An assessment of South Africa's non-genetically modified maize export potential

By

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DECLARATION

I, Joseph Leshasha Mawasha hereby declare that this dissertation that I submit for the Master of Science degree in Agricultural Economics to the University of Pretoria has not previously been submitted by me or any other person for degree purposes at any other tertiary institution.

Signature: ………………………………………………………………

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Proverbs 3: 5-6

"Trust in the LORD with all your heart and lean not on your own understanding; in all your ways submit to Him, and He will make your paths straight"

ABSTRACT

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The study endeavoured to determine South Africa's export potential in non-genetically modified maize markets using a three pronged methodological approach. The Genetically Modified (GM) status of South African maize has been observed as a challenge restraining the extent of South Africa's maize exports to major maize importing markets. The study thus sought to quantify South Africa's maize export potential to non-GM maize markets. Firstly, the study identified South Africa's non-GM maize markets using a growth share matrix. Secondly, South Africa's non-GM maize export markets with high trade potential were identified using an Indicative Potential analysis. A gravity model was then used to determine potential export markets with trade stimulating and restraining effects.

The study finds that Italy, Angola, Zimbabwe, Venezuela, Greece, Zambia and Austria exhibited the highest trade potential among the identified potential non-GM maize markets. Based on the three pronged approach employed by the study, it was concluded that despite the limited scope for non-GM maize market penetration, there are markets which displayed greater potential for expansion as they were part of the most desirable markets, exhibited high trade potential and had trade stimulating effects. These markets include; Italy, Zimbabwe, Kenya and Angola. It was recommended that farmers who choose to engage in large scale non-GM maize production should thus be guided by the forces of demand and supply in the non-GM maize export market and react to favourable opportunities as presented. Moreover, the government of South Africa needs to maintain a regulatory system that enables for segregation of non-GM and GMO maize along the maize value chain to allow for preference for South African non-GM maize by major non-GM maize importers.

Keywords: GM and non-GM maize, Indicative Trade Potential Analysis, Growth Share Matrix and Gravity Model

OPSOMMING

Die studie het probeer om Suid-Afrika se uitvoerpotensiaal in mieliemarkte wat nie geneties gemodifiseer is nie, met behulp van 'n drieledige metodologiese benadering te bepaal. Die geneties gemodifiseerde (GM) status van Suid-Afrikaanse mielies is gesien as 'n uitdaging wat die omvang van Suid-Afrika se mielie-uitvoer na groot mielie-invoermark beperk. Die studie het dus probeer om Suid-Afrika se mielie-uitvoerpotensiaal na nie-GM-mieliemarkte te kwantifiseer. Eerstens het die studie Suid-Afrika se nie-GM mieliemarkte met behulp van 'n groei-aandeelmatriks geïdentifiseer. Tweedens is Suid-Afrika se nie-GM-mielie-uitvoermarkte met 'n hoë handelspotensiaal geïdentifiseer met behulp van 'n indikatiewe potensiële analise. Daarna is 'n swaartekragmodel gebruik om potensiële uitvoermarkte met handelsstimulerende en beperkende gevolge te bepaal.

Die studie het bevind dat Italië, Angola, Zimbabwe, Venezuela, Griekeland, Zambië en Oostenryk die grootste handelspotensiaal vertoon het onder die geïdentifiseerde potensiële markte wat nie GM aanvaar nie. Op grond van die drie metodologiese benaderings wat deur die studie gebruik is, is tot die gevolgtrekking gekom dat, ondanks die beperkte ruimte vir penetrasie van nie-GM-mielies, daar markte is wat 'n groter potensiaal vir uitbreiding het, aangesien dit deel was van die wenslikste markte, wat hoë handelspotensiaal vertoon en handelsstimulerende effekte het. Hierdie markte sluit in; Italië, Zimbabwe, Kenia en Angola. Daar word aanbeveel dat boere wat kies om aan grootskaalse nie-GM-mielieproduksie deel te neem, dus gelei moet word deur die magte van vraag en aanbod in die nie-GM-mielie-uitvoermark en moet reageer op gunstige geleenthede soos dit voorkom. Die regering van Suid-Afrika moet ook 'n reguleringstelsel handhaaf wat die nie-GM- en GM-mielies volgens die mieliewaarde-ketting kan skei om voorsiening te maak vir die vraag na nie-GM mielies.

Sleutelwoorde: GM- en nie-GM-mielies, indikatiewe handelspotensiaalanalise, groeiaandeelmatriks en swaartekragmodel

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LIST OF ABBREVIATIONS

GMO	Genetically Modified Organisms
GM	Genetically Modified
ACB	African Centre for Biodiversity
DAFF	Department of Agriculture, Forestry and Fisheries
ISAAA	International Service for the Acquisition of Agri-biotech Applications
EU	European Union
ITC	International Trade Centre
HS	Harmonised System
BFAP	Bureau for Food and Agricultural Policy
IMF	International Monetary Fund
OPV	Open Pollinated Varieties
INES	Integrated National Export Strategy
DTI	Department of International Trade
SADC	Southern African Development Community
SACU	Southern African Customs Union
USA	United States of America
SARS	South African Revenue Services
ITP	Indicative Trade Potential
BCG	Boston Consulting Group
PPML	Poisson Pseudo Maximum Likelihood

CHAPTER 1: INTRODUCTION

1.1. BACKGROUND

Maize is the most important grain crop in South Africa, as a major feed grain and staple food for majority of the South African population (Mogala, 2018). The maize industry plays a significant role in the economy of South Africa, both as an employer and earner of foreign currency through exports. The significance of the industry is reflected through backward linkages to the input industries and forward linkages to the milling, animal feed, and food processing industries. According to the Maize Trust (2014), maize accounts for approximately 40% of South Africa's crop production value and around 15% of the total agricultural production.

