries is generally very low. These low inefficiency scores can be attributed to the fact that these countries have similar Comparative advantage with Ghana. Therefore they would trade less with each other and trade more with advance economies where different levels of comparative advantage exist.

Table 13: *Technical efficiency (in percent) of Ghana Bilateral Exports to Asian Pacific Economic Corporation (APEC) member countries*

Countries	2000	2001	2002	2003	2004	2005	2006	2007	2008
Australia	66.96	62.93	63.28	64.96	69.72	66.36	75.06	65.57	64.68
Canada	56.72	51.27	54.98	58.47	60.57	64.98	66.03	57.69	44.80
China	60.34	61.89	56.88	59.92	52.40	58.17	56.52	50.25	56.20
Hong Kong	60.03	56.92	51.54	51.96	49.82	56.92	54.21	56.52	56.03
Indonesia	42.94	35.02	32.23	36.77	39.52	38.53	49.77	33.27	33.69
Malaysia	56.20	48.26	48.63	53.33	62.29	65.74	67.87	65.97	65.67
New Zealand	43.58	1.12	27.60	22.57	42.83	34.06	54.43	44.92	55.03
Singapore	54.23	49.34	52.62	59.21	60.23	62.14	61.70	57.67	61.31
South Korea	46.59	43.30	42.77	51.25	56.40	54.04	59.02	54.95	46.16
Philippines	0.07	0.05	2.24	5.04	0.03	13.36	9.41	3.94	1.29
Thailand	48.61	46.76	43.25	43.27	54.87	50.31	49.09	51.46	49.15
United States	74.49	73.20	72.93	74.51	69.83	69.63	67.34	66.10	64.18
Japan	67.29	66.05	66.91	70.45	67.99	67.59	69.24	67.01	58.76
Over all Mean	52.16	45.85	47.37	50.13	52.81	53.99	56.90	51.95	**50.53**

Source: Author’s calculation (2019)

Table 13, continued

Countries	2009	2010	2011	2012	2013	2014	2015	2016	2017	Mean Efficiency
Australia	53.89	59.64	59.18	59.76	44.54	65.09	42.39	41.73	67.38	73.61
Canada	59.19	37.87	68.84	67.53	61.09	58.88	58.21	54.52	67.66	58.29
China	49.70	49.44	61.09	65.92	64.80	65.19	63.85	62.43	64.79	58.88
Hong Kong	40.71	33.33	48.82	51.36	40.06	29.30	29.95	39.64	63.74	48.38
Indonesia	50.86	36.03	44.77	43.94	44.02	43.30	36.93	21.84	28.48	38.44
Malaysia	62.09	55.32	64.85	68.08	64.03	67.24	64.88	61.68	63.77	61.44
New Zealand	51.67	30.69	61.20	61.10	59.08	58.94	61.88	56.09	55.06	66.84
Singapore	56.84	58.56	64.74	55.72	59.00	61.58	61.64	60.51	56.72	58.54
South Korea	46.12	53.28	56.57	55.00	55.99	53.40	53.17	49.10	48.15	51.40
Philippines	1.20	1.70	2.21	1.82	2.59	2.75	3.99	3.28	3.63	3.26
Thailand	46.61	45.67	46.03	52.60	44.69	43.22	38.66	5.61	28.79	43.81
United States	63.65	63.79	67.33	65.24	64.50	62.26	52.03	46.46	53.69	65.07
Japan	66.99	61.85	64.44	66.01	63.40	61.96	60.08	60.86	56.74	64.64
Over all Mean	49.96	45.17	54.62	54.93	51.37	51.78	48.28	43.37	50.66	**51.91**

Source: Author's calculation (2019)

Table 13 presents technical efficiency among APEC member countries. Outcomes show that the technical efficiencies of Ghana's bilateral exports with APEC member countries were generally high. Explicitly, countries such as Australia, Canada, New Zealand, USA, Japan, Malaysia, China, Singapore, and South Korea. These countries' mean efficiency scores are higher than the average efficiency score of both the entire APEC bloc and the world. Results show that Ghana's bilateral exports to the Philippines have enormous market potential compared to the other block members, followed by Indonesia and Hong Kong. Ghana's exports to the Philippines are generally low in the APEC countries without any improvement over the years being studied. This suggests that the border constraints facing Ghana's export to Philippine are huge behind and beyond. This also means institutional export efficiency constraints. The result shows that Ghana's export to the APEC bloc is generally efficient because most countries have efficiency scores above half the frontier level. However, there is still a gap between Ghana's actual exports and potential exports to this region as the overall mean efficiency (51.91 percent) for the entire block is only half the levels of the frontier. Based on the mean efficiency, Ghana's export efficiency to APEC members varies within the study period.

