ANALYSING THE TRADE OF MEAT PRODUCTS BETWEEN NAMIBIA AND SADC COUNTRIES

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Declaration

I, Andreas Erastus, hereby declare that the work contained in the thesis entitled: Analysing the trade of meat products between Namibia and SADC countries is my original work and that I have not previously in its entirety or in part submitted it at any university or higher education institution for the award of a degree.

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List of Acronyms

AFCFTA	African Continental Free Trade Area
ASEAN	Association of Southeast Asian Nations
BRI	Belt and Road Initiative
CEPII	Centre of Etudes Prospectives et d'Informations Internationale
CES	Constant Elasticity of Substitution
COMESA	Common Market for Eastern and Southern Africa
CU	Customs Union
EAC	East African Community
EPZ	Export Processing Zone
EU	European Union
FDI	Foreign Direct Investment
FMD	Foot and Mouth Disease
FTA	Free Trade Area
GDP	Gross Domestic Product
GNP	Gross National Product
HS	Harmonised Code
ITC	International Trade Centre
MEATCO	Meat Corporation
MRT	Multidimensional Resistance Term
NCA	Northern Communal Areas
OIE	Office International des Epizooties
OLS	Ordinary Least Squares
PPML	Poisson Pseudo-Maximum Likelihood
PTA	Preferential Trade Area
REER	Real Effective Exchange Rate
RTA	Regional Trade Agreement
SADC	Southern African Development Community
SADCC	Southern African Development Coordination Conference
SFA	Stochastic Frontier Analysis
SFGM	Stochastic Frontier Gravity Model
SITC	Standard International Trade Classification

TI	Trade Intensity
TOT	Terms of Trade
USA	United States of America
VCF	Veterinary Cordon Fence
WDI	World Development indicators
WTO	World Trade Organisation

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Dedication

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Abstract

The study examines the trade in meat products between Namibia and SADC countries. Cross-section data from the UN COMTRADE, Namibia Statistic Agency (NSA), and CEPII for 2000-2020 was used. To achieve the aim of the study, estimation from the gravity model, Stochastic Frontier Analysis (SFA), specifically using Error Components Frontier with a fixed effects model (assumes country specific and time-invariant inefficiencies), The Trade Intensity index (TII) was adopted to estimate the products that have a major effect on Namibia's meat trade with SADC countries. Technical Efficiency Effects Frontier (fixed effects model) was used to estimate Namibia's potential trade with other SADC countries. The study established a strong positive relationship between real GDP and trade. A positive coefficient was found between the population and trade. However, distance had a negative correlation coefficient. The estimates for the real GDP coefficient are statistically significant, with a level of at least 5%. The positive and significant coefficient of real GDP implied that Namibia's trade value increased with the partner countries. The distance estimate was negative, as predicted by gravity theory. According to this finding, the greater the distance between Namibia and its trading partners, the less likely they are to trade. This variable is a proxy for transportation and other trade costs, such as communication and transaction costs. Because of this, the price increases with distance.

In other words, trade volume between Namibia and its SADC members decreases proportionately as distance increases. Namibia's trade intensity trend in meat products has been on the rise from 2000 until 2020. In addition, the study shows that Namibia has performed relatively poorly and has a significant trade potential. The mean trade efficiency in meat products between Namibia and SADC countries is estimated to be approximately 22%. Mean technical efficiency shows interesting results as some SADC countries with a low percentage of trade efficiency tend to have strong potential for export growth for Namibia's exports of meat products. Furthermore, Trade efficiency is more than 50% for DRC, Zimbabwe, and Botswana; however, it is less than 50% for most SADC countries. Based on the distance and size of economies, SADC offers export market opportunities for Namibia's meat products. To understand the determinants of trade and relationships, it is crucial that the study advises conducting additional research to assess the competitiveness of Namibia's meat products in the markets in the SADC region, identify and attempt to resolve trade impediments in the SADC region, evaluate the complete liberalization of trade in the agricultural sector and other sectors that contribute to the GDP of the country.

Keywords: Trade flow, SADC, Meat products, Gravity model, Stochastic Frontier, Trade intensity.

Chapter 1 : Introduction

1.1 Background

Although agriculture accounts for only about 6% of the gross domestic product (GDP), it is an important sector of Namibia's economy. About 75% of the total agricultural economy, of which 69% is valued in commercial livestock production (Teweldemedhin & Mbai, 2013a). Beef production and live animals are an important part of the sector, followed by small-scale production (sheep and goats). The commercial agricultural sector comprises about 4,200 farmers and accounts for 44% of the cultivable land, while communal farmers make up 41% of agricultural land and 67% of the total population, 90% of whom are engaged in subsistence farming (Teweldemedhin & Mbai, 2013a). Agriculture is one of the strategies to reduce poverty; second, it employs 37% of the workforce and ultimately supports 70% of Namibia's population (Kaurivi et al., 2021).

Since gaining independence in 1990, Namibia's new government has recognized the country's export role as being competitive and sustainable. It has adopted a value-added growth export strategy. One such example is the Export Processing Zone (EPZ), which was established in 1995. EPZ aims to promote export-oriented production to create jobs and invest in and transfer technology to the rest of the economy (Jordaan & Eita, 2007).

According to the International Trade Centre (ITC) in 2011 Namibia accounted for a meager 0.1% of world meat trade rendering it not so significant in trade (ITC, 2021). The Namibian share of meat export to the UK is only 0.5%. At the national level, Namibia is an important player in the meat market in South Africa and Norway. Namibia's red meat exports are mainly to emerging markets in the EU, South Africa, and Norway. In 2010, the red meat sector accounted for 3.7% of the country's total exports of $ 1.7 billion (ITC, 2021). 50% of Namibia's meat exports to neighboring South Africa. Due to the FMD situation in Namibia, only boneless meat products are currently exported to the EU market. Other meat products from Namibia include marginal exports of dried beef, mutton, and sheep carcasses to Botswana, Zimbabwe, and Zambia (International Trade Centre, 2021).

The South African Development Communities, which comprises 16 sub-Saharan African countries, has for the past two decades reformed the market in favor of trade liberalization to promote free trade among its members (Aeby, 2019), and the agriculture sector has been earmarked to play a significant role in transforming development in the region.

The South African Development Coordination Conference (SADCC) constitute of Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe. SADCC was founded in 1980 with the initial aim of reducing its economic dependence on other non-member countries, particularly South Africa. SADCC has been successful in some areas, such as improving communication and transport networks in the region (Bischoff, 2020).

Although empirical research on Namibian exports is limited, research by Jordaan & Eita, (2007) as well as (Teweldemedhin & Mbai, 2013a) are worth noting. Jordaan & Eita, (2007) used the model of general gravity in their study. Their study shows that export is an important component of Namibia's economic growth and that the country can expand its limited domestic market by exporting to international markets for better revenue and GDP growth. In addition, the importers' GDP growth and Namibia's GDP increased. However, the distance and per capita imports for importers decreased due to a decline in exports (Jordaan & Eita, 2007). Contrast, the exchange rates did not affect Namibia's per capita and real exports. It has been observed that Namibia exports significantly with their bordering countries and the European Union.

For many African countries, most of their trade is still with global trading partners; this is also true for Namibia. Although the African Continental Free Trade Agreement (AfCFTA) will not change the trading regimes of many African countries soon, it does, however, provide incentives that make the trade with other partners to the Agreement more accessible and attractive. The AfCFTA has the potential to put in place mechanisms to address many of the non-tariff challenges frustrating intra-African trade. One way the AfCFTA will address the non-tariff challenges is to provide an improved trade facilitation environment. The potential dynamic benefits of the AfCFTA are particularly important (Bronauer & Yoon, 2018). Larger integrated markets may well be more attractive to investors, and along with new investment could come new technologies and learning that could boost productive capacity.

The study focuses on meat products because they constitute the largest share of agricultural exports. Agriculture is an important sector for addressing Namibia’s chronic development challenges—i.e., poverty, inequality, and unemployment (HPP, 2016). Trade in meat products has the potential to enhance growth in the agriculture sector, thereby contributing to the reduction in poverty, inequality, and unemployment (Uchezuba, Mbai, & Laubscher, 2016). Additionally, the study focuses on trade because of the opportunities that the AfCFTA offers. It is envisaged that the study will contribute to debates and strategies that will help Namibia harness the opportunities of the AfCFTA and expand its export markets for meat products to SADC countries.

(Teweldemedhin & Mbai, 2013a) Conducted a study on the factors determining red meat trade to the Asian and African markets and its implications for the Namibia red meat industry. In their study, they employed the extended gravity model with income, per capita income, distance, and exchange rates as the variables of their model, as well as dummy variables. Their study shows that higher income per capita is a major indicator of potential export opportunities. In densely populated countries, protein products such as meat may be in higher demand. However, more populations increase or decrease trade in terms of per capita GDP. Given its importance and its role in Namibia's economy, it is important to study the factors affecting exports and determine the trade (export) potential for different countries.

Other review shows that research on export determinants is based mainly on the total export earnings of the agricultural sector. Quite a number of scholars have employed panel data to study the determinants of agricultural exports and the potential for trade in various nations, as evidenced in the reviewed literature. Be that as it may, this study differs from previous studies. The current study did not focus on total agricultural exports but instead chose meat product exports as a dependent variable. The panel data was calculated using the gravity equation and the PPML model, which a few studies have combined into one study.

Most importantly, even though studies have been conducted to investigate the determinants of Namibian agricultural exports, little is known about the factors that influence meat product exports in Namibia, the SADC region, and elsewhere, despite the potential for trade.

To the best of the researcher’s knowledge, only Eita (2008) and Teweldemedhin & Mbai (2013) conducted a similar study based on Namibia's agricultural exports and red meat exports using the gravity model. What is missing from these studies conducted in Namibia was a specific focus on meat product exports within the SADC region and the inclusion of the PPML model, which achieves a zero-trade effect. Closer studies to the current study were those conducted outside of Namibia, for example, by Shahriar et al. (2019). Shahriar et al. (2019) examined the determinants of China’s meat exports to find out the role of the Belt and Road Initiative (BRI), in particular, by giving special priority to pork. Bose et al. (2019), which also investigated the factors affecting Oman’s fish exports to the European Union, conducted another study.

A gravity model is a useful tool in determining export potential. The model has its foundations in physical science and has become an important tool in the analysis of bilateral trade flows. (Tinbergen, 1962) and (Karim & Ismail, 2014) Poyhonen (1963) compared trade flows to Newton's law of gravity, the idea of attracting the people of two countries, weakening them because of the distance between them, and enforcing them through trade agreements. This study started this study bridges the gap using the gravity model (stochastic frontier), along with a few studies on the commercial analysis of meat export to Namibia.

1.2 Statement of the Problem

To harness the opportunities that the AfCFTA offers, export market intelligence is crucial, especially in regional economic blocks such as SADC (Bronauer & Yoon, 2018). Export market intelligence is concerned with identifying potential markets, analyzing the trade flows, evaluating the potential of increasing trade flows, and understanding the determinants of trade and the relationship thereof, inter alia. Based on the literature reviewed, there is a paucity of information on these elements of market intelligence (Apiko et al., 2020). Without such information, strategies for harnessing the trade opportunities offered by the AfCFTA will not be effective. The study seeks to fill this gap in the literature by conducting an empirical analysis of the trade in meat products between Namibia and SADC countries.

1.3 Objectives of the study

1.3.1 Overall objective

The main purpose of this study is to analyse the trade in meat products between Namibia and SADC countries.

1.3.2 Specific objective

- To evaluate whether the gravity model theory can be used to describe bilateral trade between Namibia and SADC countries; and,
- To estimate the potential of trade in meat products between Namibia and SADC countries.

1.3.3 Research hypothesis

H0: Bilateral trade between Namibia and SADC countries cannot be explained by the gravity model theory

1.4 Scope

The study focuses on the analysis of the flow of meat product trade between Namibia and SADC countries. The study sought to analyse the trade flow trend in Namibia's meat products and, in particular, determine the flow of meat trade with its SADC partners. Standard International Trade Classification (SITC) revision three different codes for each meat product, for meat and meat preparation (sitc rev 3 01) and live animals other than animals of division in chapter 1 (sitc rev 3 00). The study used meat and meat preparation trade data from all the SADC member countries for the period 2000 to 2020; thus, there was no need for a sampling technique.

1.5 Significance of the study

This study will provide information that is designed to guide policymakers in agricultural policy, negotiate trade agreements and create an environment in which domestic producers and consumers can benefit from trade. The study will contribute to the discussions on strategies that will help Namibia take advantage of the AfCFTA opportunities and help SADC countries expand their export markets for meat products. This study will contribute to literature on the application of gravity model theory to international trade analyses of commodity commercial flow of meat products trade flow in Namibia.

1.6 Ethical considerations

The researcher had to seek ethical approval from the Namibia University of Science and Technology to conduct the study. With regard to ethical considerations, the terms and conditions of using the data from the International Trade Centre had to be observed and adhered to. Data collection from the Namibia Meat Board and Ministry of Agriculture was initiated only with the informed consent of the subjects. This had to be secured through the signing of the consent forms by the responsible personnel for data files. All computer files from the researcher's computer were password protected to ensure confidentiality.

1.7 Thesis outline

The present study consists of five chapters. Chapter 1 outlines the background of the study and provides an understanding of regional trade agreements in Southern Africa. The Agreement establishes the African Continental Free Trade Area (AFCFTA). The objectives of the study and the assumptions made are also explained in the chapter, along with the importance of the study. Chapter 2 focuses on the literature related to the study. In chapter 3, the present study draws attention to the methodology and model specifications used. Chapter 4 focuses on the presentation and analysis of the results, along with the discussion of the results. In the last chapter of the study (chapter 5), a summary of the findings, conclusions, and recommendations was provided.

Chapter 2 : Literature Review

2.1 Introduction

Agriculture is a leading sector that contributes to the GDP and employment opportunities of a country. The sector, which makes up a large part of the economies of developing countries, is the main source of livelihood for most of the rural poor and an important source of export earnings (Epaphra & Mwakalasya, 2017). In particular, the livestock sector plays a key role in the development of the country's economy in agricultural exports. The theoretical literature on the factors influencing trade flows is very diverse. The gravitational model (Stochastic Frontier Model) of trade is used in the literature on agricultural products and livestock exports to study the factors affecting export flows using different determinants.

2.2 Background literature

In the following sub-sections, the study provides the main theoretical inputs into our empirical, World trends in Meat Sector, Namibia's meat sector, the meat sector overview, export trends, and major Markets. The section also highlights on main challenges affecting exports, AfCFTA, and SADC opportunities (for Namibia meat products). Lastly, the section provided a theoretical framework on trade potential analysis, Gravitational Model and specifically on the Stochastic Frontier Model, Trade Intensity Analysis, Application of Theoretical Framework in the Study, and Conceptual Framework.

2.2.1 World trends in the meat sector

Increased consumption of animal products and changes in trade policy or economic liberalization are increasing the trade in meat products (Kearney, 2010). The development of transportation, such as long-distance cold chain transport, has enabled long-distance trade and transport of perishable crops, meat products, and fodder (Rome, 2020). The livestock trade has grown steadily over the last 20 years. From 1990 to 2018, meat exports more than tripled (327%). However, trade in plant products still dominates agriculture. The share of meat in agricultural exports has dropped significantly from 5.6% to 7.5% over the last 20 years (Rome, 2020).

Although most animal products are consumed in the country of origin, increasing consumption of meat products and increasing trade transparency have allowed some countries to specialize in the export of certain types of meat products (Enahoro et al., 2021). In terms of volume, Brazil is the World's largest exporter of beef after 2017, followed by Australia, India, and the United States. Increasing beef exports from India has been a new trend in recent decades due to increasing demand from developing countries

(Enahoro et al., 2021). Foot-and-mouth disease is a major driver of global trade patterns, as countries free of the disease usually obtain meat from countries with similar foot-and-mouth disease status.

Like all meat products, but especially in the beef trade, boneless, volume-based frozen pieces predominate. Fresh high-value cuts are commonly sold in Europe and East Asia, Latin America, and Australia/USA (Perry, Rich, Rojas, Romero, Adamson, Bervejillo, Fernandez, Pereira, Pérez, & Reich, 2020). Exports are also important in European markets and from Brazil to West Africa. Exports to China are growing significantly; for example, China now accounts for 70% of Uruguay's beef exports (Perry et al., 2020).

Oceania dominates global sheep and goat exports, especially in Australia and New Zealand. Over the last five years, the average annual exports of mutton and goat meat to Australia have increased by 3% and remained stable for New Zealand. A small percentage of goat and mutton comes from some European countries (Britain, Ireland, Spain, and Belgium); Asia (including China and India); and Africa (Namibia). Unlike other types of meat, the demand for mutton and goat meat is steadily increasing, especially in the Middle East (Enahoro, Bahta, Mensah, Oloo, & Rich, 2021).

Asia, then North America, and Europe are the major importers of beef. Beef imports from Asian countries have steadily increased over the past decade and have increased by 98% since 2010, almost doubling in 2019 (Enahoro et al., 2021). Similarly, beef imports into the United States are on the rise. Over a decade, between 2010 and 2019, beef imports to Europe declined by 18% due to declining demand and an increasing population (Enahoro et al., 2021).

2.2.2 Namibia’s meat sector

In 1896, Namibia experienced a serious outbreak of rinderpest (cattle disease), which had a devastating effect on livestock production. It is estimated that Ovaherero communities lost up to half their cattle herds and the German settlers, who mostly lived in the central and southern parts of Namibia suffered severe losses. To avoid future epidemics, the German colonial government established the Veterinary Cordon Fence (VCF) in 1897 which resulted in Namibia being divided into a northern and southern part the VCF became known as the redline, because it was printed on maps in red ink. The red line has political, economic, and cultural symbolism.

The removal of the “Red line” was one of the topics of discussion at Namibia’s first and second land conference in 1991 and 2018, respectively

The 2018 land conference resolved not to remove the “Red line”, but rather, among others provide market avenues for livestock farmers north of the “red line”, renovate and upgrade of abattoirs north of the “Red line” to access export markets. Namibia maintains biosafety controls in the form of a VCF. The VCF separates the northern part of the country (primarily small municipal production) from the southern part, where large export-oriented trade takes place, as shown in **Error! Reference source not found.** below (Miescher, 2012).

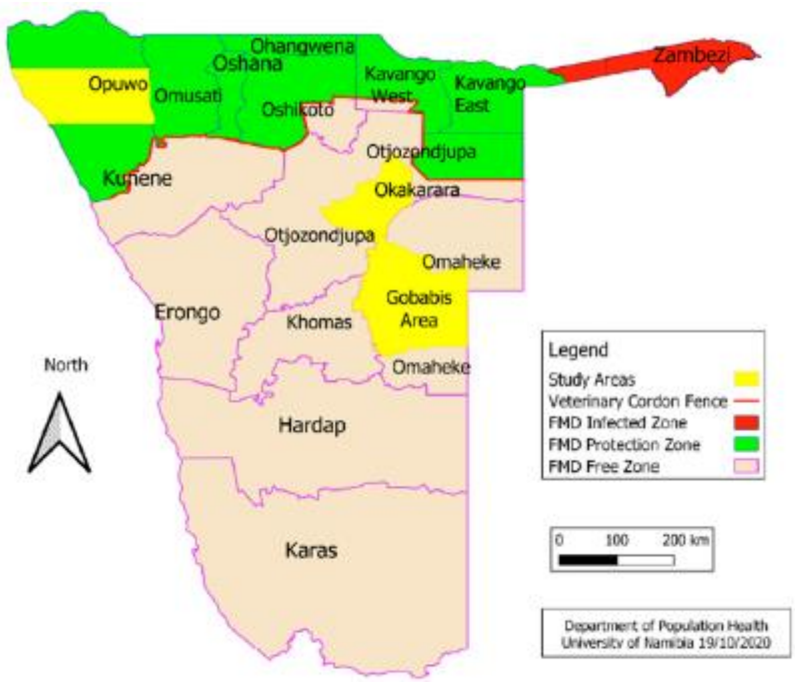

Figure 2:1 Namibia regional map showing the foot and mouth disease (FMD) zones and fences and fences

The southern part of VCF in Namibia is recognized as free from Foot-and-Mouth Disease (FMD) without Office International des Epizooties (OIE) vaccination, which allows it to enter the European market. Areas north of the VCF are inaccessible because they include control zones, vaccination zones, and the spread of FMD (Miescher, 2012). This gap in market access is significant for the Namibian government, which is shaping livestock prices. It also influences proposed investments and regulatory changes to find ways to improve the capacity of small farmers and start-ups (Naziri, Rich, & Bennett, 2015). About half of Namibia's cattle are found on either side of the fence.

Sales of livestock for slaughter usually account for 10–15% of the national production, although there are large differences between social and commercial production, as well as north and south. Across the country, approximately 75-80% of production comes from commercial producers, and delivery from the Northern Communal Areas (NCA) represents about 5% of the NCA's reserves (Kaurivi, Laven, & Parkinson, 2021).

Namibia is a small player in the global meat market, accounting for 0.1% of the global meat trade in 2011 (ITC, 2021). For example, its share of meat imports from the United Kingdom (UK) is only 0.5%. Nationally, Namibia is an important player in the meat market in South Africa and Norway. Namibia's red meat exports are mainly to emerging markets in the European Union (EU), South Africa, and Norway. In 2010, the red meat sector accounted for 3.7% of the country's total exports of $1.7 billion (ITC, 2021). About 50% of Namibia's meat exports go to neighboring South Africa. Due to foot-and-mouth disease in Namibia, only red-boned meat products are currently exported to the EU market. Namibia's other meat products include extraordinary exports of dried beef, mutton, and mutton to Botswana, Zimbabwe, and Zambia (ITC, 2021).

2.2.3 Meat Sector Profile/Overview

In the SADC region, approximately 70% of the population depends directly on agriculture for food, nutrition, and income (SADC-RVAA, 2019). In this regard, sustainable agricultural performance plays an important role in improving food security and therefore contributes to the well-being of the region. Cattle in SADC is an important natural resource for the region, with more than 60% of the total area of the region suitable for grazing (Mapiye, Chikwanha, Makombe, Dzama, & Mapiye, 2020). With a population of 64 million, it is one of the most important types of livestock farming (Chingala, Raffrenato, Dzama, Hoffman, & Mapiye, 2017). 75% of the total livestock in the region is raised on small farms in pastures (Chingala et al., 2017).

Per capita meat consumption (11 kg per year) in the SADC region is less than one-third of the global average, but significant regional differences are evident at both levels and in structure (Organization for Economic Cooperation and Development, 2016). Meat consumption in Southern Africa is four times higher than in any other region, and although it is strongly influenced by South Africa, consumption in countries such as Namibia and Botswana is much higher than the average in Southern Africa (OECD, 2016). However, population reports led to an increase in total meat consumption in East and West Africa, accounting for 54 percent of Southern Africa's meat consumption.