South Africa's annual maize consumption requirements are predominantly satisfied by domestic production with limited imports. Currently, approximately 60% of maize produced in South Africa is white and 40% being yellow maize (Mogala, 2018). White maize is primarily produced for human consumption while yellow maize is mostly utilized for animal feed production. The current local market composition of domestically produced maize consumption generally shows the following pattern: humans (50%); the animal feed industry (40%) and the balance is used for seed and industrial uses (10%) (Mogala, 2018).

According to Jones, McFarlene, Park and Tranter, (2017), the development of all sectors and industries is largely associated with a heavy dependence on technology and commodity agriculture is no different. Maize production in South Africa is divided into GM and non-GM maize. GM maize includes genes that were transferred directly to the crop through genetic engineering to insert beneficial traits that could improve the agronomic performance of the crop (Van der Walt, 2010). Conversely, non-GM maize do not have any purposeful direct gene manipulation to the crop. Since the first introduction in 1998, the national Genetically Modified (GM) maize area has gradually increased from approximately 0.09% in 1999/00 to around 90% of the total maize area in 2016/17 (Mabaya and Abidoye, 2013 and BFAP, 2018). Because the vast majority of the maize produced in South Africa is GM, the majority of the surplus maize available for exports, is also GM. The general maize production trend is explained by the yield improvements, reduced cost of production and product price (Jones *et.al*, 2017, Gouse, Pray, Kirsten and Schimmelpfenning, 2005). The financial benefits accruing to GM maize producers are attributed to reduced input costs experienced as a result of lower expenditure on crop protection activities and improved revenues through increased yields.

The maize value chain in South Africa is thus dominated by GM maize which has rapidly displaced non-GM maize in the market. There are however, several hundred GM and non-GM maize hybrids and a range of open-pollinated varieties (OPVs) available to South African producers, although only 20-25% of varieties make up the bulk of seed sales (Van der Walt, 2010). The main reason for this is that South Africa does not generally have a strong domestic demand for non-GM commodities (Gruère and Sengupta, 2010). Only a few companies including Tongaat-Hulett Starch and Woolworth's supermarket chain purchase and market non-GM commodities and products. As a result, only about 10% of the total yellow maize area and 4% of the total white maize area in South Africa is under conventional, non-GM, maize production (BFAP, 2018).

Globally, there is an increasing effort being made to develop a regulation that advocates for choice possibilities between GM and non-GM crops for both commercial and smallholder farmers (Mabaya *et.al,* 2013). Furthermore, numerous countries have established dual marketing channels for GM and non-GM crops with GM crops being subjected to compliance requirements (Ngulube, 2015). Despite scientific consensus about the safety and agronomic benefits for farmers, mainly in terms of lower input requirements and hence lower costs to consumers, public caution about the growing of GM crops continues to grow (Mabaya *et.al*, 2013). In most African and European countries, policy and regulations on GM crops are increasingly shaped by public opinion and pressure groups (Mabaya *et.al*, 2013).

Several countries on the African continent have adopted a precautionary approach to GM crops, to a point of imposing bans on the adoption and importation of GM crops and / or commodities derived from GM crops. There are only four African countries which have formalised the cultivation of GM crops, being South Africa, Burkina Faso, Egypt and Sudan (Adenle, Morris & Parayil, 2013 and Mabaya *et.al*, 2013). South Africa is generally considered as being a successful importer and exporter of both GM and non-GM maize (Bouet and Gruere, 2010).

Despite this success, South Africa finds itself at crossroads between the GM-producing and GM-rejecting nations. The rapid increase in the production of GM maize in South Africa has meant that depending on the success of the domestic season and the maize production season in especially the region, the country faces a scenario of GM maize surpluses for export, but a largely non-GM export demand.

The trade of agricultural products such as maize is usually subjected to growing dilemma between countries that are pro the adoption and trade of GM products, and countries with restrictive adoption and prohibition of products derived from GM crops into their markets. As a result of this challenge, GM technology impact on trade has been widely studied by scholars such as Nielsen and Robinson (2002), Frisvold and Reeves (2015) and Van Wyk (2007).

This study seeks to quantify South Africa's maize export potential to non-GM maize markets with the aim of establishing whether there are opportunities for non-GM maize production expansion as well as economic benefits for farmers to increase the supply of non-GM maize. The findings of the study will inform policy decision-making regarding farmer support, market and export development.

1.2. PROBLEM STATEMENT

To achieve economic growth, South Africa has adopted an export-led growth strategy known as the Integrated National Export Strategy (INES) which aims to help improve the global competitiveness of South African exporters and take advantage of the export-led economic growth benefits that have flowed to other developing countries in recent decades (DTI, 2015). Maize features as one of the major agricultural foreign exchange earners in the country, with an export value of R5 073 million according to the 2017/2018 export values (Mogala, 2018). However, the high export market concentration and reduction in market share in historically major South African maize export markets, such as Zimbabwe, is a cause for concern.

South Africa's maize exports are concentrated within Southern African Development Community (SADC) and Southern African Customs Union (SACU) countries because more than 60% of SA's maize exports are destined for those countries. Restrictions related to GM crops has been observed as constituting an obstacle for penetrating most markets across the world (Kamau and Karin, 2013). A study by Bouet and Gruere (2010) found the rapid adoption of GM maize in South Africa, meant that in certain production seasons such as 2008/09, the country faced a problem of oversupply of GM maize, but with insufficient foreign demand. Moreover, as farmers adopted more GM maize traits and planted them in an increasingly large area, many countries in the region have started to ban imports of GM maize.

The maize industry in South Africa has a comparative advantage in Africa owing to amongst others lower cost of fertilisers, improved maize seed and comparatively better transport infrastructure (BFAP, 2016). However, the GM status of South African maize still remain a challenge limiting the extent of South Africa's maize exports to major market. Furthermore, most African markets prefer non-GM maize and the emergence of Zambia as a consistent surplus producer of non-GM has provided increasing competition for South Africa in its major SADC and SACU export markets (Mabaya *et.al.* 2013 and BFAP, 2016).

The limited extent of South Africa's maize exports and declining export share in traditional major import markets due to South Africa's GM status has meant that the country find itself at a crossroad between GM accepting and GM rejecting countries. Therefore, this study will seek to answer the question of whether South Africa could benefit from increased non-GM maize production in order to diversify its export base in the non-GM maize markets.