Table 14: *Technical Efficiency (in percent) of Ghana Bilateral Exports to Common Market for Eastern & Southern Africa, East Africa Communities and Southern African Development Communities (COMESA-EAC-SADC) Free Trade Area*

Countries	Egypt	Ethiopia	Kenya	Libya	Malawi	South Africa	Tanzania	Tunisia	Uganda	Zimbabwe	Total Mean Eff.
2000	5.40	0.18	0.34	0.34	0.36	42.76	0.25	5.33	0.06	1.68	5.67
2001	4.05	0.53	0.91	0.19	0.37	42.26	1.51	2.14	0.12	0.35	5.24
2002	4.04	0.50	0.77	0.12	0.43	44.36	1.24	0.54	0.07	0.10	5.22
2003	6.48	0.61	1.08	0.14	0.62	48.25	1.64	1.96	0.10	0.11	6.10
2004	5.21	0.23	0.70	0.52	0.22	44.50	0.24	4.19	0.81	0.35	5.70
2005	7.93	0.52	0.96	0.28	0.08	60.98	0.31	0.43	0.14	1.01	7.27
2006	6.40	0.28	0.56	0.33	0.18	61.76	0.32	1.87	0.20	0.23	7.21
2007	5.69	0.33	0.82	0.27	0.12	59.78	0.57	0.56	0.42	0.51	6.91
2008	4.80	0.24	0.38	0.37	0.09	61.37	1.63	0.34	0.24	0.87	7.03
2009	3.79	0.96	0.38	0.08	0.28	62.17	0.10	0.09	0.10	0.17	6.81
2010	2.98	0.06	0.17	0.22	0.30	62.27	0.49	0.11	0.03	0.13	6.67
2011	3.36	0.84	2.65	0.08	0.32	62.72	0.43	1.57	1.62	0.07	7.36
2012	2.59	1.23	5.68	0.09	0.44	64.71	0.72	5.24	2.07	0.28	8.31
2013	1.04	1.02	0.29	0.03	0.14	52.76	0.53	7.77	3.68	0.13	6.74
2014	0.71	0.71	0.07	0.03	0.10	51.33	0.36	7.62	1.74	0.04	6.27
2015	0.61	0.89	0.06	0.06	0.13	47.24	0.37	8.50	0.54	0.03	5.84
2016	0.32	0.63	0.07	0.05	0.09	40.84	0.25	5.23	0.41	0.02	4.79
2017	2.11	0.36	0.30	0.05	0.08	47.80	0.30	4.63	0.30	0.06	5.60
Mean Efficiency	3.75	0.56	0.90	0.18	0.24	53.21	0.63	3.23	0.70	0.34	**6.37**

Source: Author’s calculation (2019)

Table 14 shows the technical efficiency of the bilateral export of Ghana to COMESA-EAC-SADC member countries. According to the results, the technical efficiency for COMESA-EAC-SADC members is generally low, as nearly all countries except South Africa have recorded efficiency scores well below frontier levels. The result has revealed that exports from Ghana to South Africa are relatively efficient and close to the frontier, especially from 2006 to 2014. The efficiency scores of South Africa over the entire study period outperformed the bloc as a whole. South Africa's remarkable performance implies that Ghana is facing less resistance to trade with South Africa than the rest of the region's members and also there is a wide gap in the phase of development between Ghana and South Africa compared to the rest. Despite South Africa's outrageous performance, the overall mean efficiency score over the period for the entire COMESA-EAC-SADC bloc is 6. 37 percent below the frontier mark of 50 percent. This suggests a low degree of trade integration between Ghana and members of this trading bloc, indicating the existence of restrictions against export flows of Ghana. It also suggests that there is a wide gap between Ghana's actual bilateral export and potential export to COMESA-EAC-SADC members, indicating a big unrealized export potential with this trade bloc. Once again, the findings indicate that differences in the region's members' technical efficiencies are fluctuating over the study period.