Livestock production and beef exports are key to Namibia's agricultural economy. In Namibia, herds range in size from 1.5 to 2 million head of cattle nationwide (Meatco, 2020). The International Trade Center (ITC) reports that Namibia exports more meat products to the rest of the World than SADC countries (ITC, 2021). Since 2001, Namibia's exports have accounted for less than 1% of total meat imports from other SADC countries (Uchezuba et al., 2016).

Kalaba & Tsedu (2008) generally reviewed the results of trade in agricultural products within the SADC following the implementation of the Trade Protocol, covering the period 2000–2006. The results of the study showed a significant increase in total volume; however, the SADC trade is weak. According to the study, SADC lags behind many other regions in terms of domestic trade compared to other regional blocs. In practice, performance statistics show that trade growth outside the SADC region exceeds that of its counterparts.

According to Food and Animal Planning Inc. (2010), presented at the Namibian Meat Council (2015), a study was conducted to assess Namibia's export potential, especially in the US market. They found that Namibian beef has the potential to gain the support of potential consumers but is limited by international competition, regulatory challenges, and financial stability. Based on the results of import growth, the study examined the expansion of the Middle East, Ghana, Russia, China, and existing markets without looking into detail (Namibia Meat Board, 2015).

2.2.4 Meat products Export Trends

The International Trade Centre (ITC) reported that Namibia exports more meat products, in terms of value, to the rest of the World than to SADC countries (ITC, 2021). As shown in the figure below, the value of Namibian meat products to the World is much more than what was exported to SADC countries. Since 2001, Namibia’s export share in the total value of meat products imported by other SADC countries has been less than 1 percent (refer to the figure below) (Uchezuba, Mbai, & Laubscher, 2016). The observed low trade volume in meat products between Namibia and SADC countries can be explained by non-tariff barriers and a non-existent or lack of trade facilitation environment.

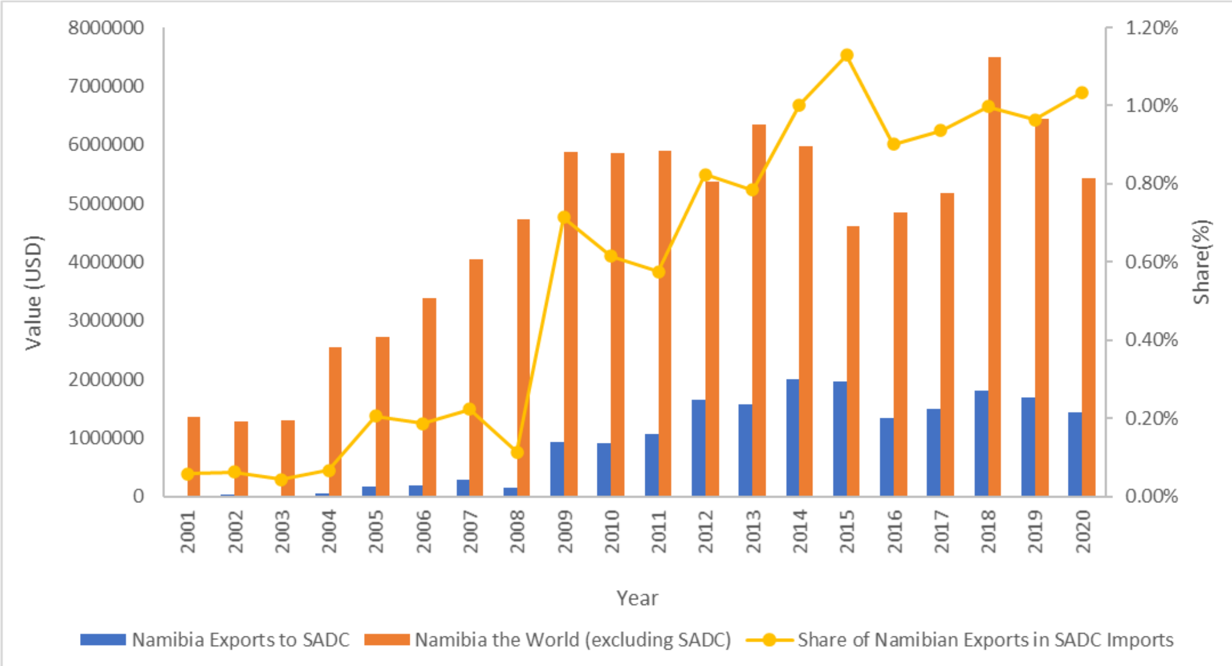

Figure 2:2: Trade in Meat products between Namibia and SADC countries and the World (ITC, 2021)

Kalaba & Tsedu (2008) assessed the results of agricultural products trading within the SADC, mainly at the aggregate level, after the implementation of the Trade Protocol covering the period 2000-2006. The results of the survey showed that despite significant growth in total exports between 2000 and 2006, SADC trade remains weak. The study concluded that SADC lags behind many other regions in terms of domestic trade compared to other regional blocs. In fact, performance statistics showed that trade growth outside the SADC area is higher than its counterparts.

2.2.5 Major Markets of Namibia meat products

With a contribution of about 75% to the total agricultural production, Namibia's red meat industry is the backbone of the nation's agriculture Spies, Idsardi, & Steenkamp, 2014). The red meat sector contributes significantly to global foreign exchange generation through its export operations. However, Namibia exclusively trades with a select few countries, such as the EU, South Africa, and Norway is, three well-established markets for Namibian red meat exports. With a value of N$1.4 billion in exports in 2010, the red meat industry made up 3.7 percent of all exports (ITC, 2021). In the same year, the largest export abattoir in Namibia sold a total of 29 percent of its red meat to markets in Western Europe, 48 percent to those in South Africa, 2 percent to those Norway, and 1 percent to those in Africa. Marginal quantities were also sent to Switzerland (Meatco, 2020). This makes it clear that a small number of markets receive the majority of Namibia's beef exports. In light of the possibility that Namibian meat exports to the EU will not get favorable treatment.

The prevalence of meat consumption in the SADC region is quite unique. Poultry accounted for 36% of total meat consumption in 2013–2015, but beef (33%) and sheep (19%) accounted for much more than the global average (Allen & Heinrigs, 2016). This is due to the consumption of pork, which has been significantly reduced by 12%. Consumer preferences reflect cultural and religious preferences as well as the dominance of extensive pasture production systems, taking into account pasture. The relative proportion of different meats in the consumer basket will remain relatively stable until 2025 (Allen & Heinrigs, 2016).

In large importing countries such as South Africa and Angola, growth in consumption is likely to remain slow (OECD, 2016). South Africa is the largest poultry producer in the region and has the largest share of its production, which will increase by 19% by 2025. This increase is far below demand, and more than half of the extra poultry meat used throughout South Africa will be imported by 2025 (OECD, 2016).

Abundant pasture resources make SADC an attractive prospect for large-scale beef production in the region. Large-scale beef production has also increased through access to an efficient EU market for key export products, particularly in Botswana and Namibia. South Africa accounts for 18% of the World's cattle herd, and the bulk of consumption is locally produced (Jayne et al., 2014). The increase in herd numbers has increased beef production by almost 2% in the last decade, despite the spread of diseases (OECD, 2016). Livestock production is much lower than the world average, indicating a significant increase in productivity. Cattle are also an important asset in the region, and most of them are raised for purposes other than beef production. Thus, only a slight increase in production units is expected in the next decade, and a large 27% increase in beef production is due to further expansion of the herd. The growth of beef consumption in the region is strong, growing at 2.6% annually by 2025 (OECD, 2016).

2.2.6 Main challenges affecting exports

Export-oriented growth strategies often seek to study the factors that affect exports and growth, as export strategies fail without a thorough understanding of the country's economic situation and the production of export-promoting factors (Dadakas, Ghazvini Kor, & Fargher, 2020a). This section provides a review of some previous studies on the trade potential of agriculture and agricultural exports using the gravitational equation. For example, Abdullahi et al., (2021) use the Stochastic Frontier Gravity Model (SFGM) to study the determinants, efficiencies, and export potential of agricultural products between Nigeria and the European Union (EU). The study reveals that agricultural exports between Nigeria and its EU partners are determined by the economic volume and income of Nigeria and its importers, as well as bilateral exchange rates and distances. In addition, the study shows that Nigeria has performed relatively poorly and has great potential, which remains to be exploited in relation to EU countries. (Hajivand, Moghaddasi, Zeraatkish, & Mohammadinejad, 2020) used the Gravitational Stochastic Frontier Analysis (SFA) to investigate Iran's agricultural export potential from 1982 to 2017. The findings revealed that partners' and Iranians' gross domestic product has an impact on the country's agricultural exports. According to the findings, 69 percent of the country's trade potential with trading partners has been utilized.

On the other hand, Nguyen, (2020) uses SFGM to study Vietnamese agricultural exports, giving special priority to rice and coffee exports. The study shows that the effects of "overseas" sanctions are statistically significant and that exports of these goods from Vietnam may not reach their full potential. The study also highlights the importance of increasing exports of these goods to the Association of Southeast Asian Nations (ASEAN) and the European Union.

To study the factors and opportunities for increasing agricultural exports from Pakistan, Atif et al., (2017) used a model of gravity using SFA. He disclosed that domestic exports of agricultural products are positively determined by the GDP of importers and exporters in terms of GDP, exchange rates, shared borders, and colonial relations. The study shows that Pakistan has a lot of potentials, especially with its neighbors in Europe and the Middle East.

(Crescimanno et al., 2013) used panel data from 1996 to 2010 to assess the key drivers of Italian agricultural food exports to non-EU Mediterranean partner countries. The study highlights a number of features related to the attractiveness of Italian agricultural food exports, including the country's wealth as a trading partner; geographical proximity; colonial and historical ties; and the importance of the agricultural sector in some of the partner countries. Shuai (2010) explored the trade potential of China and the United States using the gravity model and the fixed-effects model. The study found that China and the United States have different potentials for agricultural exports due to regional differences.

Many researchers have conducted experimental research to study the specific gravitational equations of commodities affecting the export of agricultural products in different economies. For example, Nsabimana and Tirkaso (2020) studied the production potential of coffee exports in East and South Africa using static and dynamic versions of the gravity model. The findings revealed that coffee exports are primarily determined by population, geographical distance, and the income of exporting and importing countries. He predicts that exporting countries in these regions may increase coffee exports as their results show that these countries have failed to the best of their ability in the international market. Shahriar, Qian, & Kea (2019) examine the factors affecting meat exports from China, particularly pork preferences, especially the role of the Belt and Road Initiative (BRI). The study revealed that the positive impact of BRI is significant, which means that the BRI big project will stimulate China's exports to the meat industry. In addition, the country's GDP, Chinese language, WTO membership, and land area have a significant impact on China's pork exports.

Bose, Al Naabi, Boughanmi, & Yousuf (2019) studied the factors affecting Oman's exports to the European Union, focusing on the relative importance of border exemptions and internal sanctions. The results for the period 2000–2013 show that restrictions on domestic exports, internal structural changes, and exchange rate fluctuations have affected trade in fish exports to EU markets rather than border rejection.

Some experimental research has also been done in African countries such as Namibia to assess the flow of bilateral trade and the effectiveness of African regional trade blocs, using the framework of the model of gravity.

In a study of Namibia's export determinants, Eita (2008) used an extended version of the model of gravity, using panel data covering 39 countries from 1998–2006. This model of Eita's (2008) used GDP and GDP per capita, distance, and exchange rate. Dummy variables have also been added to Namibia's export model to incorporate the effects of the common border with Namibia and its membership in the SADC and the EU. The results show that growth in Namibia's GDP and importers' GDP has led to an increase in Namibia's exports. It was found that SADC, EU membership, and border sharing with Namibia were all positive and important in promoting Namibia's exports. In addition, it was found that the GDP per capita and the distance of importers had a negative effect on Namibia's exports. Namibia's real exchange rate and GDP per capita have not been significantly affected by exports.

A similar study was carried out in Ethiopia by Yishak (2009). The gravitational model assumed that Ethiopia's exports relied on its GDP, the importer's GDP, FDI, domestic transport infrastructure, real exchange rate, foreign trade index, institutional quality index, and the distance measured between Ethiopia and its trading partners. The model was evaluated using a Generalized Two-Stages Least Squares method in a group of 30 Ethiopian trading partners from 1995 to 2007. The findings reveal that the distances and barriers to imports imposed by Ethiopia's trading partners play an important role in determining Ethiopia's exports.

According to the Gravity Model Framework, Karamuriro and Karukuza (2015) reviewed Uganda’s export performance determinants. The study covers the period from 1980 to 2012. In this study, Henry & Wilfred (2015) calculated Uganda's exports using the GDP of Uganda and its key trading partners, the per capita GDP of importing countries, the per capita income disparities, and the real exchange rate. The model with distance and dummy variables such as language, border, COMESA, and EAC. The research results show that the variables used have had a positive and statistically significant effect on Uganda's exports. Uganda's per capita GDP and the distance between Uganda and its trading partners have negatively and significantly affected Uganda's exports.

Dadakas et al. (2020b) analyzed Zimbabwe’s export effectiveness using the Poisson pseudo-maximum probability gravity model (PPML). The aim of the study was to analyze the impact of the real effective exchange rate (REER), terms of trade (TOT), labor productivity, infrastructure quality, and the state of innovation and technology on the value of exports to Zimbabwe from 2005–2015. The study included GDP, GDP per capita, distance, and two pseudo-variables, namely regional trade regulation and the common official language. The study found that REER, GDP, GDP per capita, regional trade agreements, infrastructure, innovation, and technology have a positive impact on Zimbabwe's export competitiveness. Labour productivity, trade costs, common official language, TOT, and distance have a negative impact.

Zeray and Gachen (2014) assessed the determinants of bilateral trade between Ethiopia and its main trading partners using a gravity model based on panel data from 2000–2009. The study was used to forecast key overall trade and export potential. This study of Ethiopia's export potential showed that the GDP of Ethiopia and importing countries have a positive and statistically significant impact on Ethiopian exports. Conversely, the significant distance between Ethiopia and its trading partners and the border variable (countries sharing a common border) had a negative and statistically significant effect on Ethiopia's exports. In addition, the study showed that the real exchange rate, the rate of imports from importing countries, and Foreign Direct Investment (FDI) does not have a significant impact on Ethiopia's exports.

Elshehawy et al. (2014) examined the factors affecting bilateral exports to Egypt's 42 major trading partners. The study spanned 14 years (2000 to 2013) and used a gravity model to estimate Egyptian exports. Egypt's exports depend on its GDP, the importer's GDP, the importer's population, the regional trade agreement (RTA), distance, and dummy variables on the border between Egypt and its trading partner. Egypt's GDP), the importer's GDP, the importer's population, the regional trade agreement (RTA), and the border between Egypt and its trading partners positively and significantly determine Egypt's exports. In addition, transport costs (distance variables) were found to have a negative but small impact on Egyptian exports.

2.2.7 AFCFTA and SADC opportunities

The Agreement establishing the African Continental Free Trade Area (AfCFTA) that entered into force on May 30, 2019, was signed at the 10th Extraordinary Summit of the African Union Assembly on March 21, 2018. The AfCFTA is the continent's most ambitious integration initiative. The main objectives of the AfCFTA are to (i) create a single continental market for goods and services, with free movement of persons and investments; (ii) expand intra-Africa trade across the regional economic communities and the continent in general; and (iii) enhance competitiveness and support economic transformation (Simo, 2020).

According to World Bank Group (2020) the AfCFTA agreement will establish the world's largest free trade zone in terms of the number of countries participating. The agreement will link 1.3 billion people in 55 countries with a combined GDP of $3.4 trillion. By 2035, it has the potential to lift 30 million people out of extreme poverty. However, realising its full potential will require significant policy reforms and trade facilitation measures. The agreement's scope is extensive. Tariffs will be reduced among member countries, and it will cover policy areas such as trade facilitation and services, as well as regulatory measures such as sanitary standards and technical trade barriers. It will further supplement existing sub regional economic communities and trade agreements by providing a continental regulatory framework and regulating policy areas such as investment and intellectual property rights protection that are not addressed in most sub regional agreements (World Bank Group, 2020).

Study by World Bank group on ACFTA: Economic and Distributional Effects quantifies the agreement's long-term implications for growth, trade, poverty reduction, and job creation. According to the analysis, full implementation of AfCFTA could increase income by 7%, or nearly $450 billion, in 2014 prices and market exchange rates. The agreement would also significantly increase African trade, particularly intraregional manufacturing trade. Furthermore, it would increase employment opportunities and wages for unskilled workers, as well as contribute to closing the wage gap between men and women. According to Colette and Signé (2021), It was a missed opportunity to include specific environmental provisions in the AfCFTA beyond the preamble and exceptions clauses. However, as this policy brief has demonstrated, it is not too late to strengthen the link between the AfCFTA and Africa's Agenda 2063 climate goals.

The AfCFTA provides opportunities for countries like Namibia, with a small population, to access markets in countries with larger populations. Therefore, as the African markets are opening up, it is imperative for Namibia to position itself to access these markets and trade in commodities, products, and services for which it has a competitive advantage (Viljoen, 2019). However, for Namibia to position itself and leverage the opportunities offered by the AfCFTA, market intelligence in terms of identifying potential trading partners is crucial (Bronauer & Yoon, 2018). It is within this context that is study is being undertaken to analyze the trade of meat products between Namibia and other countries in the Southern Africa Development Community (SADC).

Over the past two decades, SADC, an intra-regional group of 16 sub-Saharan African countries, has reformed the market in favor of trade liberalization to promote free trade among its members (Aeby, 2019). Like many African countries, agriculture plays a key role in the economic development of many SADC member countries.

The founders of the then South African Development Coordination Conference (SADCC) were Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe. Founded in 1980, it sought to reduce its economic dependence on other non-member countries, particularly South Africa. SADCC has been successful in some areas, such as improving communication and transport networks in the region (Bischoff, 2020).

The SADCC provided a regional identity to Southern Africa and emphasized the importance of economic integration and cooperation for sustainable economic growth and development (Frayne et al., 2019). Shortly after Namibia's independence in 1990, she became the tenth member of the SADCC. The transition from the Coordination Conference to the Development Community took place in 1992. Differences between the two organisations include a revised mandate that includes South Africa as a formal partner, as well as a shift from the original "independent" coordination agreement to a legally binding agreement (Frayne et al., 2019).

The transformation of the SADCC into the SADC was intended to use this large market to promote deeper economic cooperation and integration and to restructure the economies of member countries (SADC, 2011). This transition will eliminate dependence on many important exports and help remove obstacles to sustainable economic growth and socio-economic development. According to Aeby (2019), Significant progress has been made in regional trade integration over the last decade. Intra-SADC trade was only 5% in 1980, but it now accounts for more than 25% of total trade. This is expected to rise further once the Free Trade Zone is established.

On the economic front, the SADC region has made significant progress in terms of policy harmonisation. SADC countries had many socioeconomic policies in 1980, but now all countries in the region believe in market-oriented economic policies. Most SADC member countries have liberalised their economies, reduced budget deficits, liberalised exchange controls, and significantly improved overall macroeconomic fundamentals. The organisation has developed a programme of action that spans all sectors and cross-sectors that are critical to achieving SADC's objectives, particularly promoting deeper regional integration, integrating SADC into the global economy, promoting balanced and equitable development, eradicating poverty, and promoting gender equality (SADC, 2011).

Ordinary people have been establishing regional organizations as a spontaneous response to the Lusaka Declaration and the SADC Treaty (SADC, 2011). The enterprise sector has been encouraged to get involved and invest in the region. International Cooperating Partners for SADC's endeavours has been successfully negotiated (Bronauer & Yoon, 2018).

Although it is difficult to quantify employment levels due to a lack of data, available information indicates that formal sector employment has declined in the majority of member countries. The region's low employment levels are largely the result of a confluence of factors that contribute to slow economic growth. These include factor price distortions as well as the short-term negative effects of structural adjustment programmes. The use of capital-intensive production techniques in some sectors of the economy with the potential to generate employment has exacerbated the unemployment problem. As a result, a large proportion of the expanding labour force is absorbed in the informal sector, which is currently characterised by low income levels and underemployment. Unemployment and underemployment disproportionately affect young people and women. In order to address this challenge, the region should develop policies that not only create jobs but also encourage entrepreneurship among all citizens, regardless of gender (Makochekanwa et al., 2010).

Mapiye et al. (2020), Identify poverty as another issue that the region is dealing with. Poverty is caused by a variety of social, economic, political, and geographical factors. According to the SADC 2009-10 Annual Report, poverty affects approximately 50% of the region's population and is reflected in poor indicators such as life expectancy, adult literacy rate, access to safe water and health services, and the percentage of children under five who are underweight for their age. Aside from aiming for this, one strategy SADC could use to reduce poverty is to improve or provide education for all citizens, which will help them escape the poverty trap. A sustainable livelihood approach, which has been shown to work in reducing poverty, can also be used (Makochekanwa et al., 2010). SADC countries view the region as having a future of economic prosperity achieved by improving the living standards and living standards quality of their citizens. This shared vision is based on shared values and principles, as well as historical and cultural closeness between the peoples of Southern Africa (SADC, 2011). SADC's vision is of a region where all people have access to adequate nutrition for active and normal life (SADC, 2011).

2.2.8 Common Market for Eastern and Southern Africa (COMESA)

The Common Market for Eastern and Southern Africa (COMESA) was started in 1980 as a Preferential Trade Area (PTA) and later became a single market in 1993 (Karim & Ismail, 2007). COMESA aims to promote sustainable economic and social development for all. Increased cooperation in regional cooperation, particularly in trade, customs, infrastructure (transport and communication), science and technology, agriculture, and natural resources. According to Karim & Ismail, (2007), the main objectives of COMESA in the field of trade, in particular, are the creation of a free trade zone; the formation of a customs union; and, finally, a currency union. The COMESA free trade area (FTA) was launched in October 2000 with nine participating states, 16 years after the gradual reduction of tariffs on intra-COMESA trade (Karim & Ismail, 2007). In November 2007, 13 countries joined the Free Trade Agreement. Other member states have reduced customs duties from 10% to 80%. The region launched its Customs Union (CU) in 2009, but several member states have joined the newly formed CU.

COMESA collaborated with other regional organizations to liberalize trade. A joint working group was set up to coordinate trade liberalization programmes with the East African Community (EAC) and the South African Development Community (SADC), and finally, the COMESA-EAC-SADC tripartite free trade agreement was completed (Makochekanwa et al., 2010).

2.3 Theoretical Framework

The theoretical link between trade intensity and trade potential to improve trade is provided in a brief exposition. It is argued that the above-mentioned contribute significantly to trade. The section discusses the different models that answer the research objectives, such as the stochastic frontier gravity model, the general gravitational model, and the trade intensity index used in previous research.