1.3. OBJECTIVES OF THE STUDY AND HYPOTHESES

The overall objective of this study is to determine whether South Africa could benefit from increased non-GM maize production, and export to markets to non-GM maize. This overall objective will be achieved through pursuing these specific objectives:

- To identify and rank South Africa's potential and existing non-GM maize export markets. It is hypothesised that there are a limited number of potential non-GM maize markets

- To estimate South Africa’s maize export potential in the non-GM markets. It is hypothesised that there exists a high potential for exports to non-GM maize markets
- To examine the forces that stimulate or restrain South Africa's maize exports in non-GM markets. It is hypothesised that there are no trade restraining forces for exports to non-GM maize markets

This study will not consider the farm level costs and benefits of GM maize, but only consider the potential from an export market point of view. The exclusion of the farm level cost imply that the study outcomes will not present the production costs associated with the GM and non-GM maize but rather focus on the export values as obtained in the trade database (i.e International Trade Centre (ITC)). This limits the study’s outcomes to determination of export potential without considering the farm level costs and benefits linked to the production of either GM or non-GM maize.

1.4. DATA DESCRIPTION AND KEY ASSUMPTIONS

To date, no formal database provides data on imports and exports of non-GM products by country. The only available data is a combination of GM and non-GM products. However, countries generally have implemented national import regulations on GM and non-GM product trade. Therefore, this study made a key assumption to derive the trade data used in the study by categorizing countries based on their domestic GM policies. Countries with highly restrictive GM regulations where classified as non-GM markets. The International Trade Centre through Trade Map provides time series data on various commodity exports and imports.

Similarly for maize, there is no distinction made between GM and non-GM maize when using the Harmonized System (HS) nomenclature, under which ‘maize’ is seen as homogeneous and described on a six-digit level coded as HS 100590. The HS nomenclature is a globally accepted customs standard for categorising products traded between countries (Elhanan, Melitz, and Rubinstein, 2008). The study, in an endeavour to segregate maize to denote the heterogeneity, grouped the various South African maize markets according to their GM policies and regulations. The grouping was established to separate South Africa's maize exports to draw out non-GM maize, which is the primary commodity to be analysed by the study.

A list of countries with non-GM product bias policies were regarded as non-GM maize market for the purpose of the study (Chapter 2 Table 2.1). This is done due to the trade database limitation of regarding maize as a homogeneous product. It is however duly noted that the application and implementation of the GM policies in the identified non-GM markets differs and GM product acceptance depends on a specific country's predisposition and circumstances. However, the common denominator in these markets is that they have established a non-GM identity preservation and segregation system to safeguard and maintain the domestic non-GM product stream (Moses and Brookes, 2013). It is therefore reasonable to classify countries according to their GMO policies.

1.5. METHODOLOGY

The estimation of trade potential can be conducted using a multifaceted number methodologies and techniques. However, for the purpose of this study, a three pronged methodological approach - growth-share matrix, indicative trade potential and gravity model was used to address the objectives on the study. This approach is thus used to identify unexplored non-GM markets, estimate trade potential and determine trade stimulating or restraining forces. The growth share matrix framework aimed to help firms with prioritizing their resources (Henderson, 1979). The technique essentially views a firm as a portfolio of businesses, each offering a unique contribution to the overall growth and profitability of the firm. In the context of this study, the firms are viewed as different countries (markets) for South Africa to explore and their overall potential is based on their growth and share relationship.

The Indicative Trade Potential (ITP) was then used to measure South Africa's capacity to expand its non-GM maize exports, with its potential or existing trading partners. To establish trade stimulating and inhibiting forces, the gravity model was used to gives country specific trade determinants. The decision to use the three-pronged methodological approach was primarily based on the need to provide a complete analysis of South Africa's trade potential.

Moreover, using the three approach avoids the problem of getting biased and inconsistent findings linked to the use of only one of these approaches.

1.6. OUTLINE OF THE STUDY

This study is divided into five specific chapters aimed at addressing the study objectives. Chapter 2 provides a brief probe of the maize production and trade trends, legislative environment and emerging issues in the maize industry. Chapter 3 discusses the various techniques used for exploring and establishing trade potential. Chapter 4, describes the data and processing of data for empirical estimations while also presenting and interpreting the results. Finally, Chapter 5 concludes and provides recommendations.

CHAPTER 2: OVERVIEW OF GM REGULATION

2. INTRODUCTION

The chapter strives to identify non-GM markets by briefly discussing the restrictive GM regulations across different countries. To further contextualise the study, the chapter provides a discussion on the on GM versus non-GM maize production in South Africa. Finally, South Africa's maize trade trends are discussed.

2.1.GLOBAL GM REGULATIONS

The commercial cultivation of GM crops began in 1996 and subsequently expand in both industrialised and developing countries (Davison and Ammann, 2017). However, the exchange of agricultural products across national borders is increasingly divided between GM accepting and GM rejecting countries. This segregation thus leads to a barrier to international market access owing to the separation of markets based on GM and non-GM crops. The division between GM and non-GM crops can lead to import bans, shipment refusals and cost delaying barriers to trade (Miankhel, Thangavelu and Kalirajan, 2009). Depending on the country, the legislation may regulate application at different points along the supply chain of the crop, from the seeds planted by farmers in exporting countries, to farmer's fields, grain handling and transport system, port facilities, food processing and distribution firms in the importing countries (Miankhel *et.al*, 2009).

Table 2.1 below briefly outlines countries with restrictive GM policies from different continents. All activities relating to GM crops are regulated and countries thus have different authorization procedures. Therefore, there is no consistent and harmonized set of rules to facilitate international trade of GM crops and related products due to the substantial differences in the laws and regulations (Davison *et.al*, 2017). However, the common attribute in the GM policies is that they are generally precautionary with safeguard mechanism to try and prevent any undesirable entry of crops carrying GM traits at any stage of the product's supply chain.