Table 15: *Technical efficiency (in percent) of Ghana Bilateral Exports by trading groups, 2000-2017*

Trading Blocs	EU	ECOWAS	ASEAN	NAFTA	EA	EFTA	APEC	GAFTA	COMESA-EA-SADC	SAARC	Others	Overall Mean Efficiency
2000	31.28	4.59	40.41	65.61	58.56	45.09	52.16	4.41	5.67	16.03	13.56	30.67
2001	25.88	3.35	35.89	62.23	57.04	43.24	45.85	2.30	5.24	23.75	6.41	28.29
2002	27.31	3.46	35.79	63.96	54.52	41.62	47.37	2.04	5.22	20.76	6.02	28.01
2003	28.96	4.19	39.52	66.49	58.40	43.48	50.13	3.31	6.10	14.64	5.80	29.18
2004	26.16	3.05	43.39	65.20	56.65	25.76	52.81	2.38	5.70	9.88	8.03	27.18
2005	29.49	4.12	46.01	67.30	59.18	37.62	53.99	3.31	7.27	18.17	12.12	30.78
2006	28.62	6.26	47.57	66.69	59.75	42.96	56.90	2.41	7.21	18.49	8.17	31.37
2007	22.26	5.54	42.46	61.90	57.18	32.46	51.95	2.24	6.91	16.42	8.16	27.95
2008	21.69	4.04	42.22	54.49	54.29	24.56	50.53	1.59	7.03	21.09	13.17	26.79
2009	19.71	4.80	43.52	61.42	50.88	33.56	49.96	1.32	6.81	11.99	9.43	26.67
2010	19.22	5.94	39.45	50.83	49.47	31.59	45.17	0.97	6.67	10.17	8.61	24.37
2011	27.32	8.09	44.52	68.08	57.73	45.49	54.62	1.56	7.36	23.91	15.23	32.17
2012	26.33	6.67	44.43	66.38	59.57	36.09	54.93	1.91	8.31	18.08	11.99	30.43
2013	24.87	7.11	42.87	62.80	56.06	31.10	51.37	2.36	6.74	16.79	11.56	28.51
2014	21.03	6.71	43.62	60.57	52.46	29.48	51.78	1.70	6.27	21.22	11.26	27.83
2015	19.64	7.65	41.22	55.12	51.76	25.69	48.28	1.91	5.84	27.34	10.42	26.81
2016	15.58	6.58	30.58	50.49	53.01	26.58	43.37	1.35	4.79	20.72	10.34	23.94
2017	18.42	4.52	36.28	60.67	58.36	22.51	50.66	1.55	5.60	23.50	11.80	26.71
Mean Efficiency	24.10	5.37	41.10	61.68	55.83	34.38	50.66	2.15	6.37	18.50	10.11	**28.20**

Source: Author's calculation (2019)

It is noteworthy from Table 15 that the average technical efficiency (TE) of Ghana and its major trading partners over the 17 years was 28.20% and remained almost constant, with no significant improvement in the border constraints. Mean technical efficiency among the trading blocs is slightly higher in 2011, 2006, 2005, 2000 and 2012 than the total mean technical efficiency over the entire period under study. Among the trading blocs, Ghana's bilateral export flow is most efficient in the North American Free Trade Agreement (NAFTA) trading bloc, with the highest technical efficiency score of 61.68 %, mostly attributable to the high U.S.A and Canadian technical efficiencies, followed by the Eastern Asian (EA) bloc, with an efficiency score of 55.83 %, mostly driven by high Technical efficiencies of Japan and China. It is important to note that in limiting Ghana's export to these countries, the geographic distance factor did not play a significant role. This may be due to the long-term maintenance of a good economic relationship between Ghana and these countries.

Another important finding is that of the EU trading bloc, which is the largest trading bloc for Ghana, the variations in the efficiency scores over the period is very small. In this bloc, the Netherlands recorded the highest technical efficiency of 53.58 percent, followed by the United Kingdom with a technical efficiency of 44.17 percent, and with Hungary and Bulgaria as low as 2.35 and 2.49 percent, respectively. The EU bloc's overall mean efficiency is 21.10 %, which is below the overall mean efficiency over the whole period, meaning Ghana's export to this bloc is underway. Similarly, the technical efficiency scores in the ECOWAS region are very low even though Ghana has trade agreements with members of this bloc compared to the rest of the bloc with which Ghana has no trade agreements. It was only the GAFTA bloc ECOWAS outperformed. The Technical Efficiency score for the ECOWAS bloc is 5.37 percent, which is far below the overall mean efficiency of 28.20 percent for the entire period. This finding supports many empirical studies using SFGM analysis, such as Hassan (2017), who found that Bangladesh has very low technical efficiency with the ASEAN region, despite trade agreements, compared with other non-trade-agreement blocs. Overall, the overall mean efficiency score for the entire bloc is below 50 %, suggesting that there is a large gap between the actual exports of Ghana and the potential export flow estimated by the gravity equation.