2.3.1 Trade Potential

The stochastic frontier gravity model defines a trade frontier and justifies its use as a tool for calculating trade potential. The gravity model estimates an expected volume of trade between country pairs as the term "trade potential." They then gauge how far real trade exceeds or falls short of prospective commerce. The word "trade potential" is given a new interpretation in this context. Instead of the average as it was previously used in gravity model analysis, trade potential is now thought of as the maximum trade that can be realized. The frontier, as described in the product literature, describes trade potential and can be used to estimate what trade would be in the hypothetical case of the most frictionless and free trade possible under the current global conditions (practically speaking, the estimate of the frontier is based on the best practicable "trade technologies") (Armstrong, 2007).

Given that empirical trade gravity models have theoretical underpinnings whereas the models of social indicators do not, the stochastic frontier analysis applied to the gravity model may be more appropriate than its application to evaluating aggregate social efficiency. Therefore, rather than using a social indicator model, it could be more acceptable to impose and extract a hidden "inefficiency" feature (Armstrong, 2007).

Ravishankar and Stack (2013) Analyse the scores for each bilateral pair of nations included in the recommended stochastic frontier formulation in terms of trade efficiency. The one-sided term has a zero value when the inefficiency term is reduced to the random noise component, making the maximum trade level and actual trade level coincide. The study further discovers that a non-zero value for the inefficiency term, which indicates that actual trade differs from frontier estimates and so offers room for more trade integration, is more realistic. Then, for each bilateral pair, point estimates of technical efficiency (TE) are obtained. Low-efficiency ratings show real trade is diverging from frontier projections, indicating room for more trade integration, while high-efficiency scores indicate commerce between two countries is near to reaching their full trade potential.

2.3.2 Gravitational Model

The model of gravity is one of the most important experimental methods in international trade. It began with Newton's law in physics, where the force of gravity between two objects is equal to the product of their masses divided by the distance between them (Yotov, Piermartini, & Monteiro, 2016). Anderson (1979) was the first to attempt to provide a theoretical argument for preferences and objects based on the constant flexibility of the gravitational model (CES). These estimates conclude that countries use at least some of all commodities in another country, regardless of price (Yotov et al., 2016). Therefore, in balance, all countries participate in international trade, and all goods is done in such a way that national income is the sum of domestic and foreign demand for goods produced by each country. That is why big countries export more and import more.

Anderson & van Wincoop (2003) developed a theoretical model of gravity for consumers based on the homothetic benefits that are approximated equal to the constant flexibility of the alternative (CES). Consumer efficiency is enhanced by the excessive use of a particular product or the use of different products. On the production side, the Anderson-van Winkup model offers each company a unique product with high profits, which is why consumers enjoy different products from different countries.

Shepherd (2013) demonstrates that this model is capable of providing an experimental explanation of international trade and uses a set of equations to predict trade between the two countries on a bilateral basis. Unlike most other theories, the model seeks to define the volume of trade but not the structure of the trade. According to Shepherd (2013), economic dimension and distance between nations are important factors that determine the patterns of trade across national borders. According to this model, large economies have a higher risk of producing goods and services for domestic use and exports than small economies.

Furthermore, the distance or geographical location between countries or markets affects the import and export prices of products (Verter, 2015b). In the equation, the variables that are almost always used as a factor in the flow of exports from country I (exporting country) to country II (importing country) are national income (GDP and GNP), and there are variables as an alternative to distance to transportation costs.

The country's variable national income is expected to have a positive correlation with the volume of exports from country I to country II. This is because the higher income in the importing country forces its consumers to buy more than all goods, including the goods of the country itself. On the other hand, it is a distance variable that negatively affects exports, as long distances from country I to country II reduce exports (Kabir, Salim, & Al-Mawali, 2017). Sometimes other variables are added, such as the population of the exporting and/or importing country (for larger market sizes and thus potentially large savings).

Recent attempts to make theoretically sound equations of gravity have revealed errors in the study of the model of gravity. In order to conduct reliable and robust research, these errors and their elimination methods play a key role in the development of a gravitational model for the study of commercial flows of meat products (Martínez-Zarzoso, 2013). The first set of errors was related to data processing methods and their subsequent statistical effects on evaluation results. These errors are identified as gold, silver, and bronze, respectively (Martínez-Zarzoso, 2013).

Traditionally, the gravity equation uses the natural logarithm of GDP and other variables as an alternative to import and export factors and recalls the terms of multidimensional resistance (Martínez-Zarzoso, 2013). However, the discounted Multidimensional Resistance Term (MRT) is associated with commercial costs and leads to biased assessment. Gold medal errors can be avoided when checking cross-sectional data, including dummy import variables and MRT proxies. In panel data applications, the researcher will need to include time variables and use random effect estimators when estimating critical time variables, such as distance between business partners (Martínez-Zarzoso, 2013).

Silver medal error: The second most common error is found in traditional gravity models when researchers use the average value of imports and exports as a dependent variable (Martínez-Zarzoso, 2013). The theoretically based model of gravity assumes that trade should be considered separately, as an export from country A to country B in time t or an export from country B to country A in time t (Martínez-Zarzoso, 2013). The researcher should then choose import or export as a dependent variable, not an average of both.

Bronze medal error: The third error is the reduction in trade and GDP figures through the price index. The gravitational equation is a function of the cost function that allocates nominal GDP to nominal imports. Although GDP decline indicators are easy to use, very few countries have real trade price indicators. Therefore, incorrect degradation of import or export data using national price indicators leads to deviations through incorrect correlation. However, it should be noted that the effect of national influence will remove the defect of the bronze medal. Therefore, if the researcher corrects the error in the gold medal, the error in the bronze medal is automatically eliminated (Kareem, 2014).

2.3.3 PPML Model Specification

In line with the limitations of the general gravity model, it was clear that the log- linearized model was not an appropriate model for the current study. The alternative approach to the estimation of log- the linearized model, then lies in the direct estimation of the multiplicative form of the gravity equation using

Poison Pseudo Maximum Likelihood (PPML). The specification of the multiplicative gravity model used in this study is as follows;

$$.\mathrm{trade}_{\mathrm{ijt}} = \beta_0 \mathrm{GDP}_{\mathrm{it}}^{\beta 1} \mathrm{GDP}_{\mathrm{jt}}^{\beta 2} \mathrm{Distance}_{\mathrm{ij}}^{\beta 3} \mathrm{P}_{\mathrm{it}}^{\beta 4} \mathrm{P}_{\mathrm{jt}}^{\beta 5} \mathrm{EXCH}_{\mathrm{it}}^{\beta 6} \mathrm{FDI}_{\mathrm{it}}^{\beta 7} \exp(\mathrm{B}_8 \mathrm{COMESA} + \mathrm{B}_9 \mathrm{SACU} + \mathrm{B}_{10} \mathrm{BORDER} + \mathrm{B}_{11} \mathrm{SADC})\, \varepsilon_{\mathrm{ij}} \quad (1)$$

And thus equation (1) can be written as an exponential function;

$$\mathrm{trade}_{\mathrm{ijt}} = \exp(\beta_0 + \mathrm{B}_1 \ln\mathrm{GDP}_{\mathrm{it}} + \mathrm{B}_2 \ln\mathrm{GDP}_{\mathrm{jt}} + \mathrm{B}_3 \ln(\mathrm{distance}_{\mathrm{ij}}) + \mathrm{B}_4 \ln\mathrm{P}_{\mathrm{it}} + \mathrm{B}_5 \ln\mathrm{P}_{\mathrm{jt}} + \mathrm{B}_6 \ln\mathrm{EXCH}_{\mathrm{it}} + \mathrm{B}_7 \ln\mathrm{FDI}_{\mathrm{it}} + \mathrm{B}_8 \mathrm{COMESA} + \mathrm{B}_9 \mathrm{SACU} + \mathrm{B}_{10} \mathrm{BORDER} + \mathrm{B}_{11} \mathrm{SADC}) + \varepsilon_{\mathrm{ij}} \quad (2)$$

Table 2.1 Summary of variables definitions

Symbols	**Descriptions**
$\mathbf{Trade_{ij}}$	Represents the value of the total bilateral trade (exports plus imports) in meat products between country i and country j, in SADC region, in year t
$\mathbf{GDP_{it}}$	Namibia gross domestic product
$\mathbf{GDP_{jt}}$	Importing country's gross domestic product
$\mathbf{Distance_{ij}}$	Distance between Namibia with its trading partners
$\mathbf{P_{it}}$	Namibia population
$\mathbf{P_{jt}}$	Importing country's population

2.3.4 Stochastic Frontier Model

Aigner et al. (1977) and (Meeusen & van Den Broeck, 1977) simultaneously introduced the Stochastic Frontier Analysis (SFA) based on technical inefficiency. Stochastic frontier analysis (SFA) refers to a body of statistical analysis techniques used to estimate production or cost functions in economics while explicitly accounting for the existence of firm inefficiency. The operative word in this definition is inefficiency, which implies producers may behave sub-optimally in their decisions to maximize or minimize some objective function, for instance, profits, production, revenue, and or costs. The intellectual underpinnings of inefficiency in economics can be traced to the writings of John Hicks (1938), who argued that monopolists possess motivations other than those of pure profit maximization; these motivations may lead to suboptimal production.

The model used in this study emanates from The basic gravity model states that the GDP of each nation has a positive impact on commerce while the distance has a negative impact (Chaney 2013; Linnemann 1966; Tinbergen, 1962). International trade flows are described by the gravity model as a log-linear function of income and geographic distance. It asserts that distance has a negative impact on bilateral trade and that income has a positive influence.

The gravity equation was first calculated by Anderson (1979) using a model of product differentiation, and Bergstrand (1990) used monopolistic competition models to study the microeconomic underpinnings of trade. The gravity model was supported by Helpman and Krugman (1985) on the grounds of increasing returns to scale and a market for differentiated products. Helpman (1987) drew a connection between the monopolistic competition model and the gravity model based on research on 18 industrialized nations. Later, Deardorff (1998) showed that a wide range of trade models, including the Heckscher-Ohlin model, the growing returns to scales model, and the Ricardian model, were consistent with the gravity model. According to some experts, the Heckscher-Ohlin model and growing returns to scale are the only two key hypotheses that adequately explain why the gravity equation works (Evenett & Keller, 2002).

However, Anderson and van Wincoop (2003) claimed that because prior gravity model estimation results did not take into account multilateral resistance considerations, they could result in erroneous inferences. By including the variable resistance elements, they created a model that was more reliable and effective, and they used it to solve the infamous "McCallum border conundrum." As a result, the gravity model has become a "workhorse" for the analysis of global trade (Head & Mayer, 2014).

Technical inefficiency occurs when structural problems and market imperfections cause firms or countries to produce below their attainable output. However, with the help of the Stochastic Frontier models, over time, firms or countries can catch up to their preferred output when they become less inefficient (Mastromarco, 2008). Stochastic frontier models allow the analysis of technical inefficiency in the framework of production functions. Production units are assumed to produce according to common technology and reach the frontier when they produce the maximum possible output for a given set of inputs. Inefficiencies can be due to structural problems or market imperfections and other factors that cause countries to produce below their maximum attainable output. Over time, production units can become less inefficient and catch up to the frontier (Kutlu et al., 2019). It is also possible that the frontier shifts, indicating technical progress. In addition, production units can move along the frontier by changing input quantities. Finally, there can be some combinations of these three effects. The stochastic frontier method allows decomposing growth into changes in input use, changes in technology, and changes in efficiency, thus extending the widely used growth accounting method.

Ravishankar and Stack, 2013) used the stochastic frontier model to examine the trade performance of the new European Union (EU) member countries over the period 1995–2022. The Stochastic Frontier Model was used in this paper to identify the efficiency of trade integration relative to maximum trade levels. The study results indicate that efficiency scores across 18 European countries show a high degree of trade integration, with the new members achieving almost two-thirds of frontier estimates over the above-mentioned period. The stochastic frontier results also show that bilateral scores are affected by the trading regime and membership in regional trade agreements, as well as historical, geographical, and economic variables. However, after comparing these efficiency scores with those before Brexit, the study found that high-efficiency scores were recorded early on before the financial crisis (Ravishankar & Stack, 2013).

2.3.5 The limitations of the Stochastic Frontier Model

The majority of stochastic frontier models are intended to estimate the average technical efficiency of all firms. An examination of stochastic frontier analysis in economics. The use of existing methods, in particular, may result in the implicit introduction of strong, possibly irrelevant assumptions that are not empirically validated. This is very likely to result in an incorrect quantification of statistical evidence strengths in favour of certain hypotheses about technology or inefficient processes. As a result, consequences such as distorted inference about structural properties of the analysed processes or spurious detection of non-existent phenomena are likely (Nguyen, 2020).

However, as Makieła and Mazur(2020), point out this model can be problematic due to extremely poor identification. That is, after truncation (at zero), multiple combinations of the two parameters that govern this distribution location and scale can result in very similar shapes. SFA has traditionally assumed that the random symmetric disturbance (i.e., observation error) is normally distributed. However, in practise, this may be too restrictive, particularly in the presence of outliers or sample heterogeneity (not only in SFA).

As a result, methods that fail to account for specific, non-typical random properties of actual observables may result in inaccurate structural inference on determinants influencing potential quantity as well as identification of the factors driving inefficiency. Furthermore, existing inference methods frequently produce results that can be misinterpreted because they fail to account for alternative formulations with nearly the same explanatory power. The issue is closely related to that of poor identification (Makieła & Mazur, 2020).

According to (Rashidghalam et al., 2016) when they conducted a study were by they did a comparison of panel data models in estimating technical efficiency and one significant disadvantage of this method is that individual heterogeneity cannot be distinguished from inefficiency. Another potential issue with the fixed-effects model and the random-effects is the time-invariant assumption of inefficiency. Individual effects are interpreted as inefficiency; however, the time-varying pattern of inefficiency is the same for all individuals; thus, the problem of inseparable inefficiency and individual heterogeneity persists. Paul and Shankar (2020), argues that the inefficiency effect and the time-invariant firm-specific effect are distinct and should be estimated separately. Thus, empirical research is hampered by a model's inability to estimate individual effects in addition to the inefficiency effect.

2.3.6 Limitations of the Gravity Model

The gravity model cannot process zero-valued trade flows since the logarithm of zero is undefined. To address the limitations of the gravity model, the Poisson Pseudo-Maximum Likelihood estimation was adopted for this study.

How to solve the problem of zero trade flows between the two countries in a year has been a matter of discussion in the literature (Martin & Pham, 2020). The problem emanates from the fact that the standard method of estimating the gravitational model is to obtain logarithms and estimate its log-linear version (Martin & Pham, 2020). Therefore, the log of zero is undefined; zero trade flows are excluded from the estimate. Traditionally, three alternative approaches have been used to combat zero trade: (i) reducing the pattern by eliminating zero trade observations; (ii) adding a small constant value to the trade value before applying the logarithms; or (iii) level model evaluation (Martin & Pham, 2020).

If the zeros are distributed in a manner, the first methodology is correct. For instance, if the zeros are random missing data or random rounding errors, The intuition for this is that these zeros are not informative. Therefore they can be dropped (Krisztin & Fischer, 2015). However, if the zero-trade shown in the data is, in fact, zero trade or shows systematic rounding errors associated with very small trade flows, the removal of zero trade flows from the sample will result in the loss of useful information and inconsistent results. Maintaining a zero-trade flow in the sample requires the use of appropriate valuation techniques.

Strategies (ii) and (iii) are incorrect if an ordinary Least Squares (OLS) estimation method is used. First, the replacement of small values to prevent the exclusion of observations from the model is ad hoc, and there is no guarantee that they will reflect the key expected values that would lead to consistent estimates. Second, the use of OLS estimation on levels is not supported by theoretically founded gravity equations that present a multiplicative form (Krisztin & Fischer, 2015).

An alternative approach is to use the (Pseudo) Poisson maximum likelihood (ML) estimator. This method can be applied to the levels of trade, thus estimating the non-linear form of the gravity model directly and avoiding dropping zero trade. Because the Poisson gravity model is based on a log-linear function rather than a log-log function, it generates estimates Xij rather than ln (Xij), preventing underprediction of big or whole trade flows. When heteroscedasticity is present, Poisson regression estimates are both accurate and reliable. Additionally, Poisson estimators can easily incorporate observations for which the observed trade value is zero (Dadakas et al., 2020b). Thus, the ability of the Poisson model (PPML) to include zero observations made it an alternative estimation model, which this study employed.

2.3.7 Trade Intensity

The ratio of two export shares is the measure of trade intensity. The numerator represents the percentage of the study region's exports that go to the destination of interest. The share of the target destination in global exports serves as the denominator. An economy's integration into the global economy is gauged by its trade intensity. An economy is more vulnerable to external shocks in the global economy when its trade intensity is higher. In simple terms, trade intensity indicates if a country exports more of a product to a specific location than the rest of the World does on average.

Bela Balassa proposed the famous comparative advantage representing the intensity of trade more than half a century ago. Today, this index is used to reveal a country's export specialization through trade and development studies (Gnidchenko & Salnikov, 2021). The trade intensity approach is intended to acknowledge the interdependence of bilateral trade levels. This approach does not necessarily seek to answer questions about resistance effects on the total exports and imports of a country, but it has advantages, such as analyzing the nature of resistance to trade flows (Drysdale & Garnaut, 2016). Furthermore, (Drysdale & Garnaut, 2016) expanded on the indexes by developing indexes that separate the efforts of commodity composition of countries from factors influencing trade intensity.

According to Roemer (1976), there are four types of trade intensity indices, with the index of geographic intensity of trade being the one commonly used. The index of geographic intensity of trade assumes that both tangible and intangible inducements to international trade can empirically be divided into two categories: those that influence the geographical distribution and those that influence the level of total exports and imports (Kunimoto, 1977). The geographic intensity index remains the important index as it speaks directly to regional integration. In Africa, regional integration is considered the main strategy that will enable and help African countries to expand their markets, develop their small economies, reap the benefits of economies of scale, and at the same time, maximize their nation’s welfare (Elmorsy, 2015).

Wei and Tian (2018) analyzed the competitiveness and complementarity between China and Guinea's trade under the "Belt and Road" Initiative. The study made use of the trade index, Intra-industry trade index and Revealed Comparative Advantage Index to look at the bilateral trade between China and Guinea. According to the study's findings, there is still a significant gap in trade cooperation and a need for bilateral trade development. On the other hand, the two countries have strong complementarity features. The study recommends an improvement in the sharing mechanism between the two countries. Furthermore, the Guinea government should promote and invest in infrastructure construction and increase foreign investment. Furthermore, the two countries should also consider cooperative production capacity and, at the same time, be attentive to the structural transformation of trade.

Elmorsy (2015) investigated the determinants of the trade intensity of Egypt with COMESA countries. The study estimated the Trade Intensity Index of Egypt with COMESA as well as the econometric approach of the gravity model during the period of 2005–2011. The results from these approaches prove that there is potential for Egypt-COMESA trade if regional integration is advanced. The study also revealed that Egypt-COMESA trade is challenged by similarities in exports and imports of COMESA suppliers. This is why Egypt has low productivity and trade facilitation. As a result, the study suggests that different approaches are needed to improve intra-COMESA trade.

Chandran (2011) examined the trade complementarity and similarity between India and ASEAN countries. Trade indices such as the Trade Intensity Index and the Revealed Comparative approach were utilized, making use of 16 product groups to get complementarity and similarity. The trade indices revealed that there are complementary sectors and products that are available in order to improve trade between India and the ASEAN countries. The study further discovered that ASEAN countries have a comparative advantage in electrical goods, vegetable oils, agricultural products, and rubber products, while India has an advantage in food grains, chemicals, minerals, jewelry, gems, and manufacturing products.

2.4 Conceptual Framework

In the present study, the dependent variable represents the value of the total bilateral trade (exports and imports) in meat and meat preparations (sitc rev 3 00) and live animals (sitc rev 3 00). Apart from the distribution between country I (Namibia) and country j (all members of SADC), in the year t. Independent variables are Namibia's real GDP, the real GDP of importing countries, The value of all goods and services produced by an economy in a given year is reflected in real gross domestic product (real GDP), which is an inflation-adjusted measure. Real GDP is measured in base-year prices and is also known as constant price GDP, inflation-corrected GDP, or constant dollar GDP (Epaphra & Mwakalasya, 2017). The distance between exporting and importing countries. The physical distance between two or more points on a map. The distance in kilometres (KM) was calculated using Google Maps from Namibia's capital city (Windhoek) to the capital cities of all destination countries (SADC members). Furthermore, the distance or geographical location between countries or markets influences the price of product imports and exports (Verter, 2015a).

Exports of meat products are measured by the exporting country's production capacity, quality, quantity, and price of any product that is competitive and accessible to consumers. Consumption, government spending, investment, and net exports measure Namibia's GDP. Thus, once the country's GDP starts to grow, it has the opportunity to invest in new industries and increase the productivity of existing industries. High-income countries trade more, which will have a positive effect on the GDP of importers and exporters (Jafari et al., 2011).

The population of the exporting country helps to describe the limits of production capacity, while the population of the target country or the importing country serves as an indicator of market demand (Trabelsi, 2013). The large population of the exporting country is prone to the high probability of profit due to the chances of acquiring a cheap labor force for production to become larger and cheaper. On the other hand, the large population of the importing country is likely to have high demand (Trabelsi, 2013). This means that the population of exporting and importing countries is expected to have a positive impact on bilateral trade. The distance between exporting and importing countries affects the price of traded goods. Countries can set higher prices for distant importing countries than for neighboring countries. As a result, distance is inversely related to trade flows; that is, it is expected that trade will be more between adjacent and vice-versa trading partners. In addition, countries with common borders are expected to trade more with each other (Yego, 2015).

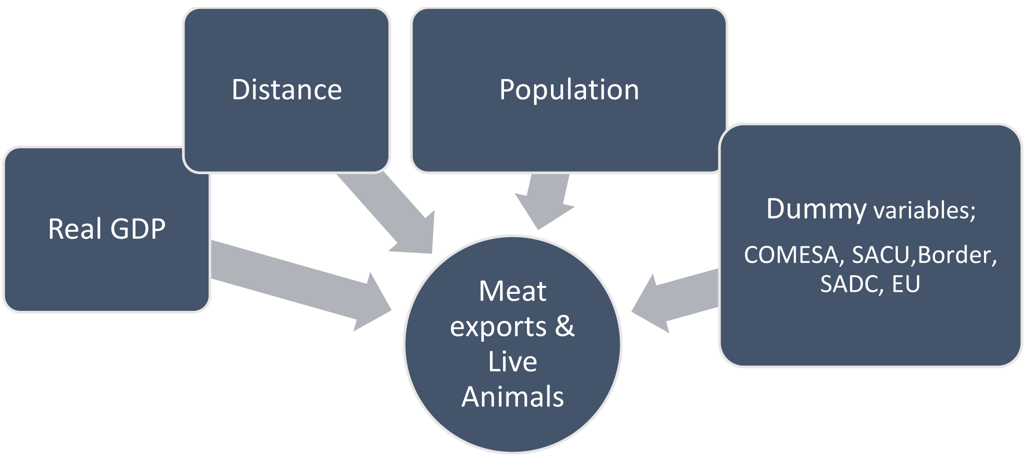

Figure 2:3 below shows the diagrammatical presentation of the independent variables and the dependent variable.