Table 2.1. Countries with restriction on GM crops

Continent	Country/State/Countries	Brief description
Europe	France, Ireland, Norway, Greece, Austria, Germany, Spain, Italy, Portugal and Luxembourg	All these countries have put in restrictive laws on GM products. Notably, France is further ahead with specific definition of what "GMO-free" means when it comes to food labelling.
Africa	Algeria, Angola, Madagascar, Kenya, Zimbabwe, Malawi, Mauritius, and Zambia	In Algeria both the planting and distribution of GM food is illegal while Kenya, Zambia and Zimbabwe have restrictive GM product laws.
Middle East	Saudi Arabia	There has been a ban on the growing of GM food and the importing of GM wheat. However, GM maize importation is permitted.
The Americas	Paraguay, Peru and USA	Despite the United States allowing of growth and imports of GM foods, they have initiated mandatory labelling requirements in most states. Paraguay and Peru also has restrictions on GM foods
Asia	Kyrgyzstan, Thailand and Japan	These countries have all put in place laws that limit GM foods. Thailand imposed a ban on GM imports early 2001, while Japan have also implemented GM restrictive laws

Sources: Kamua and Karin (2013) and International Service for the Acquisition of Agri-biotech Applications (2018)

Europe has majority of countries with GM restrictive policies which relate to mandatory labelling and traceability requirements for both processed and unprocessed GM crops barring non-GM products. Moreover, Europe follow the zero tolerance policy, under which GM imports (i.e. products with GM content more than 0.9%) are rejected at detection level (Davison *et.al*, 2017). In the United States, GM crops are generally not treated different from traditional plant breeding because laws are product-specific. The laws regulate the use of products such as food or pesticides and not the underlying process (Scott, Inbar and Rozin, 2016). Therefore, as long as a GM crop is similar to a conventional crop, no authorization is needed for its cultivation, use or trade. In Africa, the GM restrictive laws generally require all GM maize imports to be milled in the exporting country, meaning that the countries do not conduct tests on the shipments but rather rely on tests and certifications of the exporting countries (Van Wyk, 2007). Supermarkets in countries in Asia such as China and Japan have instituted private standards to avoid GM ingredients in the products they sell (Vigani, Raimondi and Olper, 2012).

Generally, bilateral resemblances or disparities in GMO regulation affects trade flows between trading partners. The parallels in trading partner's GMO regulations in labelling policies, approval processes and traceability systems have trade enhancing effects while GMO regulation disparities have trade restricting effects. As a results, both public and private sector policies on GMOs and food derived from GM crops are topical issues in contemporary agri-food chains. Globally, large agri-food importers such as Japan and the European Union (EU), have adopted strict GMO regulations, and this has the potential to present production dilemmas for GMO producing countries which rely on these markets for exports (Viguani, Ramondi and Olper, 2010). According to Viguani *et.al.* (2010), vast differences in GMO regulations between countries will result in less trade taking place between the countries. This suggests that the degree of harmonization on GMO regulation is pertinent for trade between countries. Therefore, GMO regulation similarities are an important factor in international trade between countries.

2.2.SOUTH AFRICA'S REGULATORY FRAMEWORK FOR GM USE

South Africa's regulatory framework for the use of GM is outlined in the Genetically Modified Organism Act of 1997, (Act 15 of 1997). The Act through the operations of the regulatory authorities, regulates all activities (production, application, use or release) relating to GMO in South Africa. Furthermore, permit restrictions, risk assessment measures and public notifications of releases of GM product are mandatory for all research, production and marketing of GM products under the Act (Rijssen, Moris and Ellof, 2013).

The production of maize in South Africa is categorised as GM and non-GM maize, as such maize is subjected to compliance with various items of legislation related to GM. However, non-GM maize is not subjected to compliance with any of GMO Act of 1997 because it is considered to be 'conventional' and there has been no perceived manipulation of the genetic structure of the crop.

South Africa features as one of only a few of African countries that have successfully adopted the Cartagena Protocol on Biosafety. Adopted on 29 January 2000 and subsequently entered into force on 11 September 2003, the protocol essentially governs the movement of Living Modified Organisms (LMOs) across national borders. The objective being to protect biological biodiversity from any potential risks presented by LMOs from modern biotechnology that may have adverse effects on the conservation and sustainable use of biological diversity. South Africa since giving accession to the protocol in November 2003, has drafted and implemented a Biosafety Strategy that enables it to import and export GM maize in both GM-rejecting and GM-accepting countries. The protocol is therefore concerned with the common steps to be undertaken between exporting and importing during the transboundary movement between two countries. **Figure 2.1** below depicts the details of all items of current legislation in South Africa that regulate all activities relating to GMOs.