Export Potential and Gap

Table 16 presents the results for calculating country-specific export gaps that could be obtained if there were no behind-the-border restrictions on export flow.

Export potential is defined as the trade that could have been achieved at the optimum trade frontier with open and frictionless trade possible given the current level of trade, transport and institutional technologies or as the maximum level of trade given the current level of trade determinants as well as the minimum level of restrictions within the economic system (Miankhel et al., 2009). The potential export in this study was calculated using the gravity model's estimated coefficients and imposed the mean actual bilateral export data of the period under study. The results are shown in Table 16. Table 16 shows the potential export measured by equation 14 and the trade gap measured as the difference between the potential export generated by the gravity model and the actual export. Togo recorded the highest potential of around US$28.0 trillion among the 61 countries in the sample. This potential was driven by a huge market in Togo that should be explored by Ghana. This is followed by Nigeria, Ivory Coast, South Africa, Burkina Faso, India, and Switzerland. In general, the bilateral export potential of Ghana is highest among ECOWAS member countries.

Table 16: *Country and trading bloc-wise Ghana's Bilateral Exports Potential and Gap with sixty-one trading partners, 2000-2017*

Country/ Trade Bloc	Actual Bilateral Export	Mean Potential Export	Mean Export Gap
EURPEAN UNION (EU)	**103,997,752.91**	**290,513,523.23**	**186,515,770.32**
Belgium	119,043,910.00	277,414,227.31	158,370,317.31
Bulgaria	1,602,201.89	64,470,255.23	62,868,053.34
Denmark	13,396,093.89	43,630,894.50	30,234,800.61
Finland	875,154.00	9,748,771.04	8,873,617.04
France	347,872,852.00	876,110,370.82	528,237,518.82
Germany	123,904,020.61	379,919,500.80	256,015,480.19
Greece	5,325,944.22	54,418,390.69	49,092,446.47
Hungary	407,591.50	17,338,490.46	16,930,898.96
Ireland	8,602,329.89	34,427,442.16	25,825,112.27
Italy	279,086,137.44	923,263,856.66	644,177,719.21
Poland	4,857,526.28	57,810,281.88	52,952,755.60
Portugal	45,539,212.11	313,883,211.31	268,343,999.20
Spain	108,782,921.89	380,048,253.75	271,265,331.86

Source: Author’s calculation (2019)

Table 16, continued

Country/ Trade Bloc	Mean Potential Export	Mean Potential Export	Mean Export Gap
Sweden	3,176,461.28	27,571,294.58	24,394,833.31
Netherlands	436,427,777.78	814,465,391.39	378,037,613.62
United Kingdom	165,063,911.72	373,695,739.10	208,631,827.38
ECOWAS	**103,526,362.15**	**5,889,776,322.89**	**5,786,249,960.74**
Burkina Faso	233,658,573.89	1,954,015,003.42	1,720,356,429.53
Côte d'Ivoire	56,515,159.28	5,453,394,119.42	5,396,878,960.14
Gambia	1,993,830.89	39,119,575.75	37,125,744.86
Mali	87,585,307.56	1,005,229,072.93	917,643,765.37
Niger	26,730,216.17	1,286,361,986.30	1,259,631,770.13
Nigeria	92,782,338.50	14,865,629,265.87	14,772,846,927.37
Senegal	26,441,943.78	193,123,467.80	166,681,524.02
Sierra Leone	7,722,217.06	208,606,521.01	200,884,303.96
Togo	398,307,672.28	28,002,507,893.54	27,604,200,221.27
ASEAN	**34,662,948.84**	**60,094,943.13**	**25,431,994.29**
Indonesia	8,185,945.56	21,295,649.78	13,109,704.22
Malaysia	139,009,144.83	226,253,041.74	87,243,896.90
Philippines	272,215.72	3,692,562.70	3,420,346.98
Singapore	16,997,737.33	29,034,738.60	12,037,001.26
Thailand	8,849,700.78	20,198,722.84	11,349,022.07
NAFTA	**147,382,963.50**	**230,549,962.67**	**83,166,999.17**
Canada	45,217,284.44	77,565,598.41	32,348,313.96
United States	249,548,642.56	383,534,326.94	133,985,684.38
EAST ASIA	**124,086,062.43**	**209,451,468.98**	**85,365,406.55**