2.5 Conclusion

This chapter reviewed the theoretical and empirical literature on methodologies used to analyse the trade in meat products between Namibia and SADC countries. Trade intensity and trade efficiency was estimated. Real GDP and distance was evaluated to see how if influence the bilateral trade. The overall results obtained from the reviewed studies have shown that real GDP have a positive impact on bilateral trade. While distance have a negative impact on agricultural trade.

The gravitational model (Stochastic Frontier Model) of trade was used in the literature on agricultural products and livestock exports to study the factors affecting export flows using different determinants. Use the Stochastic Frontier Gravity Model (SFGM) to study the determinants, efficiencies, and export potential of agricultural products between two countries, Results reveal that agricultural exports between countries are determined by the economic volume and income of exporter and its importers, as well as bilateral exchange rates and distances. The stochastic frontier method allows decomposing growth into changes in input use, changes in technology, and changes in efficiency, thus extending the widely used growth accounting method. Lastly the reviewed study presentment about economy's integration into the global economy that gauged by its trade intensity. The results from study reviewed shows that an economy is more vulnerable to external shocks in the global economy when its trade intensity is higher. In simple terms, trade intensity indicate if a country exports more of a product to a specific location than the rest of the world does on average.

According to this model, large economies have a higher risk of producing goods and services for domestic use and exports than small economies. The next chapter (chapter 3) will estimate the trade intensity, use gravitational model (Stochastic frontier) to evaluate the influence of real GDP and Distance on bilateral trade between Namibia and SADC countries, and lastly estimate the trade efficiency. As the present study shows, this difference is reflected in the revised literature, which contributes to the general commercial literature by examining the main important factors of agricultural exports. Thus, this study provides comprehensive evidence for the better formulation of agricultural export policies.

Chapter 3 : Methodology

3. Introduction

This chapter describes the research methodology used in this study. It provides a research design for this study and further provides data sources and characteristics, trade intensity, and model descriptions. This chapter also draws attention to the limitations of the general gravity model, which therefore led to the use of the Stochastic Frontier Model in this study. This chapter also explains the methods used to estimate.

3.1 Research design

The study followed a descriptive research design followed by a quantitative research study focusing on the use of economic analysis. The quantitative research design was ideal for the study because it allowed the measurement of concepts and variables. According to Leedy and Ormrod, 2004), quantitative research involves either identifying the characteristics of the observed phenomenon or studying the possible correlations between two or more phenomena. Quantitative research involves measurement in terms of quantity or numbers (Blumberg & Schindler, 2014). In addition, descriptive statistics and trends for estimating the flow of meat products between Namibia and its trading partners were reviewed.

3.2 Data collection

The study used secondary data on bilateral trade (import and exports) from UNCOMTRADE, Data on real GDP came from Namibia Statistic Agency (NSA), Data on distance between Namibia and SADC countries came from Google map distances in KM from windhoek to capital cities for all SADC countries. The selection of these databases for the study was based on literature, frequent updates of data, and availability of data.

The study used panel data of the 16 SADC countries' total bilateral trade of meat and meat preparation (sitc rev 3 01) at SITC 3-didgit level and live animals (sitc rev 3 00) of SADC member state from UNCOMTRADE, distance and the real GDP for the period 2000-2020. The study period was chosen based on the data availability. The panel dataset consisted of 315 trade flow observations (rows) from 16 SADC countries, including Namibia and five variables (columns).

3.3 Analytical framework

To gain a better understand of the trade flow between Namibia and the SADC countries descriptive statistics were computed using the R studio software.

Error! Reference source not found. below illustrates the steps conducted to analyse the data on meat products trade flow between Namibia and its SADC members.

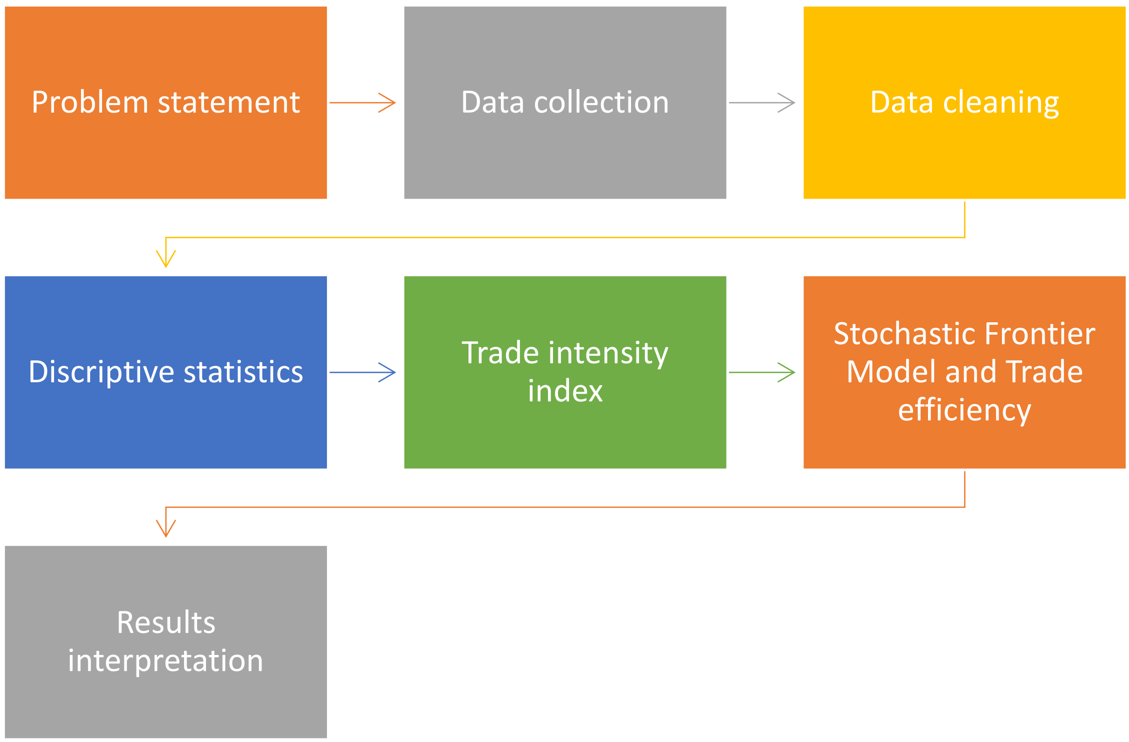

Figure 3:1 Data analysis workflow

3.3.1 Trade intensity

To analyze the extent to which Namibia is trading with SADC, the study calculated the ratio of two export shares. The numerator is the share of the destination of interest in the exports of the country under study. The denominator is the share of the destination of interest in the exports of the World. The trade intensity index (TII) is converted to percentage form, and then a simple average at the destination level is computed. To see the trajectory of trade intensity between Namibia and the trade destinations over time, a trend analysis was included.

The Trade Intensity was first discovered by Balassa in 1969. The intensity of trade measures an economy's integration into the global economy. A higher trade intensity indicates that an economy is more vulnerable to external shocks in the global economy. Trade Intensity Index (TII) was used to measure the trade intensity between Namibia and SADC member state. The index is defined as the share of one country's trade with another country, divided by the other country's share of global trade (Kojima, 1964).

The index is shown in equation 3

$$TII_{ij} = \left(\frac{X_{ij} / X_{i}}{X_{wj} / X_{wt}} \right) * 100 \tag{3}$$

Where X_{ij} is the total trade in meat products between Namibia *i* and SADC country *j*, X_i is the value of total trade in meat products between Namibia and the world, X_{wj} is the value of world trade in meat products with SADC country *j*, X_{wt} is the value of world trade in meat products. The value of TII from country j to country i with a value more than 1 (TII>1) indicates the intensity of trade conducted by country j to country i is above the average world level and indicates the country's importance in terms of intensity as a trade partner to country i. But if the value of TII from country j to country i has a value less than 1 (TII<1) it indicates that the intensity of trade made by country j to country i is below that of the average world level and indicates the country's lack of importance in terms of intensity as a trade partner to country i.

3.3.2 Stochastic Frontier Gravity Model

To measure the influence of GDP and Distance on bilateral trade between Namibia and SADC countries, the study used a gravity model. The standard gravity equation explains bilateral trade as a function of the economic size of two countries and the distance between them (Tinbergen 1962; Pöyhönen 1963). The augmented version additionally includes income per head for both countries and other trade-impeding or trade stimulating factors (Bergstrand 1989). A two-stage gravity approach to projecting countries' trade volumes is the usual route to assessing bilateral trade performance.

In the first stage, the gravity model of trade is estimated for a group of countries that best represent normal trade relations. The gravity model parameters that fit a model of a normal country A’s geographic trade patterns are used to project the expected trade flows in a country B’s direction. To assess the likelihood for future expansion or depletion of trade links between country A and country B, the trade flows predicted by the model are compared with actual trade flows. Whereas conclusions are made based on the value of more than unity, which suggests remaining potential trade growth, and the value of less unity means trade potential is exhausted. Additionally, the potential to actual trade ratios is informative to a certain degree of country A and B trade integration under normal conditions.

The second stage, trade projections, infuse empirical literature; this method was used by Baldwin 1994; Gros and Gonciarz 1996; Stack and Pentecost 2010). Operating under the assumption of full economic liberalisation, these studies define country A's trade potential in terms of average. Basically, the mean effects of trade factors are estimated, suggesting trade potential is assessed using the mean predicted values as a benchmark (Armstrong et al., 2008). The predictive ability of the gravity model, nevertheless, declines as the year of the inserted values increasingly departs from the historical average.

The standard gravity model has limitations, such as the trade cost of a third party can affect the trade between two partners, etc., to mitigate against these limitations, the study adopts a stochastic gravity model. The model was developed by Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck (1977) to measure production efficiency in production economics to measure production.

It is imperative to note that this approach advocates that the production process can be influenced by two distinct, economically distinguishable disturbances, therefore the error term should represent two components: the production inefficiency component and other random disturbances. The general form of the stochastic frontier gravity equation can be estimated as follows:

$$Y_i = f(X_i\beta + V_i - U_i) \qquad 4$$

Where Y_i denotes the output for the i^{th} country in the t^{th} time period, X_i denotes the $(1 + k)$ vector whose values are functions of inputs for the i^{th} country in the i^{th} time period, β is $(1 + k)$ vector of unknown parameters to be estimated, and V_i are the error components of random disturbances, distributed $i.i.d. N\ (0, \sigma_v^2)$ and independent from U_i.

U_i are non-negative random variables associated with the technical inefficiency and can be expressed as follows:

$$U_{it} = \{\exp[-\eta(t - T)]\}\, U_i \qquad 5$$

Where, η is an unknown scalar parameter to be estimated, which determines whether inefficiencies are time-varying or time invariant, and U_i is assumed to be $i.i.d.$ and truncated at zero of the $N\ (\mu, \sigma_u^2)$ distribution.

If η is positive, then $-\eta(t-T)=\eta(T-t)$ is positive for $t<T$ and so, $exp\ [-\eta(t-T)]>1$ which implies that technical inefficiencies decline over time. If η is zero, technical inefficiencies remain constant; if it is negative, they increase over time. The stochastic frontier model (4) was followed here to measure the efficiency of trade integration relative to maximum trade levels and trade performance of the SADC member countries over the period 2000-2020.

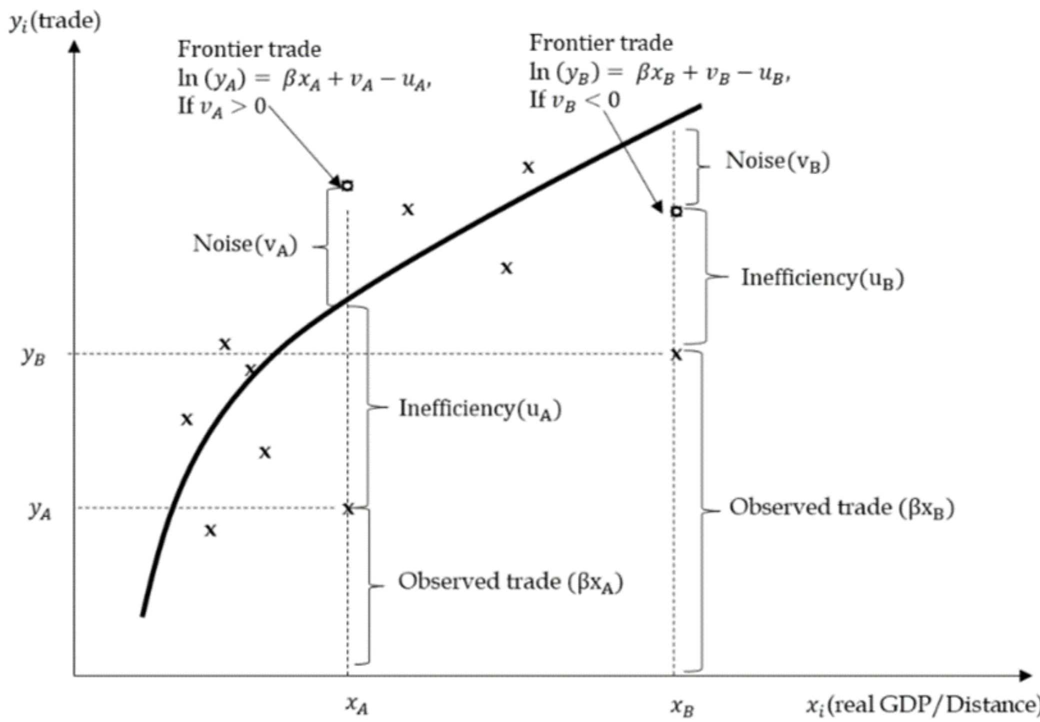

Figure 3:2 The analytical framework of stochastic frontier model

The log likelihood ratio test was used to estimate the parameters of the stochastic frontier model. The test assumes that both log-likelihoods are either negative or positive, opposite sign results in the stopping of the test. The interpretation is that the model with a greater negative log-likelihood (closer to zero) or greater positive log-likelihood offers a better fit to the data.

The log likelihood test to estimates for the parameters of the stochastic frontier model was done with the computer program R Studio.

The methods used to estimate the regression model using panel data that the study used are as follows: pooled effects model (ignores the panel structure and assumes observation-specific inefficiencies), fixed effects model (assumes country specific and time-invariant inefficiencies), and random effects model (assumes country specific and time-variant inefficiencies) approach.

Pooled effects approach is the most simply of the three approaches, as it combines only time series data and cross-section data. In this model time and individual dimensions are not considered, so it is assumed that the behaviour of cooperate data is the same in various periods. This method used the least squares technique to estimate or fit the panel data model.

The form of the panel data regression equation is as follows:

$$y_{it} = \alpha + \beta' X_{it} + \varepsilon_{it} \qquad 6$$

For i = 1, 2, ..., N and t = 1, 2, ..., T.

Where N is the number of individuals or crosses is sections, and T is the number of time periods. From this model N multiplied by T can generate an equation, that is equal to T equation of cross and as much N equation coherent time or time series.

Model 1: Using equation 6, is a pooled effects model (ignores the panel structure and assumes observation-specific inefficiencies). Appendix 1 shows the model's results that the estimates for the coefficients of real GDP and distance were all statistically significant, at least at the 5% level. The positive and significant real GDP coefficient implies that if both Namibia's real GDP and its partner country's real GDP increase by 1%, Namibia's trade value will increase by 1.5%. However, findings from this model showed a positive coefficient for distance. This result implied that the trade value of Namibia increased with its partner countries by 73.6% if the distance between them increased by 1km. The results obtained in this model for the distance variable were inconsistent with the expected signs in gravity theory. The mean efficiency was 19.8% for the model. The study, therefore, ran the second model, which is a fixed effects model (assumes country specific and time-invariant inefficiencies).

Model 2: Using equation 7, Error Components Frontier from Battese & Coelli (1992) with time-invariant inefficiencies. Appendix 2 represents the results from model 2 and reveals that the estimates for the coefficient of real GDP were positive and statistically significant. The positive and significant real GDP coefficient implies that if Namibia's real GDP and its partner country's real GDP both increase by 1%, Namibia's trade value will increase by 1.8%. The study established that the estimate for the coefficient distance was significant at a 5% level. The Model 2 mean efficiency improved to 21.7% from 19.8% in Model 1. However, the estimate for distance was negative, as expected by the gravity theory.

The fixed effect approach model assumes a difference between individuals, which could be accommodated from a different intercept.

Fixed effects assume that differences between individuals (cross-section) can be accommodated from a different intercept. To estimate the Fixed Effects Model with different intercept between individuals, the dummy variable technique is used. Such estimation models are often referred to as the Least Squares Dummy Variable technique or abbreviated LSDV.

The regression equation of fixed effects model panel data is as follows:

$$y_{it} = \alpha_i + \beta' X_{it} + \varepsilon_{it} \qquad 7$$

for i = 1,2, ..., N N and t = 1,2, ..., T

Where N is number of individuals or cross sections and T is the number of time periods.

The Random effects (assumes country specific and time-variant inefficiencies) approach, this model will estimate panel data where interference variables may be interconnected between time and between individuals. In the Random Effects model, the difference between intercepts is accommodated by the error terms of each company. The advantage of using the Random Effect model is to eliminate heteroscedasticity. This model is also called the Error Component Model (ECM) or Generalized Least Square (GLS) technique. In principle, the random effects model is different from the pooled effects and fixed effects, especially since this model does not use the principle of ordinary least squares but uses the principle of maximum likelihood or general least squares. It should be noted that the inefficiency is now time-variant.

The form of the panel data regression equation is as follows:

$$y_{it} = \alpha + \beta' X_{it} + u_i + \varepsilon_{it} \qquad 8$$

For i = 1,2, ..., N and t = 1,2, ..., T

Where N is number of individuals or crosses sections, T is the number of time periods. ε_{it} is the residual as a whole where the residual is a combination of cross section and time series, U_i is the individual residual, which is the random character of unit observation i^{th}; it remains at all times.

Error Components Frontier (Battese & Coelli 1992) with time-variant efficiencies

Efficiencies Error Components Frontier (see Battese & Coelli 1992) Inefficiency decreases the endogenous variable (as in a production function). The dependent variable is logged Iterative ML estimation terminated after 21 iterations: log-likelihood values and parameters of two successive iterations are within the tolerance limit. Appendix 3 shows the results of this model show that the estimates for the real GDP coefficient are statistically significant, at least at the 5% level. The positive and significant coefficient of real GDP implied that the trade value of Namibia increased with the partner countries if the real GDP of Namibia and the real GDP of its partner country increased. Similarly, with time-invariant inefficiencies, the study determined that the distance coefficient was statistically significant at a 5% level. The choice of model in panel data must be based on information about the individual-specific components and the homogeneity of the independent variables (Gebresilassie & Woldu, 2020).

Based on the output of the least square method, the four models were compared using the likelihood ratio test. Model one is a pooled effects model (ignores the panel structure and assumes observation-specific inefficiencies) compared with model two fixed effects model (assumes country specific and time-invariant inefficiencies). The results show that model two is better fitted compared to model one (Appendix 4). The results further show that model two, when compared to model three random effects model (assumes country specific and time-variant inefficiencies), is better fitted (Appendix 4). Model two compared to model four OLS model (assumes no inefficiency) and results show that model two is better than model four (Appendix 4). The fitted model for this study is model 2: is a fixed effects model (assumes country specific and time-invariant inefficiencies) (Appendix 1).

Chapter 4 : Results and Discussions

4. Introduction

This study aimed to assess the trade volumes in meat products between Namibia and fellow SADC countries. Export market intelligence is crucial to harness the opportunities that the AfCFTA offers, especially in regional economic blocks such as SADC. Export market intelligence is concerned with identifying potential markets, analysing the trade flows, evaluating the potential of increasing trade flows, and understanding the determinants of trade and the relationship thereof, among other things. Based on the literature reviewed, more information needs to be provided on these market intelligence elements. Without such information, strategies for harnessing the trade opportunities offered by the AfCFTA will not be effective. The study has filled this gap in the literature by conducting an empirical analysis of the trade in meat products between Namibia and SADC countries.

This chapter presents the results of trade intensity as explained in chapter 3. It mainly describes the real GDP and Distance's influence on bilateral trade between Namibia and SADC countries. The applied stochastic frontier model (Error Components Frontier with time-invariant inefficiencies) to determine the significance of variables within the model. Based on the output of the least square method, the four models were compared using the likelihood ratio test.

The chapter also presents the results of the descriptive statistics, the distribution of Namibia's meat trade volume, and the trade intensity of Namibia and its trade partners. Correlation analysis was used to examine the relationship between the dependent variable trade and its independent variables. The economic potential of different meat products between Namibia and SADC countries was analysed using the Technical Efficiency Effects Frontier (Battese & Coelli 1995) (efficiency effects model with intercept). In addition, it provides Namibia's mean technical efficiency.

4.1 Descriptive Statistics

The table below shows a distribution of the total trade value (Export plus import), mean, minimum and maximum meat trade values between Namibia and SADC countries. The dataset was downloaded from the UN COMTRADE website.

Table 4.1 Descriptive statistics 2000-2020

Country	**Total**	**Mean**	**Maximum**	**Minimum**
South Africa	$1.2B	$205.3M	$274.3M	$103.5M
Dem. Rep. of the Congo	$84.6M	$14.1M	$25.9M	$4.5M
Botswana	$28.6M	$4.8M	$5.6M	$3.6M
Angola	$18.8M	$3.1M	$4.3M	$1.3M
Zimbabwe	$15.0M	$2.5M	$3.5M	$1.2M
Zambia	$3.5M	$589.0K	$1.3M	$78.5K
Malawi	$23.0K	$3.8K	$23.0K	$0.00
United Rep. of Tanzania	$13.5K	$2.2K	$12.8K	$0.00
Seychelles	$9.3K	$1.6K	$9.1K	$0.00
Mauritius	$6.2K	$1.0K	$6.2K	$0.00
Mozambique	$45.00	$7.50	$45.00	$0.00
Lesotho	$15.00	$2.50	$15.00	$0.00
Comoros	$0.00	$0.00	$0.00	$0.00
Eswatini	$0.00	$0.00	$0.00	$0.00
Madagascar	$0.00	$0.00	$0.00	$0.00

Table 2 above indicates that Namibia traded, on average, mainly with South Africa, with a total trade value of $1.2 billion of meat products between 2000 and 2020, while the minimum was at $103.5 million and the maximum was $274.3 million. The study findings revealed that the second largest trade partner of Namibia in meat products from 2000 to 2020 was the Democratic Republic of Congo, with a total trade value of $84.6 million, followed by Botswana ($28.6 million), Angola ($18.8 million), Zimbabwe ($15 million) and Zambia ($3.5 million). As depicted in the table, the rest of the other countries traded less with Namibia, with the lowest being the Comoros, Eswatini, and Madagascar.