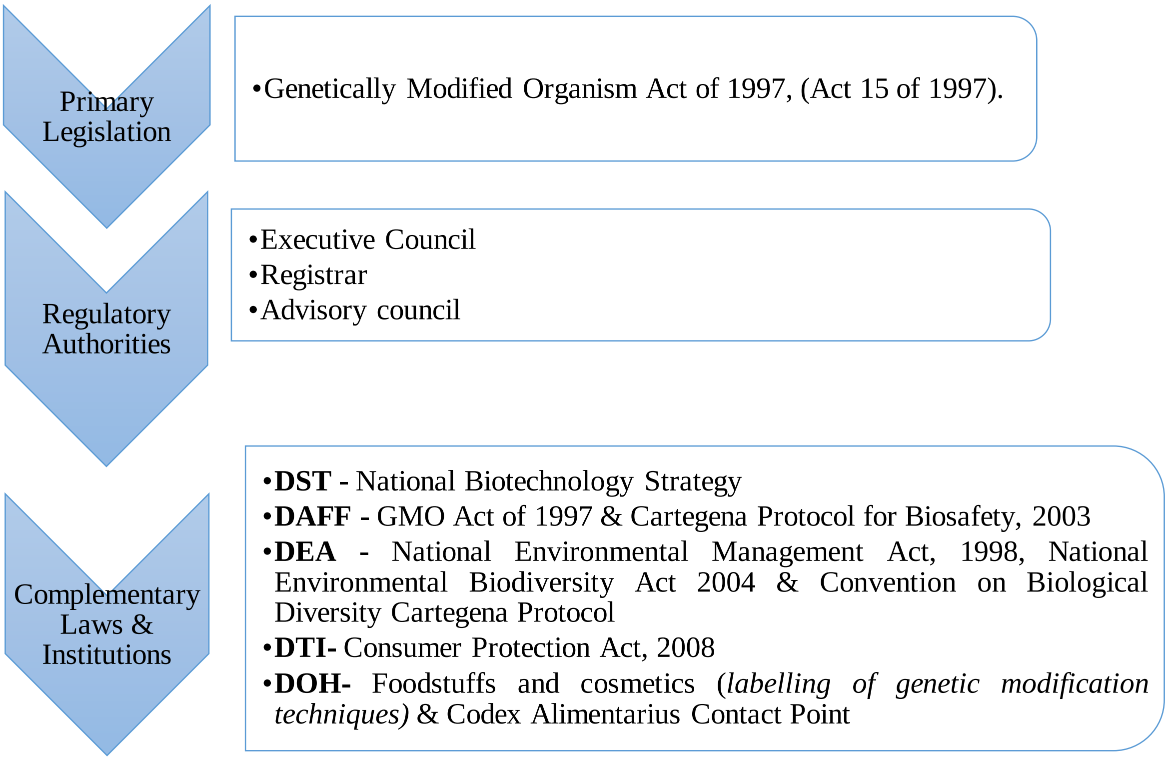

Figure 2.1: South Africa's GM legislative framework
Source: De Beer and Wynberg (2018).

The primary GMO Act decision making structure comprises of the Executive Council, the Advisory Committee and a Registrar. Each of this structure established under the Act is tasked with performing the following functions (De Beer and Wynberg, 2018):

i. The Executive Council (EC) advices the government, industry and public on the safety activities involving GMOs and ensure that all activities with regard to the development, production, use, application and release of GMOs are performed in accordance with the provisions of the Act. The Council is comprised of representatives from government departments in South Africa, Agriculture, Forestry and Fisheries (DAFF), Health, Labour, Science and Technology, Water and Environmental Affairs, Art and Culture, Tourism, Trade and Industries. However, the Department of Agriculture, forestry and Fisheries that chairs the Council.

i. The Advisory Committee serves as a national advisory body on all matters concerning or related to GMOs. The committee is constituted by a body of scientific experts primarily responsible evaluating the scientific data contained in applications.

ii. The registrar is charged with the responsibility of the administration of the Act subject to the instructions of and the conditions laid down by the Council (such as issuing of permits and ensuing compliance with permit conditions by applicants). The register is appointed by the Minister of Agriculture, Forestry and Fisheries (DAFF).

Therefore, before a decision on the use of GMOs is made, a multidisciplinary risk assessment process is undertaken involving a scientific Advisory Committee and the cross-governmental decision-making body, the Executive Council.

2.3.SOUTH AFRICA'S MAIZE PRODUCTION TRENDS

South Africa's maize production includes both GM and non-GM maize. In this section, the aim is to reflect on the production patterns observed for the different types of maize produced in South Africa. A specific focus is made on reflecting the gradual shift in maize production from non-GM maize to GM maize. Furthermore, the rationale behind the shift is discussed.

2.3.1 GM and non GM maize production in South Africa

Figure 2.2 below depicts South Africa's GM and non-GM maize production for the production seasons 2001/02 to 2016/2017. The graph indicates a gradual shift in maize production from non-GM maize production to GM maize production. This is indicated by the consisted decline in non-GM maize, both yellow and white maize from 9.1 million tons in the 2001/01 production season to 162 601 tons in the 2016/17 production season. Conversely, GM maize production has been gradually increasing 2001/02 to 2016/17.