Source: Author's calculation (2019)

Table 16, continued

Country/ Trade Bloc	Mean Potential Export	Mean Potential Export	Mean Export Gap
China	410,557,827.61	697,324,041.54	286,766,213.93
Japan	68,685,098.67	106,249,833.58	37,564,734.91
South Korea	9,175,878.17	17,850,920.21	8,675,042.04
EFTA	**358,703,737.92**	**663,130,206.32**	**304,426,468.40**
Norway	3,228,235.56	23,128,955.69	19,900,720.14
Switzerland	714,179,240.28	1,303,131,456.94	588,952,216.66
GAFTA	**2,400,893.01**	**89,746,925.34**	**87,346,032.33**
Egypt	4,330,223.50	115,441,226.65	111,111,003.15
Kuwait	53,392.08	18,544,713.05	18,491,320.96
Libya	81,492.78	45,263,706.83	45,182,214.05
Morocco	1,806,567.06	130,089,583.54	128,283,016.48
Tunisia	4,476,303.14	138,623,433.05	134,147,129.91
Saudi Arabia	3,657,379.50	90,518,888.94	86,861,509.44
COMESA-EAC-SADC-FTA	**175,098,827.33**	**382,373,155.35**	**207,274,328.02**
Ethiopia	207,113.78	36,807,140.18	36,600,026.40
Kenya	1,423,010.78	158,302,271.37	156,879,260.59
Malawi	18,657.22	7,742,228.49	7,723,571.27
South Africa	1,222,891,767.44	2,298,034,616.47	1,075,142,849.03
Tanzania	431,360.00	69,008,766.88	68,577,406.88
Uganda	692,094.33	98,591,745.25	97,899,650.92

Source: Author's calculation (2019)

Table 16, continued

Country/ Trade Bloc	Mean Potential Export	Mean Potential Export	Mean Export Gap
SAARC	**290,502,374.70**	**840,193,767.31**	**549,691,392.61**
Zimbabwe	27,787.78	8,125,318.80	8,097,531.03
Pakistan	702,921.07	50,425,115.68	49,722,194.61
OTHERS	**19,741,639.47**	**225,974,512.51**	**206,232,873.05**
Australia	10,570,270.56	17,406,054.67	6,835,784.12
Brazil	40,262,853.61	474,061,553.12	433,798,699.51
Cameroon	3,367,190.67	615,878,160.46	612,510,969.79
Turkey	68,602,699.50	398,439,407.36	329,836,707.86
Ukraine	21,894,808.89	114,000,609.65	92,105,800.76
Iran	8,329,983.44	149,188,211.14	140,858,227.70
Israel	3,430,755.11	35,592,585.83	32,161,830.72
New Zealand	1,474,553.94	3,229,517.88	1,754,963.94

Source: Author's calculation (2019)

Note: Export potential was measured using equation 14 and Trade gap was computed as the difference between actual and potential exports.

All countries recorded a positive export gap from the results in Table 16. A positive export gap implies that the export potential predicted by the gravity model is far greater than the actual bilateral export observed. Countries such as Togo, Cote d'Ivoire, Nigeria, South Africa, Switzerland, India, France, and Italy recorded the highest export gap compared to all sampled countries. In terms of a trading bloc, the bilateral export gap in Ghana is very high in the ECOWAS region of about USD 5.8 billion. This is followed by the South Asian Association for Regional Corporation (SAARC) and the European Free Trade Association (EFTA) with a trade gap of around USD549.7 million and USD304.4 million respectively. The fourth region with the highest export gap is the Common Market for East and Southern Africa -Eastern African Community -Southern African Development Communities Free Trade Area (COMESA-EAC-SDAC) with an export gap of approximately USD207.3 million and finally European Union with a gap of about 186.5 million. Also, Ghana's export gap is least among the following regions: the Association of Southern Asian Nations (ASEAN), the North American Free Trade Agreement (NAFTA)), the East Asian (EA), and the Greater Arab Free Trade Area (GAFTA). Ghana's export gap between these trading blocs is approximately USD 25.4 million, USD 83.2 million, USD 85.4 million, and USD 87.3 million, respectively.

These results show that although there is an export gap in each country included in the sample, there are high variations in actual export volumes and export potential among these countries.