4.2 Distribution of Namibia meat trade volume

This section focuses on the Namibia meat trade volume distribution between 2000 and 2022. Results are shown in Figure 4:1 below.

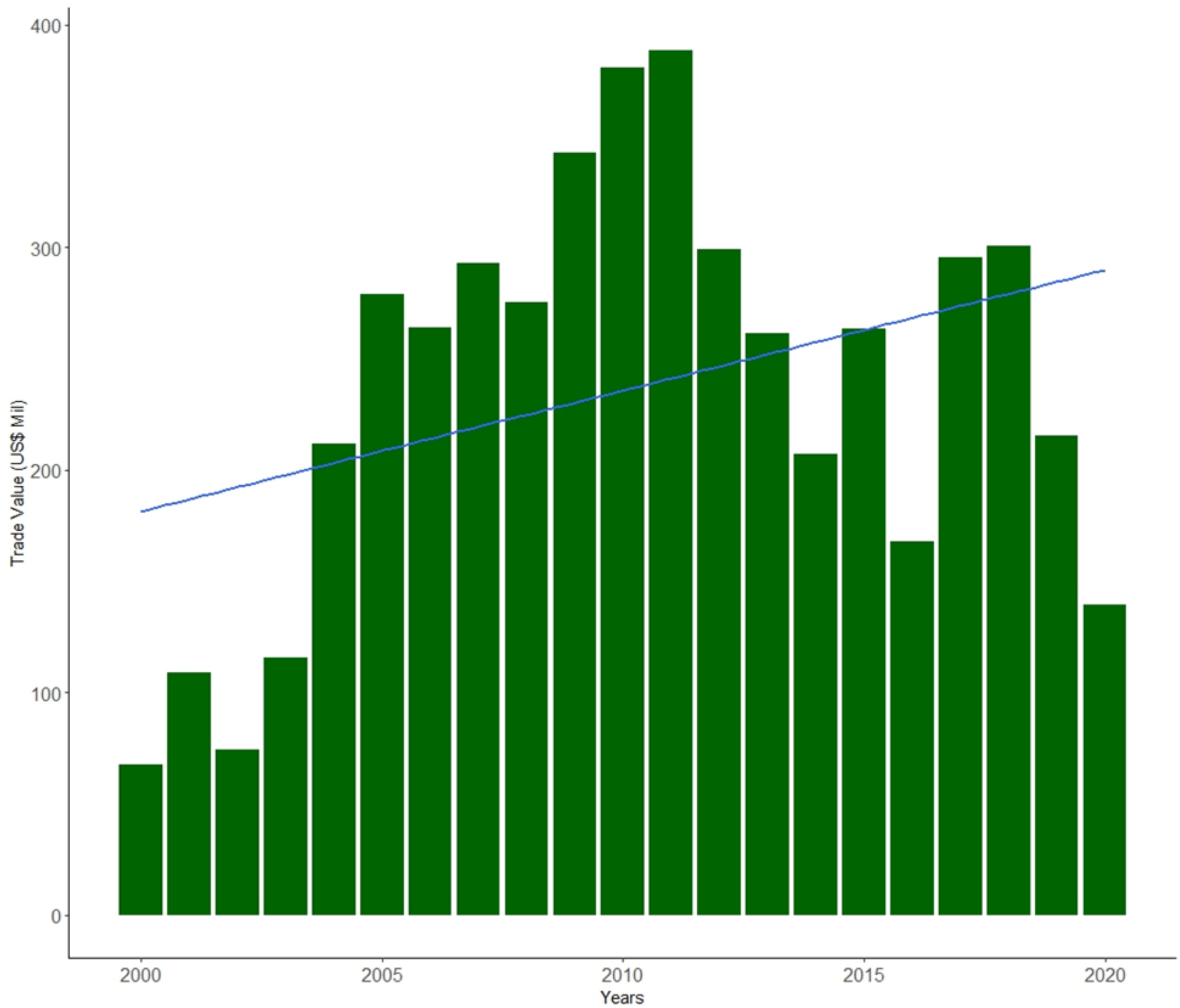

Figure 4:1 Distribution of Namibia meat trade from UNCOMTRADE's data set 2022 ***(Source:*** *own computation)*

The study's findings revealed that from 2000 to 2003, Namibia's meat trade value was below $150 million. The policy could be impacting industries like the sheep scheme, leading to the Abbatoir closure and declining sheep in the country. Farmers diversify to other profitable forms of farming, like games. From

2004 until 2011, Namibia’s meat trade value experienced an increase of approximately $400 million, with the peak year being 2011. The goat sector has been traditionally live exports due to the demand in rituals of many cultures, but a decline could also be what happened in SA - who are the consumers. Results from the study further indicate that, since 2011, Namibia's meat trade value has gone below $300 million and remained below that up until recently. In the recent year, 2020, Namibia experienced low levels in meat trade value, especially after being hit by the adverse effects of the COVID-19 pandemic, which brought the trade value close to the 2004 level. Namibia A2 sheep prices increased by 9.03%, but slaughter numbers are currently uneconomic due to the drought that has plagued the southern parts of Namibia in recent years. Forage production data for the eastern and northern areas needed more and thus was not shown. Included are the seasons 2015/16, 2016/17, 2017/18, and 2018/19. The 2018/2019 data clearly shows that production was low, resulting in the declaration of a drought-related national disaster. Findings, however, reveal that the general trend of Namibia's meat trade value has been upward since 2000. The following section outlines the findings to ascertain the distribution of Namibia's meat trade with each of the SADC countries.

4.3 Top Trading countries

This section analyses the top trading countries with Namibia in trade value. The shaded area is a confidence interval (The level of confidence is unknown, but it is reasonable to assume it is 95%), and the wider it is, the more variables vary. The straight line represents the expected value; in other words, it is known as a linear regression line. Trend analysis was conducted, and results are displayed in **Error! Reference source not found.** below.

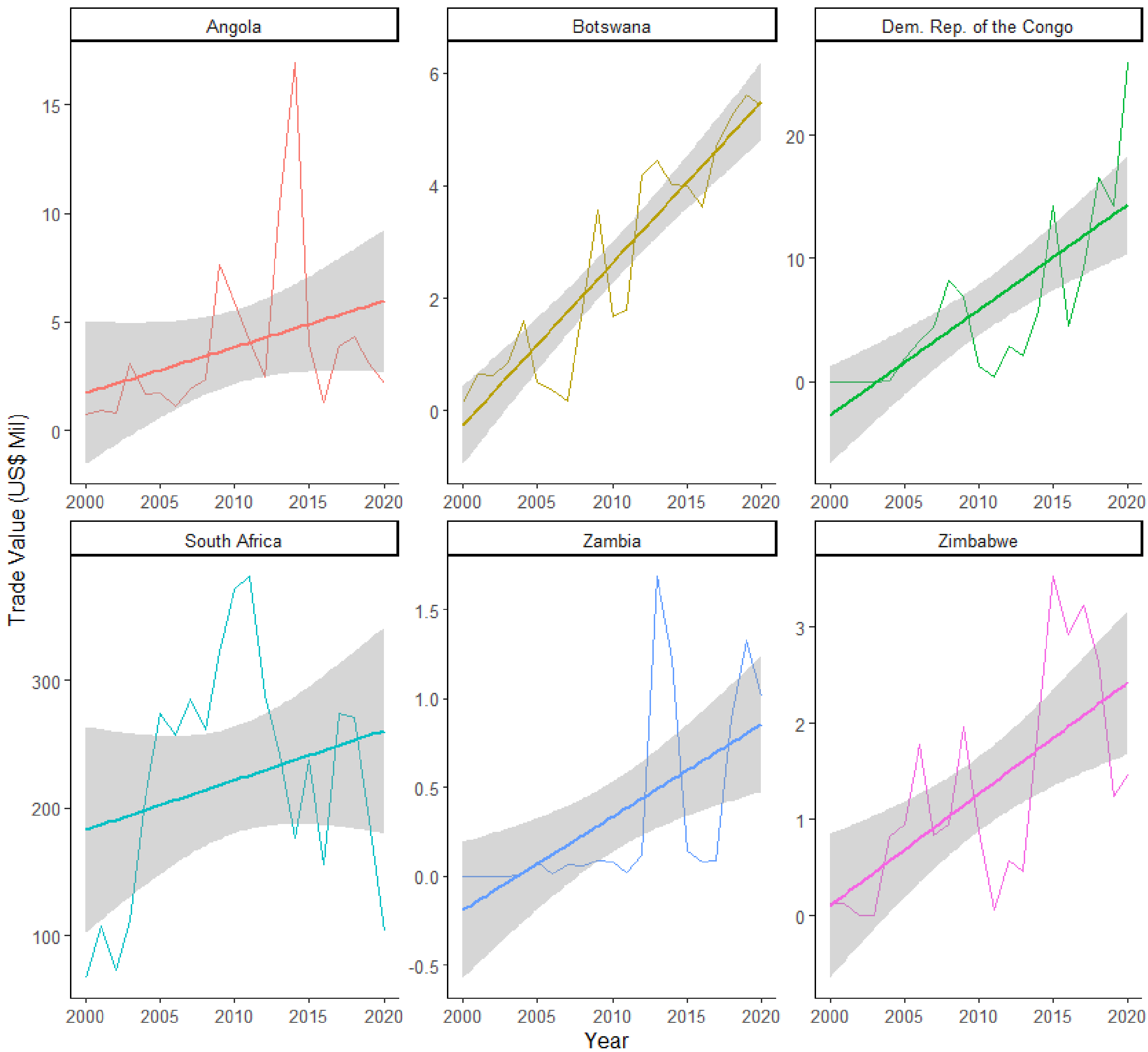

Figure 4:2 Top trading countries in meat trade value as analysed from UNCOMTRADE's data set 2022 (**Source:** own)

Error! Reference source not found. depicts a distribution of the top countries that traded meat products with Namibia between 2000 and 2020. The study's findings revealed that six top countries traded meat products with Namibia during the demarcated period. From **Error! Reference source not found.** above, Namibia experienced a consistent flow of meat trade values from Botswana and the Democratic Republic of Congo, unlike the other countries shown. The fluctuations in meat trade value were generally more between South Africa, Zambia, Zimbabwe, and Angola because the devastating drought affected all sectors and market segments, with the sheep sector suffering the most.

Results from the study also showed that there was also a disparity in peaks and depths in terms of trade value between Namibia and the countries shown in **Error! Reference source not found.**. This indicated a shift in meat trade between Namibia and its trading partners during 2000 and 2020. For Angola, the highest peak in meat trade value occurred in 2014 (over $15 million), while for South Africa in 2010, Zambia in 2012, and Zimbabwe around 2015. The peaks in trade value were therefore preceded by sharp drops in trade value, except for Botswana and the Democratic Republic of Congo, with whom Namibia maintained a constant flow in the trading of meat products.

The study also found that as of recently (2019 to 2020), Namibia has experienced sharp drops in meat trade values between South Africa, Angola, and Zimbabwe. Caused by cattle marketing decreased by 31.39%, sheep marketing decreased by 59.25%, goat marketing decreased by 24.94%, and pig marketing decreased by 5.91% compared to the first quarter of 2019. However, overall, Namibia's meat trade value trend with all its top trading countries has been up, indicating a healthy trajectory regarding trade value flows.

4.4 Number of trading events

This section outlines the number of trading events between Namibia and its SADC trading partners. Results are shown in **Error! Reference source not found.** below.

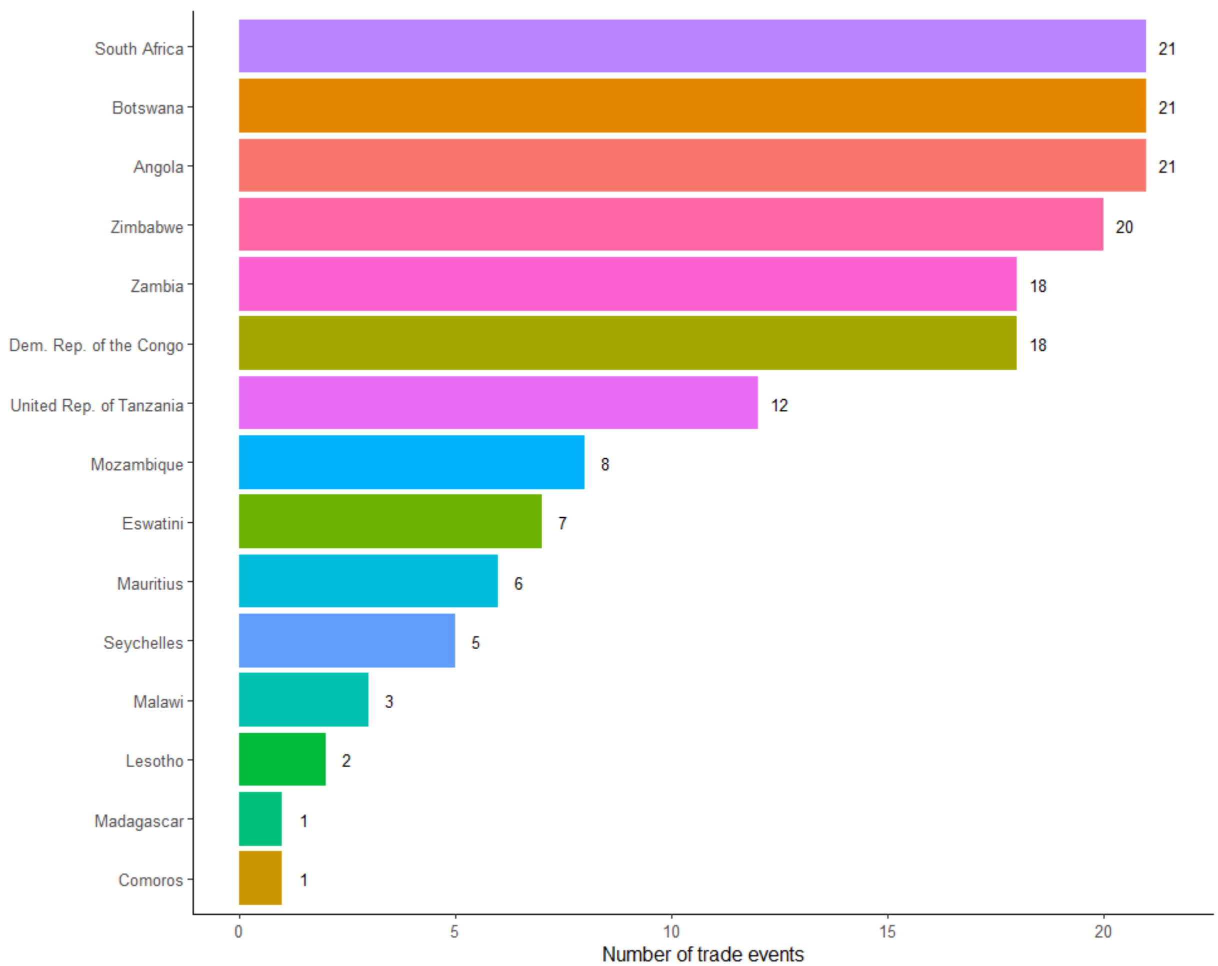

Figure 4:3 Shows the number of trade event as interpreted from UNCOMTRADE's data set 2022 **(source:** own).

Error! Reference source not found. shows the distribution of Namibia's trade events in meat products with its SADC trading partners. Results revealed that Namibia had had trade events 20 and more with Zimbabwe, Angola, Botswana, and South Africa. These were the top four countries per meat trade events from 2000–2020. The distance between exporting and importing countries affects the price of traded goods. Governments can set higher prices for distant importing countries than for neighboring countries. As a result, distance is inversely related to trade flows; that is, it is expected that trade will be more between adjacent and vice-versa trading partners. In addition, countries with shared borders are expected to trade more with each other (Yego, 2015). Findings from the study further showed that Namibia had between 10 to 20 meat trade events with Zambia, the Democratic Republic of Congo, and Tanzania. While with the rest of the countries depicted in **Error! Reference source not found.**, Namibia experienced meat trade events lower than 10. The lowest meat trade events were encountered between Namibia and Madagascar, and Comoros.

Figure 4:4 below illustrates the clusters of Namibia's trading partners in terms of frequency in meat products trade. The vertical axis indicates the trade value (TV) in exponential numbers.

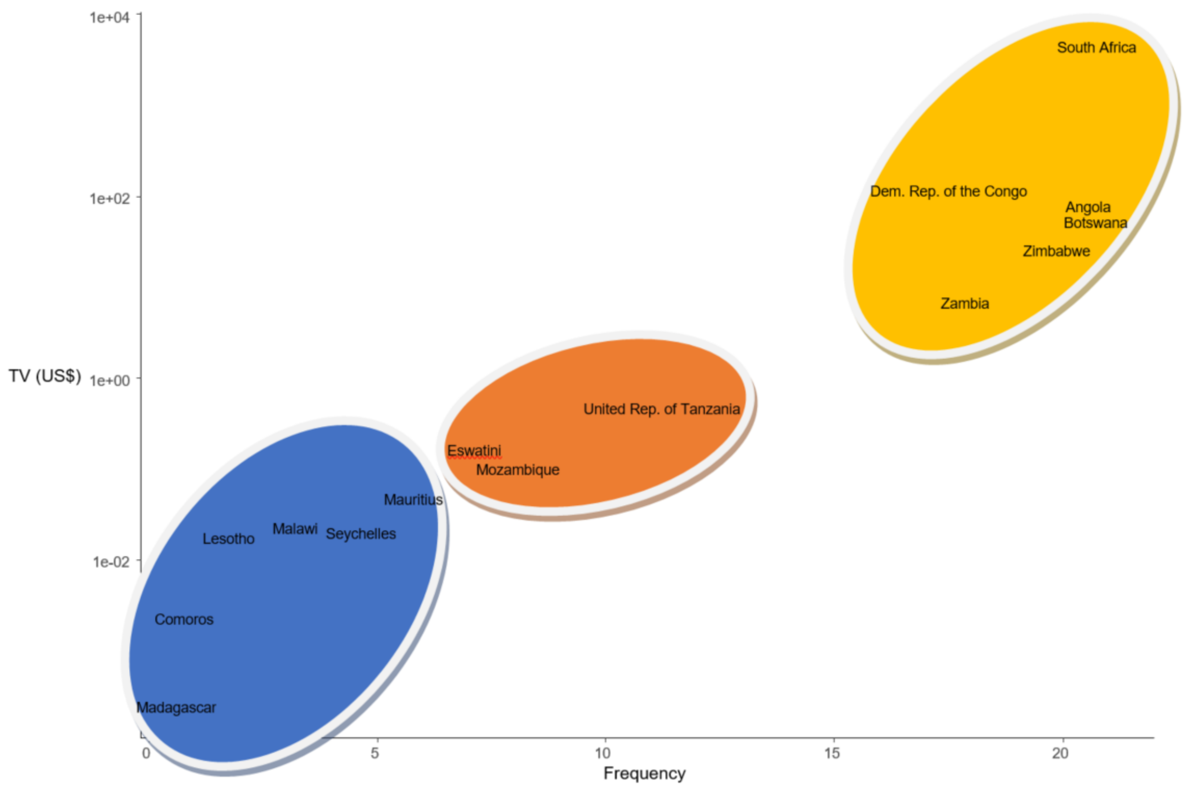

Figure 4:4 Shows clusters of top trading countries as computed from UNCOMTRADE's data set 2022 *(***source:** own).

The study established three clusters of countries with which Namibia frequently trades. The high-frequency cluster in the trade of meat products was comprised of South Africa, DRC, Angola, Botswana, Zimbabwe, and Zambia. The study established that Mozambique and Tanzania trade with Namibia at a medium level; therefore, these countries were considered to be in the medium frequency cluster. The low-frequency cluster consisted of Madagascar, Comoros, Lesotho, Malawi, Seychelles, and Mauritius.

Results from the study indicated that most of Namibia's trade value in meat products comes from trading with South Africa, DRC, Zambia, Angola, Botswana, and Zimbabwe.

4.5 Trade intensity

The study determined the intensity of trade in meat and meat products of Namibia and its SADC trade partners. The intensity of trade measures an economy's integration into the global economy. A higher trade intensity indicates that an economy is more vulnerable to external shocks in the global economy. Simply put, trade intensity indicates whether a country exports more of a particular product to a specific location than the rest of the world. According to Balassa (1969), if the value of TI is one or more, then it means there is an opportunity to increase trade between the country (i) and the world (w).