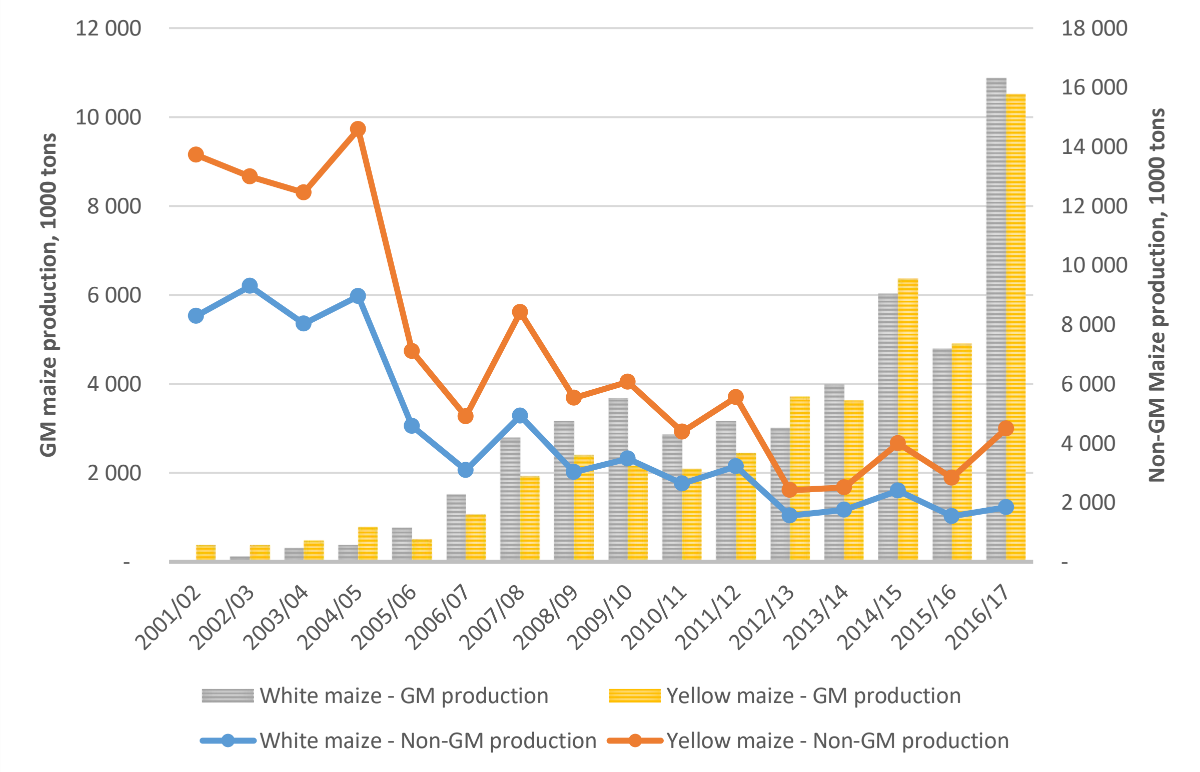

Figure 2.2: South Africa's GM and non-GM maize production.
Source: GrainSA, 2018

The rationale behind the seemingly skewed maize production is that maize production in South Africa is to a large extent attributed to the market-driven economy in the country which determines the choice of the type of maize seed a farmer utilise in production (Van der Walt, 2010). According to the African Centre for Biodiversity (2010); the economic benefits of planting GM crops and the costs of the identity preservation system necessary to segregate GM and non-GM crops are the main variables that farmers consider in their choices of crop to produce.

Various GM crop adoption studies generally found that farmers derive higher economic benefits, primarily at farm level, which incentivise them to rapidly adopt GM maize, in preference to non-GM maize (Mabaya *et.al*, 2015, Brookes & Barfoot, 2018, Gouse, 2004, Smyth, Kerr & Phillip, 2015, Raman, 2017 and Gouse *et.al*, 2005). Moreover, the production of GM maize has been observed to require less frequent use of insecticides and herbicide spraying as well as lower fuel use which consequently reduces the amount of carbon dioxide released into the atmosphere (Brookes and Barfoot, 2010). These benefits make GM maize production more attractive to farmers than non-GM maize. Moreover, GM crop production is most preferred because most farmers regard GM maize production as offering a solution to the important problems in agriculture of pest infestation, drought, plant diseases and high use of pesticides (Aerni and Bernauer, 2006).

In instances where the cost of separation of GM and non-GM maize is lower than the premium receivable for non-GM maize, GM maize farmers tend to also produce non-GM maize to supply the non-GM maize niche markets (African Centre for Biodiversity, 2010). Non-GM maize producers employ the segregation, identity preservation and traceability systems to separate the non-GM maize from GM maize. These systems essentially allow for the tracking of the maize crop back to its point of origin along the commodity chain to ensure that no contamination has occurred. Due to the strict segregation requirements and the increasing adoption of GM maize, a group of farmers have appeared who tend to specialise in the production of non-GM maize. They produce maize under contract for mainly grain trading companies and tend to only produce non-GM maize, or at least spatially and logistically separate their GM and non-GM crop production activities. Most of these farmers are situated in the maize production regions of Mpumalanga where grain trading companies have access to sufficient storage facilities earmarked for non-GM maize.

Figure 2.3 below indicates South Africa's major maize producing provinces from the production seasons 2000/01 to 2017/18. In the nine provinces in South Africa, the Free State, Mpumalanga and the North West provinces produces the largest quantities of maize. The highest total maize production was obtained in the production season 2016/2017. This production is achieved subsequent to a drought prone production of 2015/16 where South Africa produced the least quantity of maize.

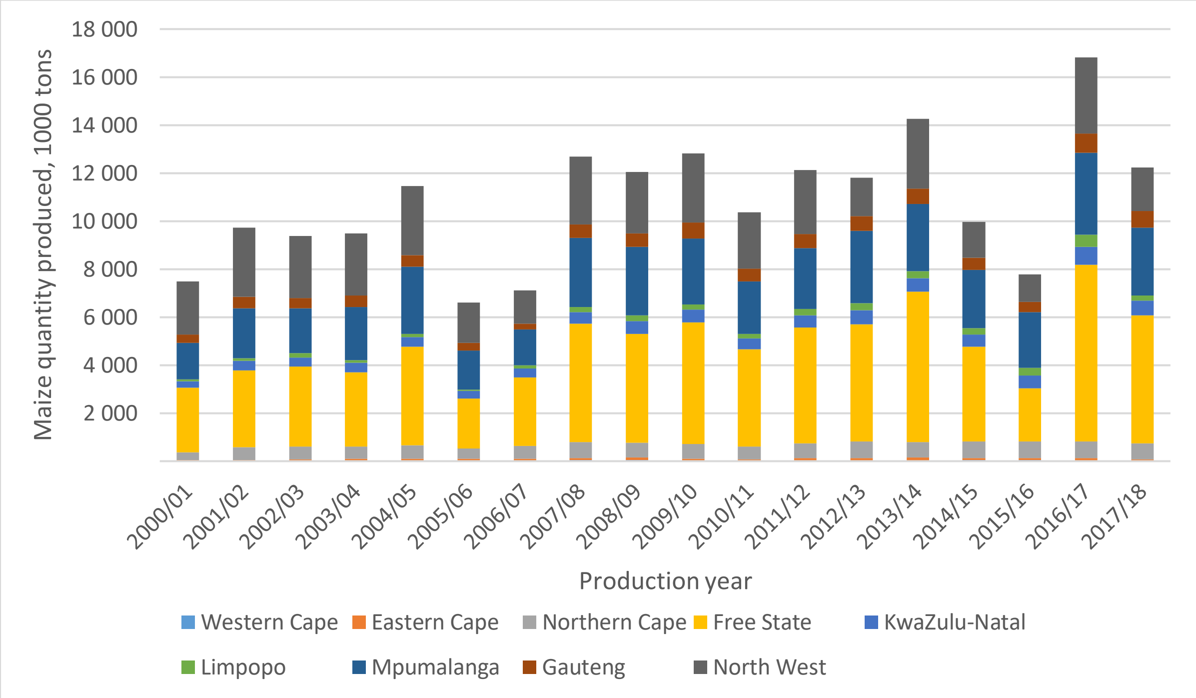

Figure 3.3: South Africa's maize production by province
Source: Abstract (2018)

Commercial agriculture produces approximately 98% of maize in South Africa with the difference being produced by developing farmers (Mogala, 2018). South Africa's total maize production over the production has notably fluctuated largely attributed to unfavourable climatic conditions and reduced planted area. The Eastern Cape, Western Cape and Limpopo provinces produce less maize relative to other provinces in South Africa.