The greatest potential is shown respectively in the EU region, Italy, France, the Netherlands, Spain, Portugal, the United Kingdom, and Belgium. This suggests that though Ghana has been trading with these countries for a long time, export levels are nowhere near their potential. Among the ECOWAS trading bloc, the countries with the highest export potential are Togo, Nigeria, and the Ivory Coast, Burkina Faso, Niger, and Mali, with Gambia and Senegal recording the lowest export potential respectively. This means that, despite trade agreements with member countries, Ghana is doing less in terms of exporting to ECOWAS countries.

For the Association of Southern Asian Nations (ASEAN), Malaysia, Singapore, and Indonesia are the countries with the highest export potential, while the Philippines is the country with the lowest export potential. Again, Ghana's export potential of the European Free Trade Area is high with Switzerland compared to Norway. Tunisia, Morocco, Egypt, and Saudi Arabia recorded greater export potential in the Greater Arab Free Trade Area member countries, while Kuwait recorded the lowest potential among the Greater Arab Free Trade Area trading bloc. Concerning the Common Market for East and South Africa-East African Community–Southern African Development Communities Free Trade Area (COMESA-EAC-SDAC), South Africa’s export potential was very high compared to the other members. This is possibly due to the similarities in comparative advantage among members of these region and Ghana. This is followed distantly by Kenya, Uganda, Tanzania, and Ethiopia, while in Malawi and Zimbabwe, respectively, the least export potential was found.

Considering the SAARC trading bloc, India recorded the highest export potential, which is over a billion compared to the export potential of Pakistan which was in a thousand. Finally, Ghana’s export potential with Cameroon, followed by Brazil, Turkey, Iran, and Ukraine, was found to be high among the other countries. However, the potential exports between Israel, Australia, and New Zealand were found to be low.

Conclusion

This study contributes to the empirical literature which makes use of the stochastic frontier gravity model to export potential. The results reveal that '*behind the border*' constraints have significantly contributed to gaps between the potential and actual export of Ghana. Specifically, it was revealed that institutional quality of both partners, the infrastructure of the importing country, trade freedom of the exporter, corruption freedom of the importing country, exports to APEC bloc, membership of ECOWAS, the commonality of language and domestic credit to the private sector significantly reduces export inefficiencies. However, the tax burden negatively affects Ghana's export efficiency. The result also reveals Ghana's untapped export potential for the study with all sampled countries.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Introduction

This chapter presents the study summary and conclusion. It also provides some policy measures or recommendations based on the findings. Limitations and suggestions are also made for future studies.

Summary

Ghana has been pursuing an export-led growth strategy since the 1970s on its journey to become a middle-income country. Although the country's success in export promotion is remarkable, however, due to lack of diversity in its export portfolio, Ghana's export sector is extremely vulnerable to external shocks in terms of both products it exports and shocks in the importing country. Again, the potential export performance of Ghana as a developing country is thought to be influenced by numerous behind-the-border socio-political-institutional constraints.

The aim of this study was to examine Ghana's bilateral export potential and gap over the period 2000-2017. With regard to the theoretical background on production theory, this study uses a stochastic frontier gravity model (SFGM) to measure trade performance against the maximum potential level of trade defined by a stochastic frontier. In order to estimate the parameters of the frontier gravity model, the study used the maximum likelihood estimate. The estimated coefficients were used to estimate Ghana's bilateral export potential. This export potential was used to estimate the technical efficiency of each country in the sample and was also aggregated to measure the impact of country groups, regional trade agreements, and interregional trade agreements. The study also highlighted factors that affect technical inefficiency with stochastic frontier. This method focuses on resolving other factors that influence bilateral trade between Ghana and its top trading partners, such as inefficiencies "beyond the border" and "behind the border", which were ignored by the traditional gravity model embraced in earlier studies.

The frontier estimates revealed that Ghana's bilateral export flows are positively influenced by GDP of the importing country, population size of both the importing and the exporting countries, and common colony whiles negatively influenced by the distance between the trading partners as well as landlocked. It was also revealed that "behind the border' constraints have significantly contributed to gaps between the potential and actual export of Ghana. The result again discovered that Ghana has a huge untapped export potential with all trading partners and blocs with export gap been greatest among the ECOWAS, SAARC, EFTA, COMESA-EAC-SADC, and EU member countries.

Conclusions

Therefore, the following conclusions are drawn;

Based on the first specific objective which seeks to determine the drivers of Ghana's bilateral export inefficiencies, the frontier estimates revealed that Gross Domestic Products of the importing country, population size, which proxy the size of the economy of both the exporting and the importing country and common colony significantly increased Ghana’s bilateral exports flows. However, distance, which is a proxy for transportation cost and landlocked of the trading partner significantly reduces Ghana’s bilateral export flows.