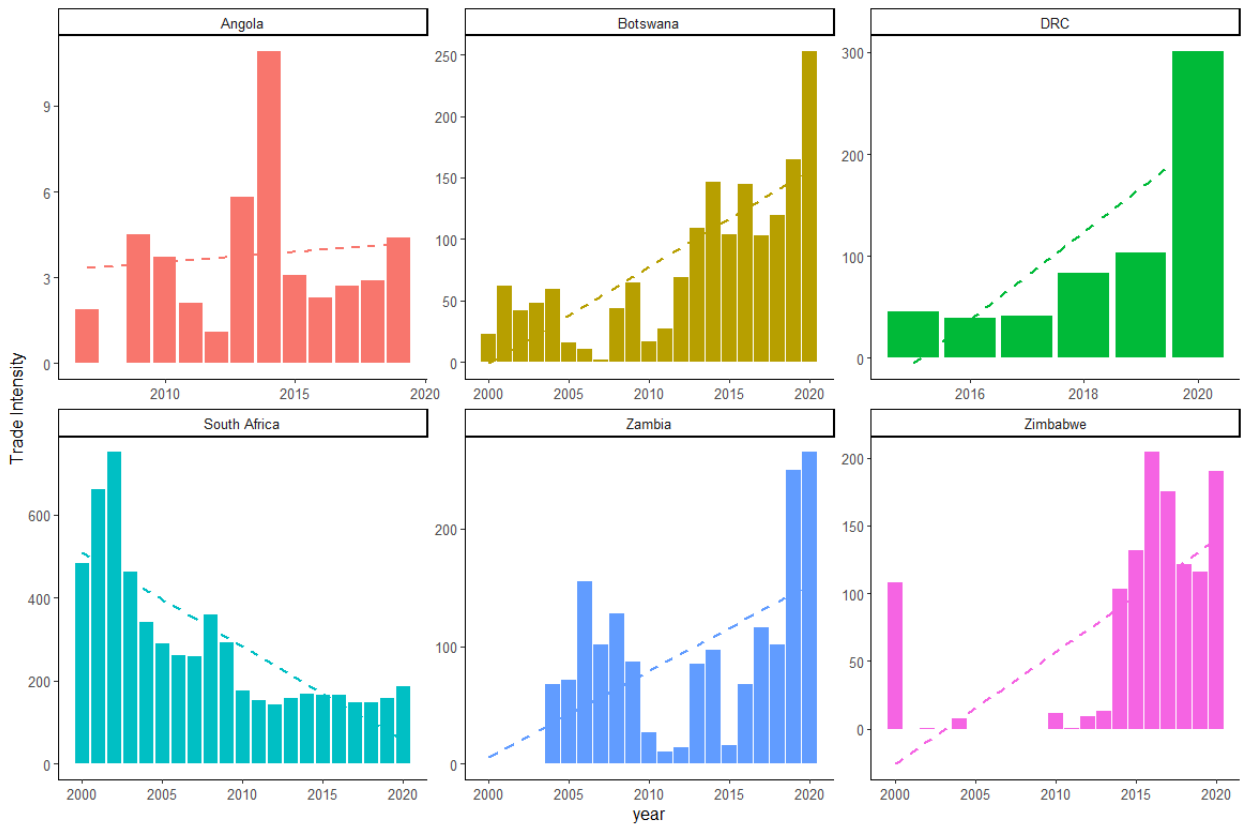

Figure 4:5 Trade intensity of Namibia and trade partners **Source:** own computation from UNCOMTRADE's data set 2022

Figure 4:5 above illustrates the distribution of trade intensity/concentration in meat products between Namibia and its top trading partners in the SADC region. The study revealed that Namibia's trade intensity trend in meat products has generally increased with Botswana, DRC, Zambia, and Zimbabwe from 2000 to 2020. Results indicate that Namibia traded highly intensively (above 200 levels) with South Africa from 2000 to 2009 before a decrease, while with Zambia, Zimbabwe, DRC, and Botswana, it has been recently (2019 and 2020). A great increase in Namibia's meat trade intensity has been noted from the DRC, where the strength of the meat products trade has surged from levels of 100 in 2019 to approximately 300 in 2020. Results from the study indicate a shift in trade concentration in meat products between Namibia and its top trading countries in the SADC region.

Further revelations from the study revealed that Namibia's trade intensity trend with Angola has been relatively low over the 21 years, although it has surged during 2013 and 2014. After that, Namibia has been trading meat products with Angola at a meager concentration rate. The study also found that Namibia's trade strength with South Africa has been low in recent years, from 2015 to 2020. Trade concentration with South Africa has ranged from 150 to 180 from 2010 until 2020. Generally, findings indicate that since 2000 up until 2020, trade concentration between Namibia and South Africa has been diminishing more strongly than the other countries depicted in Figure 4:5 above.

4.6 Average trade intensity

This section focused on the average trade intensity between Namibia and SADC trading partners from 2000 to 2020. The trade intensity index (TII) is converted to percentage form, and then a simple average at the destination level is computed. A trend analysis was included to see the trajectory of trade intensity between Namibia and the trade destinations over time. The intensity of trade measures an economy's integration into the global economy. A higher trade intensity indicates that an economy is more vulnerable to external shocks in the global economy. Trade Intensity Index (TII) was used to measure the trade intensity between Namibia and SADC member state. The value of TII from country j to country i with a value more than 1 (TII>1) indicates the intensity of trade conducted by country j to country i is above the average world level and indicates the country's importance in terms of intensity as a trade partner to country i. But if the value of TII from country j to country i has a value less than 1 (TII<1), it indicates that the intensity of trade made by country j to country i is below that of the average world level and indicates the country's lack of importance in terms of intensity as a trade partner to country i. The results obtained are summarised in Figure 4:6 below.

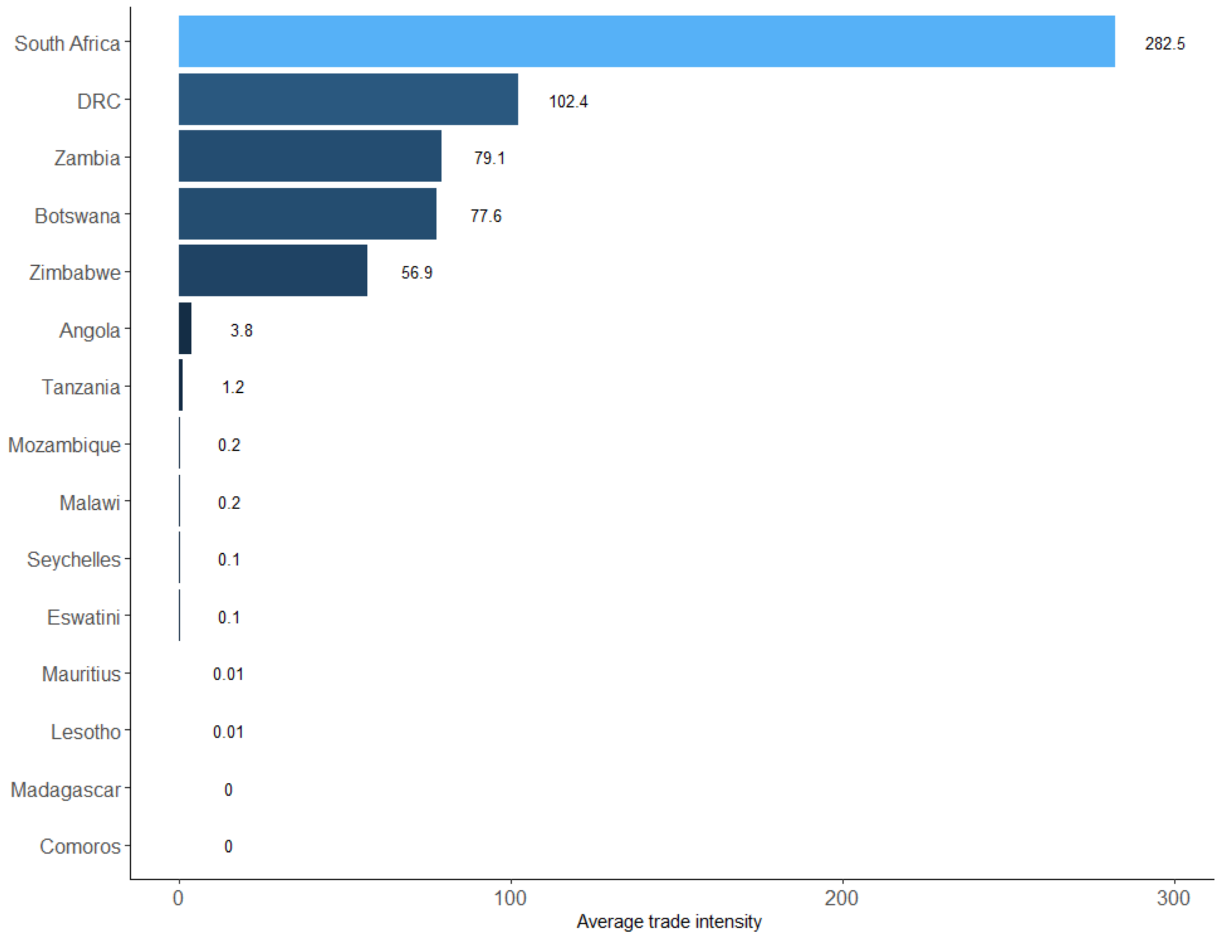

Figure 4:6 Shows average trade intensity as computation from UNCOMTRADE's data set 2022 (source: own).

Figure 4:6 shows the distribution of the average trade concentration in meat products across 21 years. The study noted that, on average, Namibia's meat products trade was intensely concentrated in South Africa (282.5), followed by DRC (102.4), Zambia (79.1), Botswana (77.6), and other countries, as shown in Figure 4:6 above. These results indicated that despite the trend in trade strength decreasing in trading with South Africa, Namibia had strong ties with South Africa in the meat products trade and the worst with Madagascar and Comoros.

4.7 Correlation Matrix

The study conducted a correlation analysis to observe the relationship that existed between the dependent variable trade (US$) and its independent variables, Real GDP (US), Distance (KM), and Population(Million). The results obtained were summarised and presented in Table 4.2 below.

Table 4.2 Correlation Matrix

	Trade	**Real GDP**	**Distance**	**Population**
Trade	1	0.69	-0.5	0.42
Real GDP	0.69	1	-0.28	0.52
Distance	-0.5	-0.28	1	-0.07
Population	0.42	0.52	-0.07	1

Table 4.2 shows the correlation analysis between the variables of the study. The study established a strong positive relationship (0.69) between real GDP and trade. However, distance had a negative correlation coefficient of -0.5. A positive coefficient of 0.42 was found between population and trade. Results from the study indicated that as real GDP and population increase, so likely is the trade and further away, the distance between the trading partners relates negatively to trade value.

4.8 Trade Volume and the factors

This section focused on the relationship between trade volume and the independent variables (Distance KM); distance was measured using google Maps from the capital city of Namibia (Windhoek) to the capital city of all destination countries in kilometres (km). Depicted visually in form of scatter plots.

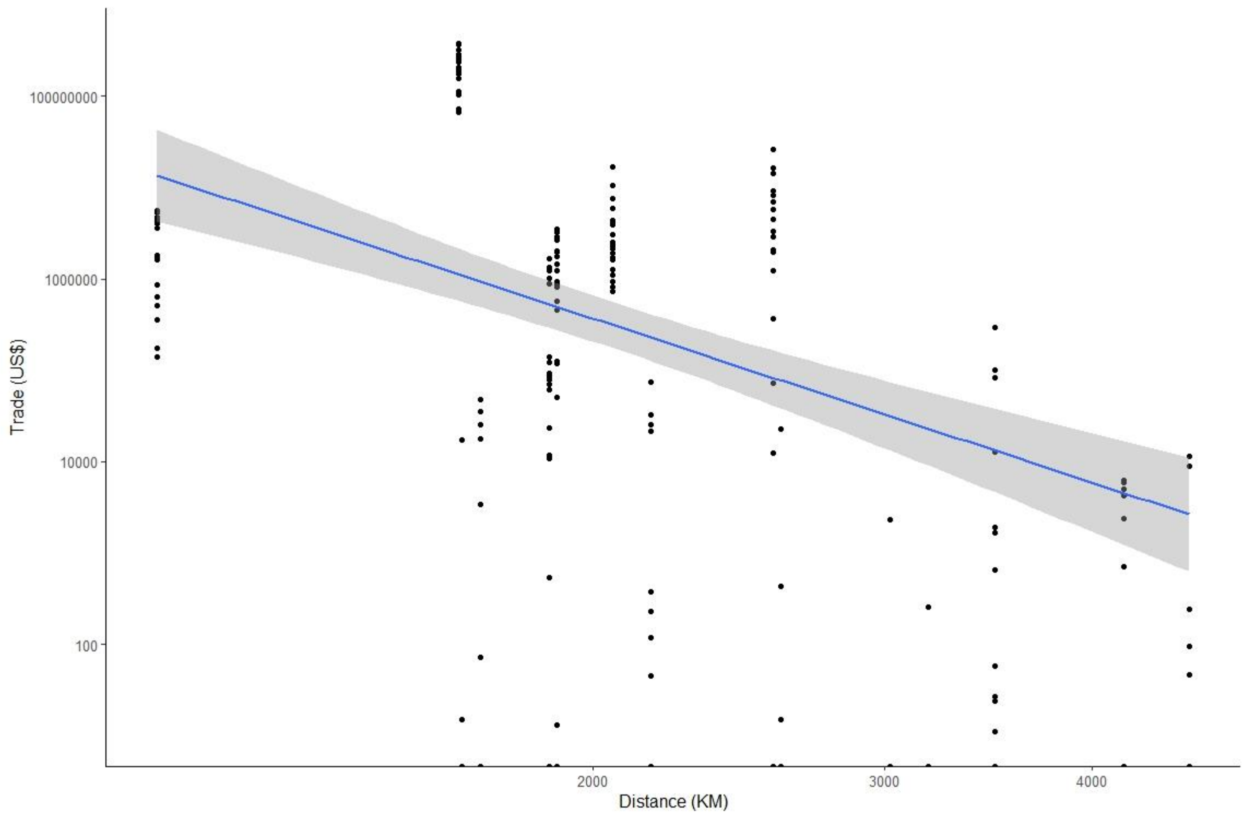

Figure 4:7 Trade volume and Distance ***Source:*** *own combination from UNCOMTRADE's and CEPII data set 2022*

Figure 4:7 shows the relationship between trade volume and distance. The study established that the trade value is much higher when the distance is less than 2000 km. The study also showed that most trades were highly concentrated within the 3000 km distance in terms of trading partners. In addition, being more than 3000km away lowered the trade concentration between Namibia and its trading partners. Results from the study indicated an inverse relationship between trade volume and distance. These results implied that trade volume tended to diminish as the distance between Namibia and its trading partners increased. Moreover, the distance or geographical location between countries or markets affects the price of imports and exports of products (Verter, 2015a).

The following scatter plot, Figure 4:8, focused on the relationship between trade volume and population.

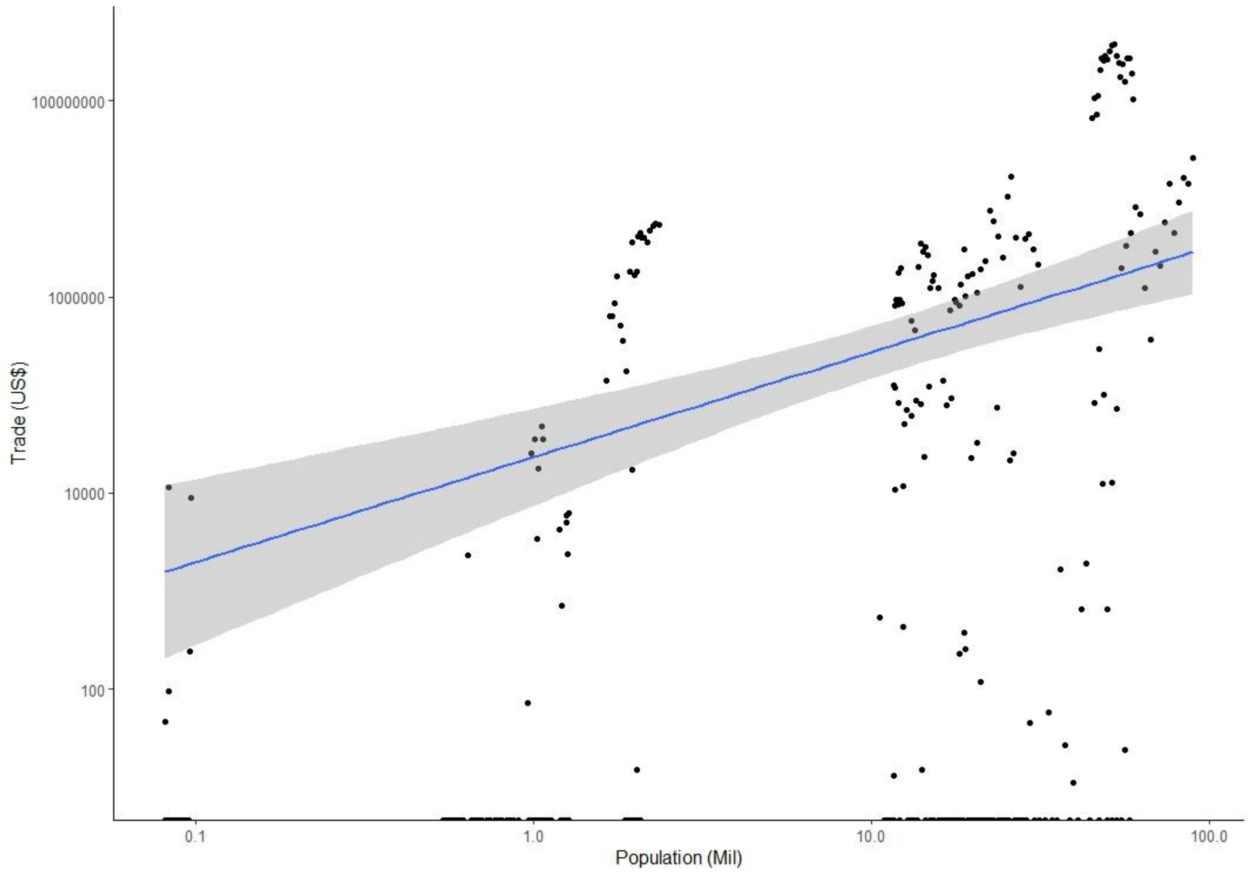

Figure 4:8 Trade volume and Population ***Source:*** *own combination from UNCOMTRADE's and FAO data set 2022*

Figure 4:8 shows the distribution of results obtained from the relationship between trade volume and population. Results from the study revealed that trade volume was relatively low for a population of under 2 million. According to the study, the trade volume between Namibia and its SADC partners is highly concentrated above a population of 10 million. Although trade volume was higher for the 10 million population, the study also revealed a notable low trade volume in the same category of the population. These results indicated that there was a positive relationship between trade and population. Due to the likelihood of finding inexpensive labor, a country with a large population that exports are more likely to experience significant profit potential. On the other hand, the importer's colossal population is expected to have high demand (Trabelsi, 2013). Accordingly, it is anticipated that the people of the exporting and importing nations will have a favorable effect on bilateral trade.

The following scatter plot shows the relationship between trade volume and real GDP. The results obtained were summarized in Figure 4:9 below.

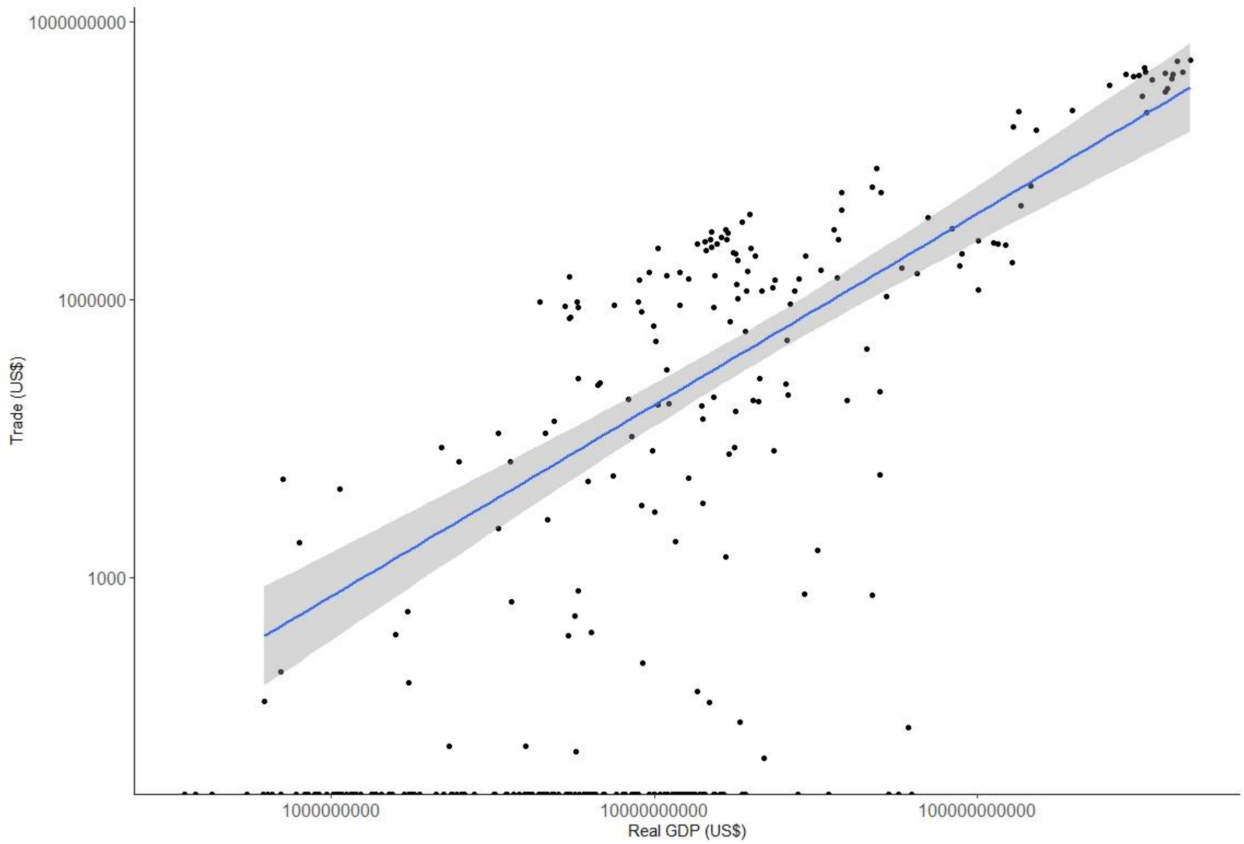

Figure 4:9Trade volume and Real GDP **Source:** own combination from UNCOMTRADE's and FAO data set 2022

Figure 4:9 illustrates the relationship between trade volume and real GDP. The study's findings established a positive relationship between trade and real GDP. Results from the study indicated that, as real GDP increased, so did trade volume.

4.9 Gravity Model (Stochastic Frontier Model)

This section presents the log-likelihood ratio test results used to estimate the parameters of the stochastic frontier model. In addition, to evaluate whether the gravity model theory can be used to describe bilateral trade between Namibia and SADC countries and it is presented in this section. The standard gravity equation describes bilateral trade as a function of economic size and distance between two countries, as explained in chapter 3. The stochastic frontier model equation (4) was followed here to measure the efficiency of trade integration relative to maximum trade levels and trade performance of the SADC member countries over the period 2000-2020.

4.9.1 Model selection (Log likelihood ratio test)

The log-likelihood ratio test was used to estimate the parameters of the stochastic frontier model. The test assumes that both log-likelihoods are either negative or positive, the opposite sign results in the stopping of the test. The interpretation is that the model with a more significant negative log-likelihood (closer to zero) or greater positive log-likelihood offers a better fit to the data. Program R studio was used to estimate the parameters of the stochastic frontier model in the log-likelihood test. Based on the output of the least square method, the four models were compared using the likelihood ratio test. Model one is a pooled effects model (ignores the panel structure and assumes observation-specific inefficiencies) compared with model two fixed effects model (assumes country specific and time-invariant inefficiencies). The results show that model two is better fitted compared to model one (Appendix 4). The results further show that model two, when compared to model three random effects model (assumes country specific and time-variant inefficiencies), is better fitted (Appendix 4). Model two compared to model four OLS model (assumes no inefficiency) and results show that model two is better than model four (Appendix 4). The fitted model for this study is model 2: is a fixed effects model (assumes country specific and time-invariant inefficiencies) (Appendix 1).