2.3.2. South Africa's maize industry supply chain

The maize industry in South Africa has linkages to the primary, secondary and tertiary sectors. The backward linkages extends to the input industries and forward linkages to the milling, animal feed, and food processing industries. **Figure 2.4** illustrate the entire maize industry in South Africa. Since the development of maize industry in South Africa is heavily dependent on technology, research and biotechnology is a vital component of the maize supply chain. It helps the industry respond to changing climatic and market conditions through scientifically proven practices that help farmers in the production and marketing of their maize produce.

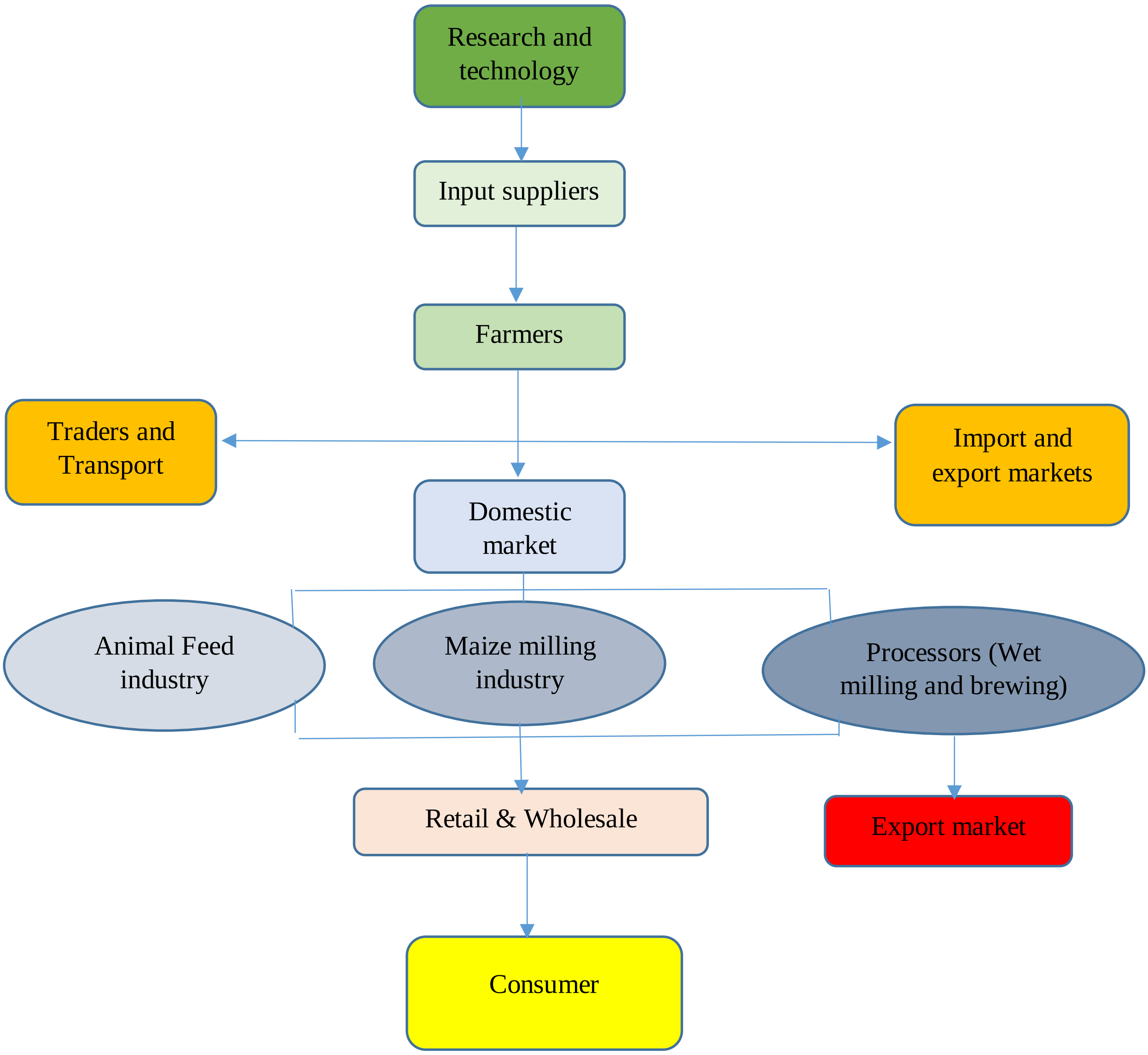

Figure 4.4: South Africa's maize supply chain
Source: Maize Tariff Working group

The maize industry primary sector include input suppliers, farmers and silo owners. Following farmers' harvest of the maize, it is stored on farm storing facilities where is it subsequently supplied to potential buyers. The maize is traded both in the domestic and export markets. The maize milling industry converts the maize to maize meal for human consumption, conversely, the animal feed industry use the yellow maize for the manufacture of feed (Mogala, 2018). Retailers and wholesalers are the primary outlets through which consumers (end-users) access the final products.

2.3.3 Price and demand of GM and Non-GM maize

The limited non-GM maize production has largely resulted in non-GM maize becoming a speciality crop which can be sold at high price relative to the GM maize which is produced widely. According to the African Centre for Biodiversity (2010), the demand for non-GM maize is limited to human consumption as there is no demand from feed manufacturers for non-GM maize. **Table 2.2** below indicates the average non-GM and GM maize seed price variations between 2014 and 2017 in South Africa.