Also, the research disclosed that the limitations of “behind the border” have contributed considerably to the inefficiencies in Ghana’s bilateral exports. In particular, Ghana's membership of ECOWAS, exports to the Asian Pacific Economic Cooperation, language commonality, institutional performance of both trading partners, the exporting country’s free trade climate, domestic credit to both the exporting and importing country’s private sector, the importing country’s infrastructure and the importing country’s freedom from corruption significantly decreases Ghana’s bilateral exports inefficiencies whiles tax burden of both trading partners and poor infrastructure development of Ghana increases its bilateral export inefficiencies.

Again, the second objective of this research was to estimate bilateral export technical efficiencies between Ghana and her trading partners. For all sample countries, the computed export efficiency scores are below the frontier, suggesting that Ghana’s exports to the trading partners are inefficient. However, the efficiency scores are relatively high among countries such as the United States of America, Japan, Malaysia, Australia, China, Singapore, Canada, Switzerland, the Netherlands, South Africa, and South Korea. In terms of country groups, RTA and inter-regional trading agreements, the North American Free Trade Agreement (NAFTA) trading bloc has been recorded as the most efficient country for Ghana's export flows with a mean efficiency score of 61.68 percent. Ghana also created a powerful connection between East Asian countries, APEC members and ASEAN members. EFTA, EU, and SAARC provided Ghana with export potential or opportunities to expand export flows. At the country level, EU members such as Bulgaria, Finland, Greece, Hungary, and Poland, as well as all ECOWAS members, COMESA-EAC-SADC, SAARC, GAFTA, Philippines, Brazil, Iran, Cameroon, Turkey, Ukraine, and Israel posed enormous untapped export potential for bilateral exports of Ghana.

The third objective seeks to estimate Ghana's bilateral export Gaps. From the estimates, all countries recorded a positive export gap implying that the export potential predicted by the gravity model is far greater than the actual bilateral export observed. Countries such as Togo, Cote d'Ivoire, Nigeria, South Africa, Switzerland, India, France, and Italy have reported the largest export gap relative to all the nations sampled. In terms of a trading bloc, the bilateral export gap in Ghana is very big in the ECOWAS region of around USD 5.8 billion. This is followed by the South Asian Regional Corporation Association (SAARC) and the European Free Trade Association (EFTA) with a trade gap of approximately USD 549.7 million and USD 304.4 million respectively. The fourth region with the largest export gap is the Common Market for East and Southern Africa – Eastern African Community – Southern African Development Communities Free Trade Area (COMESA-EAC-SDAC) with an export gap of about USD 207.3 million and lastly the European Union with a gap of about 186.5 million. The export gap in Ghana is also lower among the following areas: the Association of Southern Asian Nations (ASEAN), the North American Free Trade Agreement (NAFTA), East

Asia (EA) and the Greater Arab Free Trade Area (GAFTA). The findings indicate that although there is an export gap in each country included in the sample, there are huge variations in actual export volumes and export potential among these countries. It is important to acknowledge that, Ghana cannot export to its full potential level, since the country's ability to export also depends on the socio-economic and political situations in other countries. For instance, the closure of Nigeria's border affect the exports potential of Ghana to Ghana.

Recommendations

The following are the recommendations suggested based on the study's estimated results;

First of all, the result revealed that increase in the share of domestic credit to the private sector helps in reducing export inefficiencies. Therefore, it is suggested that the government of Ghana through Ghana EXIM bank and commercial banks should increase the proportion of credit to the private sector at a considerable interest rate, as this sector is the major sector that can help promote the country's exports. When enough credits are made easily accessible to the private sector, it would enable them to increase production and export more to trading partners.

Again, from the results, it was found that the tax burden of Ghana and that of the importing country increases Ghana's bilateral export inefficiencies. This study, thus recommends the government of Ghana to put policies in place to reduce the high taxes paid by the exporters at the port and borders of Ghana through the

Ghana Revenue Authority - Customs Division. Similarly, Ghana needs to have efficient negotiations with trading partners to tackle the tax burden of importing country, which impedes export flows and this can be done through the Ministry of Trade and Industry (MOTI). Proper negotiation and elimination of some of these taxes would reduce the inefficiencies which prevents Ghana’s exports from reaching it potential levels. The government of Ghana should provide domestic exporters with special tax incentives so that it can increase their export competiveness and boost their ability to export more to trading partners.