4.9.2 Error Components Frontier with time-invariant inefficiencies results

The study opts to fit the fixed effects model (assumes country specific and time-invariant inefficiencies) based on the output of the least square method using the likelihood ratio test. If η is positive, then $-\eta(t-T)=\eta(T-t)$ is positive for $t< T$ and so, $\exp[-\eta(t-T)]>1$ which implies that technical inefficiencies decline over time. If η is zero, technical inefficiencies remain constant; if it is negative, they increase over time.

Table 4.3 Error Components Frontier with time-invariant inefficiencies

Final maximum likelihood estimates				
	Estimate	**Std. Error**	**z value**	**Pr(>|z|)**
(Intercept)	-13.4475	9.8967	-1.3588	0.1742
log(real_gdp)	1.8265	0.2022	9.0326	< 2.2e-16 ***
log(distance)	-1.9725	1.0190	-1.9358	0.0529 .
sigmaSq	16.8632	5.8480	2.8836	0.0039 **
gamma	0.8051	0.0710	11.3437	< 2.2e-16 ***
sigmaSqU	13.5771	5.8578	2.3178	0.0205 *
sigmaSqV	3.2862	0.3721	8.8304	< 2.2e-16 ***
sigma	4.1065	0.7120	5.7672	8.06E-09 ***
sigmaU	3.6847	0.7949	4.6356	3.56E-06 ***
sigmaV	1.8128	0.1030	17.6607	< 2.2e-16 ***
lambdaSq	4.1316	1.8700	2.2106	0.0271 *
lambda	2.0326	0.4598	4.4212	9.82E-06 ***
varU	4.9336			
sdU	2.2212			
gammaVar	0.6002			

Log likelihood value: -347.5965				
Mean efficiency: 0.2175006				
Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1				

Results from Table 4.3 above show that the real GDP coefficient estimates are statistically significant, at least 5 percent. The positive and significant real GDP coefficient implied that if Namibia's real GDP and its partner country's real GDP increased by 1%, Namibia's trade value increased by 1.83%. Further research by Jordaan and Eita (2007) revealed that while Distance and the importer's GDP per capita were linked to a decline in exports, rises in the importer's GDP and Namibia's GDP resulted in a rise in exports.

The study determined that the distance coefficient was statistically significant at the 5% level. However, the distance estimate was negative, as predicted by gravity theory. The cost of traded goods is influenced by the distance between exporting and importing nations. Countries have the option to charge distant importers more than their immediate neighbors. As a result, it is predicted that trade will be more prevalent between trading partners who are close to one another and vice versa.
Additionally, it is projected that nations with common borders will engage in increased trade (Yego, 2015). This finding suggests that the greater the Distance between Namibia and its trading partners, the less likely they trade. This variable is a proxy for transport costs and other trade costs like communication and transaction costs, among others. Thus, the greater the distance, the higher the cost. A percent increase in distance decreased trade volume between Namibia and its trading partners by -1.97%. Gamma variation shows that inefficiency account 60%.

The study revealed that Namibia's average means efficiency for all the years was 21%. That means it has great potential, which is still to be used in relation to SADC members. Using a panel of 38 nations from 1982 to 2017, Hajivand et al. (2020) investigated Iran's agricultural export potential using the Gravitational Stochastic Frontier Analysis (SFA). The results revealed that the gross domestic product of partners and Iranians had an impact on the country's agricultural exports. The results showed that 69 percent of the nation's potential for trade with trading partners had been used. Because of inefficiencies, countries produce less than their maximum possible output. Structural issues, market defects, and other factors can cause these inefficiencies, especially in Namibia. Production facilities may eventually become less inefficient and surpass the frontier (Kutlu et al., 2019).

4.10 Trade Efficiency

The stochastic frontier gravity model defines and justifies using a trade frontier to calculate trade efficiency. As the term "trade potential," the gravity model estimates the expected trade volume between country pairs. They then determine how much real trade exceeds or falls short of prospective trade. The term "trade potential" takes on a new meaning in this context. Trade potential is now thought of as the maximum trade that can be realized rather than the average, as it was previously used in gravity model analysis. For each bilateral pair, trade efficiency (TE) point estimates are obtained. Low-efficiency ratings show real trade is diverging from frontier projections, indicating room for more trade integration. In contrast, high-efficiency scores indicate commerce between two countries is near to reaching its full trade potential.

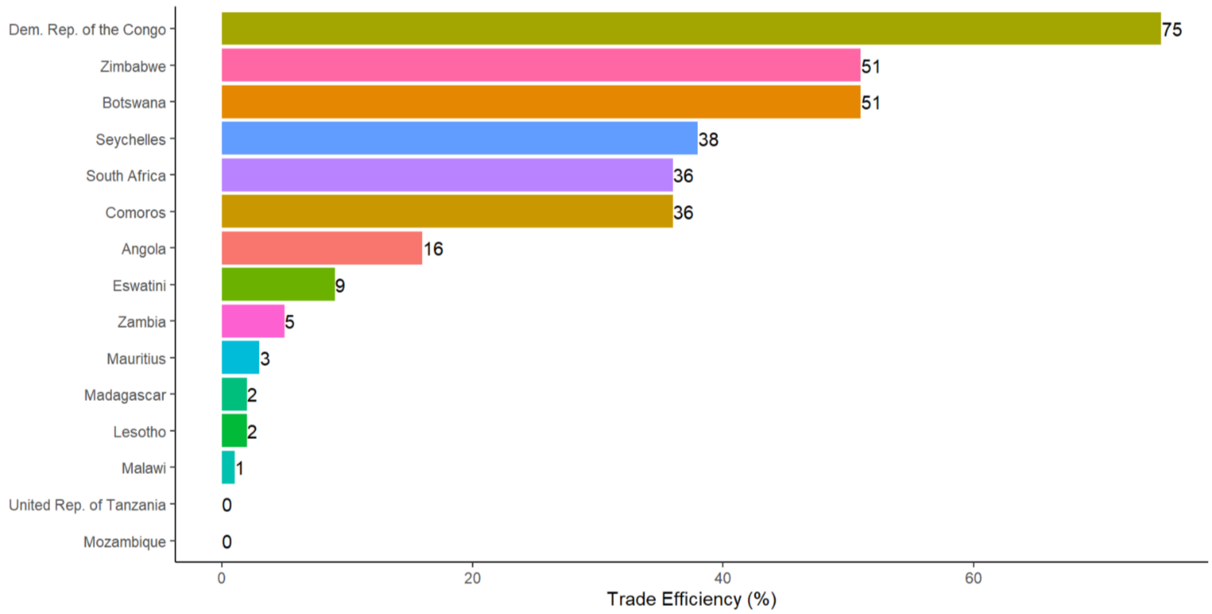

Figure 4:10 Trade efficiency. ***Source:*** *own computation from UNCOMTRADE's data set 2022*

Figure 4:10 shows Namibia' Trade efficiency in meat products with its SADC trading partners, and this result tells us the potential trade for meat products Namibia has with SADC members. As compared to the countries, the results obtained revealed that the DRC had a high efficiency at 75% compared to South Africa's 36%, even though it is Namibia's top trading country. However, the fact that the Democratic Republic of Congo (DRC) has a higher trade efficiency in meat products with Namibia compared to South Africa, which is Namibia's top trading partner, may be due to several factors. One possible reason is that the DRC has a relatively underdeveloped meat industry and may have a greater need for imported meat products. Additionally, trade between Namibia and South Africa may be subject to greater regulatory barriers and competition, which could affect trade efficiency. Some SADC countries, for example, Zimbabwe, Botswana, Comoros, and Seychelles, tend to have the potential for trade in Namibia's meat industry since their trade efficiency is 53% on average. The trade efficiency shows an interesting result as some SADC countries with a low percentage of trade efficiency, like Mozambique, Tanzania, Malawi, Lesotho, Madagascar, Mauritius, Zambia, Eswatini, and Angola, tend to have strong potential for export growth for Namibia's exports of meat products. Furthermore, the results indicate that Namibia has a lot of trade potential in exporting meat products to many SADC members. This is because Namibia is a major producer and exporter of high-quality beef, and there is strong demand for these products in neighboring countries.

Atif et al.'s (2017) analysis of the drivers and possibilities for expanding Pakistan's agricultural exports used a gravity model based on SFA. He revealed that the GDP of importers and exporters, exchange rates, shared borders, and colonial links favorably influence local agricultural exports. The study shows Pakistan has enormous potential, particularly with its neighbors in the Middle East and Europe. Overall, these results highlight the potential for Namibia to further develop its trade in meat products with other SADC countries, while also pointing to the need to address barriers to trade with key trading partners.

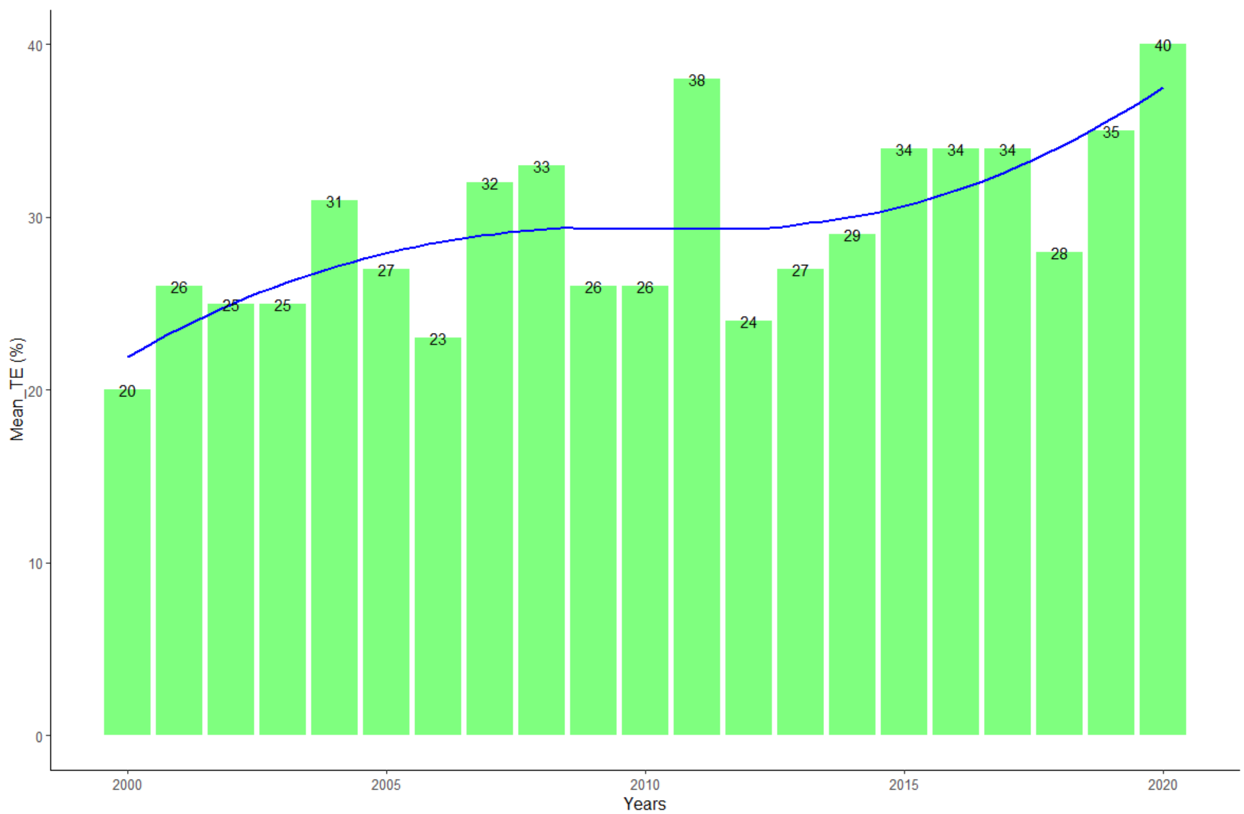

Figure 4:11 Namibia mean technical efficiency ***Source:*** *own computation from UNCOMTRADE's data set 2022*

Figure 4:11 Shows the mean technical efficiency score of Namibia from 2000 until 2020. This means the technical efficiency level has been increasing from 20% in the year 2000 and after 20 years, it doubled efficiency to 40%. The findings indicate that the meat industry has the potential to increase its efficiency by 40% by using existing resources more effectively within existing technology and operating on the efficiency frontier. This suggests that the remaining 60%'s technical efficiency is a cause for concern and should be addressed.

4.11 Conclusion

This chapter reports the results of the descriptive statistics. Firstly, it analyses the distribution of the total trade value, mean, minimum, and maximum meat trade values between Namibia and SADC countries. It indicates that Namibia traded mostly with South Africa between 2000 and 2020. The study findings revealed that Namibia's second largest trade partner in meat products from 2000 to 2020 was the Democratic Republic of Congo. As depicted in the table, the rest of the other countries traded less with Namibia. Secondly, it checked the distribution of Namibia's meat trade, and the general trend of Namibia's meat trade value has been upward since 2000.

The study analyzed the trade intensity of Namibia and the average trade intensity. The average trade intensity and the distribution of the average trade concentration in meat products across the 21 years were shown. Namibia's trade intensity trend in meat products has generally increased with Botswana, the DRC, Zambia, and Zimbabwe. A great increase in Namibia's meat trade intensity has been noted from the DRC, where it surged from levels of 100 in 2019 to approximately 300 in 2020. The study reveals that apart from South Africa, DRC, Zambia, Botswana, and Zimbabwe, other members have less than one trade intensity, meaning their trade flow is smaller than expected with Namibia, and there is more trade potential for meat products.

A correlation analysis was used in the study to examine the relationship that existed between the dependent variable trade and its independent variables, Real GDP, Distance, and Population. The study established a strong positive relationship between real GDP and trade. A positive coefficient was found between the population and trade. However, distance had a negative correlation coefficient. Results from the study indicated that as real GDP and population increase, so likely is the trade and further away, the distance between the trading partners relates negatively to trade value. The methods used to estimate the regression model using panel data that the study used were the pooled effects, fixed effects, and random effects approaches. The log-likelihood ratio test was used to estimate the parameters of the stochastic frontier model. The test assumes that both log-likelihoods are either negative or positive; the opposite sign results in the stopping of the test.

The applied gravity model (Error Components Frontier with time-invariant inefficiencies) was used to determine the significance of variables within the model. The estimates for the real GDP coefficient are statistically significant, with a level of at least 5%. The positive and significant real GDP coefficient implied that if Namibia's real GDP and its partner country's real GDP both increased, Namibia's trade value increased.

The study determined that the distance coefficient was statistically significant at the 5% level. However, the estimate for distance was negative, as expected by the gravity theory. This finding suggests that the greater the Distance between Namibia and its trading partners, the less likely they trade. This variable is a proxy for transport costs and other trade costs like communication and transaction costs, among others. Thus, the greater the distance, the higher the cost. There is a -2% decrease in trade volume between Namibia and its trading partners for every percent increase in distance.

To identify potential markets, the Technical Efficiency Effects Frontier (Battese & Coelli 1995) (efficiency effects model with intercept) was used to measure Namibia's potential trade with other SADC countries. The study reveals that the GDP, population, and distances determine meat trade exports between Namibia and its SADC partners. Namibia's mean technical efficiency in meat products shows the potential trade for meat products Namibia has with SADC members. According to the findings, Namibia's mean technical efficiency has been increasing from 20% in the year 2000 to 40% in 2020, meaning 60% of meat exports have yet to be utilized, and there is more potential.

Chapter 5 : Conclusion and Recommendation

5.1 Introduction

This study analyzed the total bilateral trade of different meat products between Namibia and other SADC countries. The studied products have been defined by Standard International Trade Classification (SITC) revision three different codes for each meat product. The code for meat and meat preparation (sitc rev 3 01) and live animals other than animals of division (sitc rev 3 00). The study used secondary data obtained from UNCOMTRADE, Namibia Statistic Agency (NSA), and the google map. These databases were selected for the study based on literature, frequent updates of data, and the availability of data from SADC member states. The data for this study was from 2000 to 2020, which were analyzed using a fixed effects model (assumes country specific and time-invariant inefficiencies).

Export market intelligence is concerned, among other things, with identifying potential markets, analyzing trade flows, assessing the potential for increased trade flows, and comprehending the determinants of trade and their relationships. Literature has pointed to a need for more critical information on these aspects of market intelligence. This information must make strategies for capitalizing on the AFCFTA trade opportunities effective. This study also contributes to efforts to address the "red line" issue by identifying potential export markets for Namibia's meat products (include live animals) on northern of Namibia where are less stringent requirements.

Trade intensity measures an economy's integration with the world economy. The trade intensity approach is assumed to acknowledge the interdependence of bilateral trade levels. The geographic intensity index, which speaks directly to regional integration, remains the most important. Regional integration is widely regarded as the primary strategy for enabling and assisting African countries to expand their markets, develop their small economies, reap the benefits of economies of scale, and maximize their national welfare.

As evidenced by the reviewed literature, several scholars have used panel data to study the determinants of agricultural exports and the potential for trade in various countries. Regardless, this study differs from previous studies. This study began to bridge the gap using the gravity model (stochastic frontier) and a few studies on the commercial analysis of meat exports to Namibia. The study filled a gap in the literature by conducting an empirical analysis of meat product trade between Namibia and SADC countries.

A gravity model is valuable in determining a country's export potential. The model has its foundations in physical science and has become an essential tool in analyzing bilateral trade flows. Therefore, this study evaluate whether the gravity model theory can be used to describe bilateral trade between Namibia and SADC countries. A panel regression was estimated using Error Components Frontier with time-invariant inefficiencies.

5.2 Summary of findings

The overall trade flow between Namibia and SADC members was analyzed using fixed effects model (assumes country specific and time-invariant inefficiencies). Study results are consistent with the gravity model theory. The study established a strong positive relationship between real GDP and trade, meaning real GDP positively impacts trade (elasticity: 1.83%). A positive coefficient was found between the population and trade. However, distance has a negative impact on trade (elasticity: -2 %), which is statistically significant.

The findings have indicated that Namibia trades intensively with other SADC members' feathers. The research finds out that South Africa is the biggest partner of other members; based on the results there is quiet potential in meat products by Mozambique and Tanzania have huge opportunities compared to other state members such as Congo, South Africa, and Zimbabwe. At a significant level of 5%, the null hypothesis that bilateral trade between Namibia and SADC countries cannot be explained by the gravity model theory is rejected. Based on the results it can be concluded that there is strong evidence that real GDP and distance can be used to explain bilateral trade in meat products between Namibia and SADC countries. The distance estimate was pessimistic, as predicted by gravity theory. The cost of traded goods is influenced by the distance between exporting and importing nations.

The estimates for the actual GDP coefficient are statistically significant, with a level of at least 5%. The positive and significant real GDP coefficient implies that if Namibia's real GDP and its partner country's real GDP both increased, implied that if Namibia's real GDP and its partner country's real GDP both increased by 1%, Namibia's trade value increased by 1.8%.

The study determined that the distance coefficient was statistically significant at least 5%. However, the distance estimate was negative, as predicted by gravity theory. This finding suggests that the greater the distance between Namibia and its trading partners, the less likely they trade. This variable is a proxy for transport costs and other trade costs, like communication and transaction costs, among others. Thus, the greater the distance, the higher the cost. A percent increase in distance decreased trade volume between Namibia and SADC countries by -2%.

Namibia's trade intensity trend in meat products has generally increased with Botswana, the DRC, Zambia, and Zimbabwe. A great increase in Namibia's meat trade intensity has been noted from the DRC, where it surged from levels of 100 in 2019 to approximately 300 in 2020. In simple terms, trade intensity tells us that Namibia exports more meat products to closer countries or the ones they share borders with than the other members on average. The study reveals that apart from South Africa, DRC, Zambia, Botswana, and Zimbabwe, other members have less than one trade intensity, meaning their trade flow is smaller than expected with Namibia, and there is more trade potential for meat products.

The Technical Efficiency Effects Frontier (Battese & Coelli 1995) (inefficiency effects model with intercept) was used to measure Namibia's potential trade with other SADC countries. The study reveals that the GDP, population, and distances determine meat trade exports between Namibia and its SADC partners. In addition, the study shows that Namibia has performed relatively poorly and has great potential, which remains to be exploited with other SADC countries. Namibia's mean technical efficiency in meat products shows the potential trade for meat products Namibia has with SADC members. Because the DRC is more efficient than South Africa, it has less export potential for Namibia. One possible reason is that the DRC has a relatively underdeveloped meat industry and may have a greater need for imported meat products. The results indicate that Namibia has much trade potential in exporting meat products to many SADC members. Some SADC countries, for example, Zimbabwe, Botswana, Comoros, and Seychelles, have the potential for trade in Namibia's meat industry.

The mean technical efficiency shows an interesting result as some SADC countries with a low percentage of trade efficiency, like Mozambique, Tanzania, Malawi, Lesotho, Madagascar, Mauritius, Zambia, Eswatini, and Angola, tend to have strong potential for export growth for Namibia's exports of meat products. According to the findings, Namibia's mean technical efficiency has been increasing from 20% in the year 2000 to 40% in 2020, meaning 60% of meat exports have not been utilized, and there is more potential. Furthermore, the results show that trade in meat products is significant for the Namibian trade, and the growth of SADC will be substantial for Namibia's export growth.

5.3 Policy implication

The main findings of this study indicate that there is still more trade potential that can be used to boost trade among its members. While this study did not produce specific information on how Namibia trades with other SADC members to narrate more on trade intensity and determinants for the entire agricultural sector trade flows, the findings did indicate the presence of significant determinants of trade flow and trade potential among SADC partners. The results are instructive and helpful in determining the factors influencing trade flow and trade potential for Namibian meat products. It emphasizes the significance of investigating the trade flow of meat products between Namibia and SADC countries. The study concludes that real GDP and Distance have increased trade flows there is still room to improve trade flows between counties by adopting new strategies. The 2018 land conference resolved not to remove the “Red line”, but rather, among others provide market avenues for livestock farmers north of the “red line”. Renovate and upgrade of abattoirs north of the “Red line” to access export markets. Therefore, policymakers should revise existing policies so that SADC members can trade freely among themselves.

5.4 Further study and recommendations

Based on the distance and size of economies, SADC offers export market opportunities for Namibia's meat products;

5.1 Assess the competitiveness of Namibia’s meat products in the markets in the SADC region;

5.2 Identify and attempt to resolve trade impediments in the SADC region;

5.3 The Ministry of Agriculture and related stakeholders should scout for foreign markets to trade its meat and meat products, i.e., EU, USA, and China, to increase its market share;

5.4 Addressing the ‘Red line’ issue partly implies finding export market opportunities for livestock producers north of VCF where are less stringent requirements;

5.5 New policies should be derived to allow free trade between SADC countries;

5.6 Namibia should develop strategies to protect its meat industry which is relatively infant as compared to SA;

5.7 The Namibian government and stakeholders should commit more money to research in the meat industry for product diversification and marketing; and

5.8 A stringent value-addition strategy should be adopted for the Namibia meat industry.

References

Abdullahi, N. M., Huo, X., Zhang, Q., & Bolanle Azeez, A. (2021). Determinants and Potential of Agri-Food Trade Using the Stochastic Frontier Gravity Model: Empirical Evidence From Nigeria. *SAGE Open*, *11*(4), 215824402110657. https://doi.org/10.1177/21582440211065770

Aeby, M. (2019). *SADC – the southern arrested development community? : Enduring challenges to peace and security in Southern Africa*. Nordiska Afrikainstitutet. http://urn.kb.se/resolve?urn=urn:nbn:se:nai:diva-2322

Aigner, D., Lovell, C. A. K., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics*, *6*(1). https://doi.org/10.1016/0304-4076(77)90052-5

Allen, T., & Heinrigs, P. (2016). *Emerging Opportunities in the West African Food Economy* (West African Papers No. 1; West African Papers, Vol. 1). https://doi.org/10.1787/5jlvfj4968jb-en

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

Anderson, J. E., & van Wincoop, E. (2003). Gravity with Gravitas: A Solution to the Border Puzzle. *American Economic Review*, *93*(1), 170–192. https://doi.org/10.1257/000282803321455214

Apiko, P., Woolfrey, S., & Byiers, B. (2020). *Promise African Continental Free Trade Area (AfCFTA)*. https://ecdpm.org/wp-content/uploads/Promise-African-Continental-Free-Trade-Area-AfCFTA-ECDPM-Discussion-Paper-287-December-2020.pdf

Armstrong, S. P. (2007). Measuring Trade and Trade Potential: A Survey. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1760426

Atif, R. M., Haiyun, L., & Mahmood, H. (2017). Pakistan's agricultural exports, determinants and its potential: An application of stochastic frontier gravity model. *The Journal of International Trade & Economic Development*, *26*(3), 257–276. https://doi.org/10.1080/09638199.2016.1243724

Bank, W. (2020). *The African Continental Free Trade Area: Economic and Distributional Effects*. World Bank Publications.

Bergstrand, J. H. (1990). The Heckscher-Ohlin-Samuelson Model, The Linder Hypothesis and the Determinants of Bilateral Intra-Industry Trade. *The Economic Journal*, *100*(403), 1216–1229. https://doi.org/10.2307/2233969

Bischoff, P.-H. (2020). How Far, Where To? Regionalism, the Southern African Development Community and Decision-Making into the Millennium. In *Globalization and Emerging Trends in African States' Foreign Policy-Making Process*. Routledge.

Blumberg, B., Cooper, Donald R., & Schindler, P. S. (2014). *Business research methods*.

Bose, S., Al Naabi, A. M. R., Boughanmi, H., & Yousuf, J. B. (2019). Domestic Ban Versus Border Rejections: A Case of Oman's Fish Exports to the EU. *SAGE Open*, *9*(1), 2158244018823079. https://doi.org/10.1177/2158244018823079

Bronauer, J., & Yoon, J. (2018). *Regional economic development in SADC: Taking stock and looking ahead.* (p. 48).

Chandran, S. (2011). Trade Complementarity and Similarity Between India and ASEAN Countries in the Context of the RTA. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.1763299

Chaney, T. (2013). *The gravity equation in international trade: An explanation* (No. 19285; p. 50). NATIONAL BUREAU OF ECONOMIC RESEARCH. https://www.nber.org/system/files/working_papers/w19285/w19285.pdf

Chingala, G., Raffrenato, E., Dzama, K., Hoffman, L. C., & Mapiye, C. (2017). Towards a regional beef carcass classification system for Southern Africa. *South African Journal of Animal Science*, *47*(4), 4. https://doi.org/10.4314/sajas.v47i4.1

Colette, van der V., & Signé, L. (2021, September 1). *Greening the AfCFTA: It is not Too Late*. https://www.africaportal.org/publications/greening-afcfta-it-not-too-late/

Crescimanno, M., Galati, A., & Yahiaoui, D. (2013). Determinants of Italian agri-food exports in non-EU Mediterranean Partner Countries: An empirical investigation through a gravity model approach. *Undefined*. https://www.semanticscholar.org/paper/Determinants-of-Italian-agri-food-exports-in-non-EU-Crescimanno-Galati/65a1120acb8d1dfb2aba6dbd91e7f55acf0c4c8c

Dadakas, D., Ghazvini Kor, S., & Fargher, S. (2020a). Examining the trade potential of the UAE using a gravity model and a Poisson pseudo maximum likelihood estimator. *The Journal of International Trade & Economic Development*, *29*(5), 619–646. https://doi.org/10.1080/09638199.2019.1710551

Dadakas, D., Ghazvini Kor, S., & Fargher, S. (2020b). Examining the trade potential of the UAE using a gravity model and a Poisson pseudo maximum likelihood estimator. *The Journal of International Trade & Economic Development*, *29*(5), 619–646. https://doi.org/10.1080/09638199.2019.1710551

Deardorff, A. (1998). Determinants of Bilateral Trade: Does Gravity Work in a Neoclassical World? In *The Regionalization of the World Economy* (pp. 7–32). University of Chicago Press. https://www.nber.org/books-and-chapters/regionalization-world-economy/determinants-bilateral-trade-does-gravity-work-neoclassical-world

Drysdale, P., & Garnaut, R. (2016). TRADE INTENSITIES AND THE ANALYSIS OF BILATERAL TRADE FLOWS IN A MANY-COUNTRY WORLD: A SURVEY. *Hitotsubashi Journal of Economics*, *22*(2), 62–84.

Eita, J. H. (2008). *Determinants of Namibian Exports: A Gravity Model Approach*.

Elmorsy, S. S. (2015). Determinants of trade intensity of Egypt with COMESA Countries. *Bandung*, *2*(1), 1–25. https://doi.org/10.1186/s40728-014-0002-6

Elshehawy, M. A., Shen, H., & Ahmed, R. A. (2014). The Factors Affecting Egypt's Exports: Evidence from the Gravity Model Analysis. *Open Journal of Social Sciences*, *2*(11), 11. https://doi.org/10.4236/jss.2014.211020

Enahoro, D., Bahta, S., Mensah, C., Oloo, S., & Rich, K. (2021). Current and future trade in livestock products. *Revue Scientifique et Technique (International Office of Epizootics)*, *40*. https://doi.org/10.20506/rst.40.2.3232

Epaphra, M., & Mwakalasya, A. H. (2017). Analysis of Foreign Direct Investment, Agricultural Sector and Economic Growth in Tanzania. *Modern Economy*, *08*(01), 111–140. https://doi.org/10.4236/me.2017.81008

Evenett, S. J., & Keller, W. (2002). On Theories Explaining the Success of the Gravity Equation. *Journal of Political Economy*, *110*(2), 281–316.

Frayne, B., Crush, J., & McCordic, C. (Eds.). (2019). *Food and Nutrition Security in Southern African Cities*. Routledge. https://doi.org/10.4324/9781315226651

Gebresilassie, Y., & Woldu, G. (2020). *Determinants of Ethiopia's Livestock Exports: Analysis of Gravity Model of Trade*. *5*, 1–9.

Gnidchenko, A., & Salnikov, V. (2021). Trade Intensity, Net Trade, and Revealed Comparative Advantage. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3820672

Hajivand, S., Moghaddasi, R., Zeraatkish, Y., & Mohammadinejad, A. (2020). An Application of Stochastic Frontier Gravity Approach (The Case of Iran's Potential Agricultural Exports). *International Journal of Analysis and Applications*, *18*(3), 3.

Head, K., & Mayer, T. (2014). Gravity Equations: Workhorse,Toolkit, and Cookbook. In *Handbook of International Economics* (Vol. 4, pp. 131–195). Elsevier. https://doi.org/10.1016/B978-0-444-54314-1.00003-3

Helpman, E. (1987). Imperfect competition and international trade: Evidence from fourteen industrial countries. *Journal of the Japanese and International Economies*, *1*(1), 62–81. https://doi.org/10.1016/0889-1583(87)90027-X

Helpman, E., & Krugman, P. (1985). *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition, and the International Economy*. MIT Press.

Hub, U. S. A. T., & Secretariat, S. (2011). *Technical Report: 2011 Audit of the Implementation of the SADC Protocol on Trade*. Gaborone, Botswana: SATH.

International Trade Centre. (2021, October). *Trade Map—Trade statistics for international business development*. https://www.trademap.org/Index.aspx?nvpm=1%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c%7c

Jafari, Y., Ismail, M., & Kouhestani, M. (2011). Determinants of Trade Flows among D8 Countries: Evidence from the Gravity Model. *Journal of Economic Cooperation and Development*, *32*.

Jayne, T. S., Meyer, F., & Traub, L. N. (2014). *Africa's Evolving Food Systems*. 24.

Jordaan, A. C., & Eita, J. H. (2007). Export and economic growth in Namibia: A Granger causality analysis. *South African Journal of Economics*, *75*(3), 540–547.

Kalaba, M., & Tsedu, M. (2008). *Regional Trade Agreements, Effects and Opportunities: Southern African Development Research Network* (p. 30). Trade and Industrial Policy Strategies. http://tips.org.za/files/Kalaba_M._April08_Intra-SADC_Trade_Performance.pdf

Karamuriro, H. T., & Karukuza, W. N. (2015). Determinants of Uganda's export performance: A gravity model analysis. *International Journal of Business and Economics Research*, *4*(2), 45–54.

Kareem, F. O. (2014). *Modeling and Estimation of Gravity Equation in the Presence of Zero Trade: A Validation of Hypotheses Using Africa's Trade Data*.

Karim, I. E. E. A., & Ismail, I. S. (2007). Potential for agricultural trade in COMESA region: A comparative study of Sudan, Egypt and Kenya. *African Journal of Agricultural Research*, *2*(10), 481–487.

Kaurivi, Y., Laven, R., & Parkinson, T. (2021). *Assessing Extensive Semi-Arid Rangeland Beef Cow–Calf Welfare in Namibia: Part 1: Comparison between Farm Production System's Effect on theWelfare of Beef Cows*.

Kearney, J. (2010). Food consumption trends and drivers. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *365*(1554), 2793–2807. https://doi.org/10.1098/rstb.2010.0149

Krisztin, T., & Fischer, M. M. (2015). The Gravity Model for International Trade: Specification and Estimation Issues. *Spatial Economic Analysis*, *10*(4), 451–470. https://doi.org/10.1080/17421772.2015.1076575

Kunimoto, K. (1977). TYPOLOGY OF TRADE INTENSITY INDICES. *Hitotsubashi Journal of Economics*, *17*(2), 15–32.

Kutlu, L., Tran, K., & Tsionas, E. (2019). *A Spatial Stochastic Frontier Model with Endogenous Frontier and Environmental Variables*.

Leedy, P. D., & Ormrod, J. E. (2004). *Survey of research methodology for human services learners*. Upper Saddle River, NJ: Pearson Custom.

Makieła, K., & Mazur, B. (2020). *Stochastic Frontier Analysis with Generalized Errors: Inference, model comparison and averaging*.

Makochekanwa, A., Maringwa, J., & Mahembe, E. (2010). *The Impacts of SADC Trade Protocol implementation on Trade in Agrifood Products, African Integration Review, 4(1), pp. 107 -156.*

Mapiye, O., Chikwanha, O. C., Makombe, G., Dzama, K., & Mapiye, C. (2020). Livelihood, food and nutrition security in Southern Africa: What role do indigenous cattle genetic resources play? *Diversity*, *12*(2), 74.

Martin, W., & Pham, C. S. (2020). Estimating the gravity model when zero trade flows are frequent and economically determined. *Applied Economics*, *52*(26), 2766–2779. https://doi.org/10.1080/00036846.2019.1687838

Martínez-Zarzoso, I. (2013). The log of gravity revisited. *Applied Economics*, *45*(3), 311–327.

Mastromarco, C. (2008). Stochastic frontier models (pp. 1–49). *Lecce, Italy: Department of Economics and Mathematics-Statistics, University of Slanto*.

Meatco. (2020). *Annual Report*.

Meeusen, W., & van Den Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review*, *18*(2). https://doi.org/10.2307/2525757

Miescher, F. (2012). *Namibia's Red Line: The History of a Veterinary and Settlement Border, Palgrave MacMillan: New York.*

Nguyen, D. D. (2020). Determinants of Vietnam's rice and coffee exports: Using stochastic frontier gravity model. *Journal of Asian Business and Economic Studies*.

Nsabimana, A., & Tirkaso, W. T. (2020). Examining coffee export performance in Eastern and Southern African countries: Do bilateral trade relations matter? *Agrekon*, *59*(1), 46–64. https://doi.org/10.1080/03031853.2019.1631864

Oecd, F. (2016). Agriculture in sub-Saharan Africa: Prospects and challenges for the next decade. *OECD-FAO Agricultural Outlook*, *2025*(181), 1–39.

Paul, S., & Shankar, S. (2020). Estimating efficiency effects in a panel data stochastic frontier model. *Journal of Productivity Analysis*, *53*(2), 163–180. https://doi.org/10.1007/s11123-019-00568-3

Perry, B., Rich, K. M., Rojas, H., Romero, J., Adamson, D., Bervejillo, J. E., Fernandez, F., Pereira, A., Pérez, L., & Reich, F. (2020). Integrating the technical, risk management and economic implications of animal disease control to advise policy change: The example of foot-and-mouth disease control in Uruguay. *EcoHealth*, *17*(3), 381–387.

Rashidghalam, M., Heshmati, A., Dashti, G., & Pishbahar, E. (2016). A Comparison of Panel Data Models in Estimating Technical Efficiency. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.2750290

Ravishankar, G., & Stack, M. (2013). *THE GRAVITY MODEL AND TRADE EFFICIENCY: A STOCHASTIC FRONTIER ANALYSIS OF POTENTIAL TRADE*. 32.

Roemer, J. E. (1976). EXTENSIONS OF THE CONCEPT OF TRADE INTENSITY. *Hitotsubashi Journal of Economics*, *17*(1), 29–35.

Rome, I. (2020). Food and Agriculture Organization of the United Nations. *Durham, USA: Duke University*.

SADC-RVAA. (2019). *Synthesis Report on the State of Food and Nutrition Security and Vulnerability in Southern Africa; SADC-RVAA:Windhoek, Namibia.*

Shahriar, S., Qian, L., & Kea, S. (2019). Determinants of exports in China's meat industry: A gravity model analysis. *Emerging Markets Finance and Trade*, *55*(11), 2544–2565.

Shepherd, B. (2013). *The gravity model of international trade: A user guide*.

Shuai, C. (2010). Sino–US Agricultural Trade Potential: A Gravity Model Approach. *Outlook on Agriculture*, *39*(3), 169–176. https://doi.org/10.5367/oa.2010.0008

Simo, R. Y. (2020). Trade in Services in the African Continental Free Trade Area: Prospects, Challenges and WTO Compatibility. *Journal of International Economic Law*, *23*(1), 65–95. https://doi.org/10.1093/jiel/jgz031

Teweldemedhin, M. Y., & Mbai, S. (2013a). *Factors determining red meat trade to the Asian and African markets: Its implication to the Namibian red meat industry*.

Teweldemedhin, M. Y., & Mbai, S. (2013b). Factors determining red meat trade to the Asian and African markets: Its implication to the Namibian red meat industry. *Journal of Development and Agricultural Economics*, *5*(9), 351–364. https://doi.org/10.5897/JDAE12.153

Tinbergen, J. (1962). Shaping the World Economy: Suggestions for an International Economic Policy. *The Economic Journal*, *76*(301), 92–95. https://doi.org/10.2307/2229041

Trabelsi, I. (2013). Agricultural Trade Face to Non-Tariff Barriers: A Gravity Model for the Euro-Med Area. *Journal of Studies in Social Sciences*, *3*(1). http://infinitypress.info/index.php/jsss/article/view/86

Uchezuba, D. I., Mbai, S., & Laubscher, K. (2016). The Impact of Alternative Livestock Market Choice, Constraints and Opportunities: A Case of Smallholder Farmers in the Southern Communal Area of Namibia. *Journal of Natural Sciences Research*, *6*(14), 14.

Verter, N. (2015a). *The application of international trade theories to agriculture. Mediterranean Journal of Social Sciences, 6(6 S4), 209-209.*

Verter, N. (2015b). The Application of International Trade Theories to Agriculture. *Mediterranean Journal of Social Sciences*, *6*(6 S4), 6 S4.

Viljoen, W. (2019). *The intra-Africa non-tariff barrier dilemma – the challenges facing the AfCFTA approach*. 2.

Wei, X., & Tian, Z. (2018). *An Analysis of Competitiveness and Complementarity between China and Guinea Trade under the "The Belt and Road" Initiative*. 355–360. https://doi.org/10.2991/hsmet-18.2018.69

Yego, H. (2015). An Analysis Of Kenyan Livestock Exports: A Gravity Model Approach. *Researchjournali's Journal of Economics*. https://www.academia.edu/39976420/An_Analysis_Of_Kenyan_Livestock_Exports_A_Gravity_Model_Approach

Yishak, T. (2009). Determinants of Ethiopia's export performance: A gravity model analysis. Trade and Development Discussion Paper, No. 1, BKP. *Development Research and Consulting, Germany*.

Yotov, Y. V., Piermartini, R., Monteiro, J.-A., & Larch, M. (2016). *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model*. WTO. https://doi.org/10.30875/abc0167e-en

Zeray, N., & Gachen, D. (2014). Determinants of Bilateral Trade between Ethiopia and Its Major Trading Partners': A Gravity Model Approach. *Journal of Economics and Sustainable Development*, *5*(15), 82.

Appendix A

Appendix 1. Error components Frontier (Baattese & Coelli, 1992) with observation-specific efficiencies (ignoring the panel structure). **Source:** Author's estimation

```
Warning in sfa(trade ~ real_gdp + I(1/distance), data = .) :
  the parameter 'gamma' is close to the boundary of the parameter space [0,1]: this
can cause convergence problems and can negatively affect the validity and reliability
of statistical tests and might be caused by model misspecification
Error Components Frontier (see Battese & Coelli 1992)
Inefficiency decreases the endogenous variable (as in a production function)
The dependent variable is logged
Iterative ML estimation terminated after 34 iterations:
log likelihood values and parameters of two successive iterations
are within the tolerance limit

final maximum likelihood estimates
                 Estimate  Std. Error  z value  Pr(>|z|)
(Intercept)   -29.3485850   5.3975572  -5.4374 5.407e-08 ***
real_gdp        1.5013233   0.1072677  13.9960 < 2.2e-16 ***
I(1/distance)  73.7509969  32.3878184   2.2771   0.02278 *
sigmaSq        19.5438065   2.4570009   7.9543 1.801e-15 ***
gamma           0.9940412   0.0059842 166.1112 < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
log likelihood value: -371.3361

cross-sectional data
total number of observations = 164

mean efficiency: 0.197985
```

Appendix 2. Error Components Frontier from Battese & Coelli (1992) with time-invariant inefficiencies.

Source: Author's estimation

```
final maximum likelihood estimates
               Estimate Std. Error z value  Pr(>|z|)
(Intercept)   -13.447546   9.896662 -1.3588  0.174211
log(real_gdp)   1.826503   0.202211  9.0326 < 2.2e-16 ***
log(distance)  -1.972515   1.018990 -1.9358  0.052898 .
sigmaSq        16.863243   5.848009  2.8836  0.003932 **
gamma           0.805128   0.070976 11.3437 < 2.2e-16 ***
sigmaSqU       13.577062   5.857782  2.3178  0.020461 *
sigmaSqV        3.286181   0.372145  8.8304 < 2.2e-16 ***
sigma           4.106488   0.712045  5.7672 8.061e-09 ***
sigmaU          3.684706   0.794878  4.6356 3.560e-06 ***
sigmaV          1.812783   0.102645 17.6607 < 2.2e-16 ***
lambdaSq        4.131563   1.868998  2.2106  0.027065 *

lambda          2.032625   0.459750  4.4212 9.818e-06 ***
varU            4.933636         NA      NA         NA
sdU             2.221179         NA      NA         NA
gammaVar        0.600212         NA      NA         NA
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
log likelihood value: -347.5965

panel data
number of cross-sections = 15
number of time periods = 21
total number of observations = 164
thus there are 151 observations not in the panel

      mean efficiency: 0.2175006
```

Appendix 3. Error Components Frontier (Battese & Coelli 1992) with time-variant efficiencies. **Source:** Author's estimation

```
final maximum likelihood estimates
              Estimate Std. Error z value  Pr(>|z|)
(Intercept) -5.941929  20.695146 -0.2871  0.774023
real_gdp     1.638732   0.335999  4.8772 1.076e-06 ***
distance    -2.365240   1.833780 -1.2898  0.197114
sigmaSq     14.474118   5.592551  2.5881  0.009651 **
gamma        0.776428   0.089002  8.7237 < 2.2e-16 ***
time         0.011298   0.013987  0.8077  0.419240
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
log likelihood value: -346.575

panel data
number of cross-sections = 15
number of time periods = 21
total number of observations = 164
thus there are 151 observations not in the panel

mean efficiency of each year
     2000      2001      2002      2003      2004      2005      2006
0.2038642 0.2631487 0.2508250 0.2479939 0.3088262 0.2728643 0.2281879
     2007      2008      2009      2010      2011      2012      2013
0.3165575 0.3273118 0.2610846 0.2570946 0.3812765 0.2427791 0.2663876
     2014      2015      2016      2017      2018      2019      2020
0.2936450 0.3374571 0.3400992 0.3449182 0.2765911 0.3470224 0.3994864

mean efficiency: 0.2901258
```

Appendix 4. Model selection (Likelihood ratio test) **Source:** Author's estimation

```
Likelihood ratio test

Model 1: sfa_model_1
Model 2: sfa_model_2
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   5 -371.14
2   5 -347.60  0 47.094  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Likelihood ratio test
```

```
Model 1: sfa_model_2
Model 2: sfa_model_3
  #Df  LogLik Df Chisq Pr(>Chisq)
1   5 -347.60
2   6 -347.25  1 0.702     0.4021
Likelihood ratio test

Model 1: OLS (no inefficiency)
Model 2: Error Components Frontier (ECF)
  #Df  LogLik Df  Chisq Pr(>Chisq)
1   4 -388.57
2   5 -347.60  1 81.953  < 2.2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```