It was found that internal infrastructure of Ghana contributes to its export inefficiencies. It is therefore, recommended that the government of Ghana need to invest in infrastructure to facilitate the production of goods and services for export. The country need to improve upon its electricity production and also ensure that the cost of electricity for the industrial consumers are reduced. The government through the Millennium Development Authority (MiDA), Ministry of Trade and Industry (MoTI), and Ghana Investment Promotion Center (GIPC) should ensure that the necessary internal infrastructure development that would support production for exports are put in place. The development of trade-related facilities is essential for generating favorable conditions for increasing the export potential of the country and reducing the gaps in the country’ bilateral exports flows in the long run.

Besides, the study also found that Ghana's bilateral export flows to all trading partners are inefficient. We therefore recommend that the government through the Ministry of trade and industry and the Ghana Revenue Authority -

Customs Division should embark on initiatives to engage trading partners through dialogues and negotiations for new trade agreements that will see to the removal of trade barriers and other unnecessary bureaucracies at the various ports and borders of both countries to allow efficient movement and clearance of goods and services. This is because the removal of barriers and efficient clearance of goods at the port and borders of both partners would improve export flows among partners.

It was disclosed that Ghana has large export potential and gap with all trading partners. We therefore recommend that the Ministry of Trade and Industry (MoTI) and Ghana Export Promotion Authority (GEPA) should develop trading partner-specific strategies in diversifying Ghana's export portfolio. Specifically, MoTI and GEPA must double up efforts to engage in vertical diversification to transform the country's export of primary products to manufactured products through value addition. Also, Ghana Standard Authority (GSA) must guarantee that products or goods and services produced in Ghana for export, are secure, reliable and of excellent quality, which would help increase foreign demand for our goods.

The efficiency results shows that, despite Ghana's membership to the ECOWAS, her export to the region is inefficient. It is therefore suggested that the Ministry of Foreign Affairs and Regional Integration must engage the Member States of the ECOWAS to speed up attempts to resolve all impasses about closure of borders and other trade barriers to facilitate the free movement of goods and services among members of ECOWAS. Also, since members of the ECOWAS has similar comparative advantage, Ghana should make an extra effort to add value to its exports to the region. Addressing these issues will improve the flow of exports from Ghana to members of the ECOWAS region.

Suggestions for Further Research

Future studies can consider a similar analysis by investigating the trade potential for Ghana focuses on a single trading bloc such as ECOWAS or EU region and estimate the efficiency scores for each country pair. This will, however, help to design a specific policy direction to affect the particular bloc. Also, there are many socio-political–institutional factors that are responsible for export inefficiencies, but the study could not exhaust all of them. For instance, the study used government effectiveness in place of institutional quality and electricity production as a proxy for infrastructure. Future studies can include all the institutional quality indicators and also other individual infrastructure components in the inefficiency model and look at their individual effect on exports inefficiency.

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APPENDICES

APPENDIX A

List of Sampled Ghana's Major Trading Partners

EUROPEAN UNION (EU)	**ASEAN**	**COMESA- EAC- SADC- FTA**
Belgium	Indonesia	Ethiopia
Bulgaria	Malaysia	Kenya
Denmark	Philippines	Malawi
Finland	Singapore	South Africa
France	Thailand	Tanzania
Germany	**NAFTA**	Uganda
Greece	Canada	Zimbabwe
Hungary	United States	**OTHERS**
Ireland	**EAST ASIA (EA)**	Australia
Italy	China	Brazil
Poland	Hong Kong	Cameroon
Portugal	Japan	Turkey
Spain	South Korea	Ukraine
Sweden	**EFTA**	Iran
Netherlands	Norway	Israel
United Kingdom	Switzerland	New Zealand
GAFTA	**ECOWAS**	
Egypt	Burkina Faso	
Kuwait	Côte d'Ivoire	
Libya	The Gambia	
Morocco	Mali	
Tunisia	Niger	
Saudi Arabia	Nigeria	
SAARC	Senegal	
India	Sierra Leone	
Pakistan	Togo	

APPENDIX B

Table1. Diagnostic Test

Null hypothesis	P-Value	Decision	Conclusion
$\gamma = 0$	0.0002	Reject null hypothesis	Technical inefficiency
LR test = 380.618		Reject null hypothesis	Technical inefficiencies

Note: 5% Critical value for LR = 2.706 and was obtained from the critical values of Kodde and Palm (1986).