Table 2.2: The average prices (R) of yellow and white GM and non-GM maize seeds 2014-2017

White maize				
Cultivar	**2014**	**2015**	**2016**	**2017**
GM	2 971	3 125	3 341	3 772
Non-GM	2 151	2 231	2 413	2 802
Yellow maize				
GM	2 852	3 045	3 311	3 822
Non-GM	2 156	2 363	2 558	2 913

Source: DAFF (2018)

Non-GM maize seeds are relatively cheaper than GM maize seeds for both yellow and white maize. The changes in white maize seed prices between 2014 and 2017 were recorded at 27% for GM and 30.3% for non-GM maize seed. Conversely, the price of non-GM yellow maize seed increased by 35.1% while the price of GM yellow maize seed grew by 34% in the same period. Despite the relatively low non-GM maize seed cost, most farmers in South Africa prefer GM maize seed mainly for the low production cost benefits linked to reduced herbicide and pesticide use, low labour requirement and low fuel use.

2.4. OVERVIEW OF SOUTH AFRICA'S INTERNATIONAL MAIZE TRADE

South Africa is generally a net exporter of maize barring years of adverse climatic conditions. This section endeavours to explore South Africa's maize trade overview through following trends in exports and imports of maize over a specified period with the objective of discussing the major trade trends in maize.

2.4.1. South Africa's maize exports

South Africa's maize export trend is depicted in **Figure 2.5** below and denotes an inconsistent, but inclining, export pattern. The periodic fluctuations can be explained by adverse climatic conditions (i.e. such as periodic droughts) being experienced domestically and in importing markets. Therefore, the consequent below average domestic maize production inhibit domestic surplus production for export.

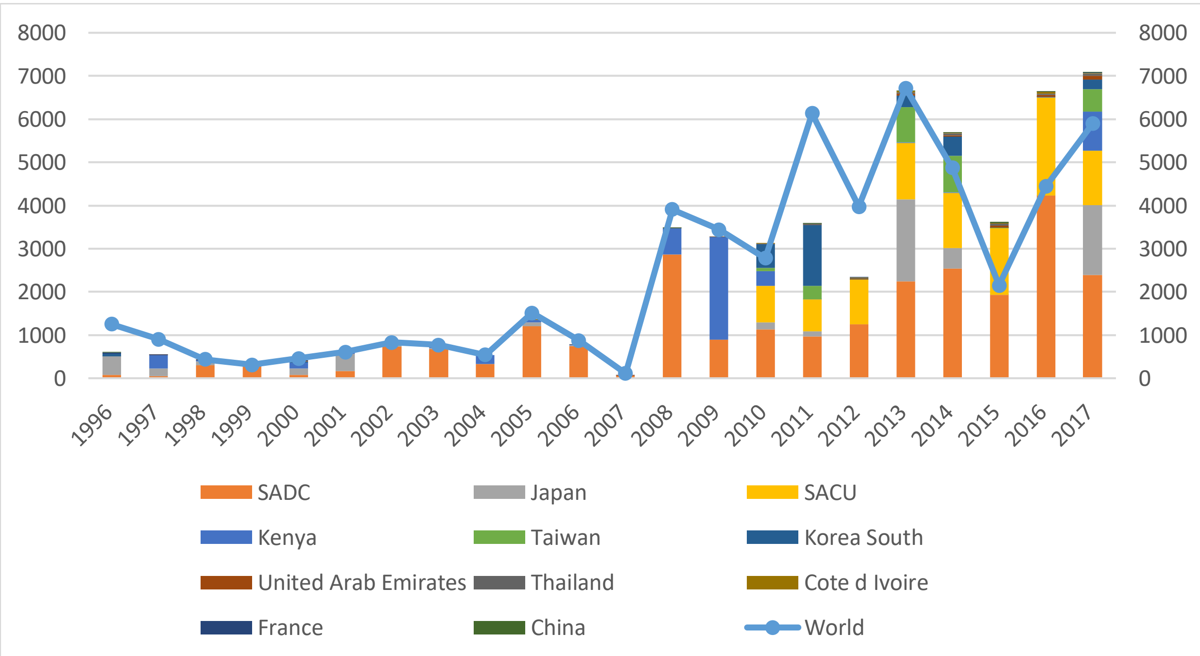

Figure 5.5: South Africa's maize exports between 1996 and 2017
Source: Global Trade Atlas 2018, SARS

South Africa generally exports white maize and imports yellow maize with the exception of drought prone years such as 2015/16 where South Africa had to import both yellow and white maize to make up for the insufficient production. The highest maize exported by South Africa was in 2013, at approximately R6.7 billion whereas the lowest exported value was observed in 2007, at approximately R111 million. SACU, SADC countries, Japan and Kenya have been South Africa's most preferred export markets over the period under review. The rationale for the skewed exports is attributable to a multitude of reasons including the proximity of the markets to South Africa and preferential market treatments. Any bilateral trade between South Africa and other SADC and SACU countries is subject to lower or no tariffs thus facilitating increased exports to member countries. Furthermore, the geographical distance between South Africa and the major maize importing countries is very small thus resulting in a reduction in transportation costs and encouraging trade.

The export trend reveals that South Africa mostly exports maize to SADC and SACU countries which constituted 60% of the major maize export destinations between 1996 and 2017. Based on the key assumption which were made by the study in classifying the markets (see Table 2.1), Japan, Zimbabwe and Kenya would be regarded as non-GM maize markets. Therefore revealing that of the top ten maize export markets, South Africa exports mostly to GM markets. The observed export trajectory highlights a reduction on export volumes to South Africa's maize exports markets such as Zimbabwe and Kenya. The primary for this export pattern is due to shifting consumer preferences in this markets from GM to non-GM maize thus importing increased quantities of maize from Zambia which is a predominant supplier of non-GM maize in Africa (BFAP, 2016).

2.4.2. South Africa's maize imports

Figure 2.6 below highlights South Africa's maize import trends between 1996 and 2017. South Africa generally meets its consumption demand for maize from domestic production. This is evident from the significantly inactive and low import activity for maize by South Africa.

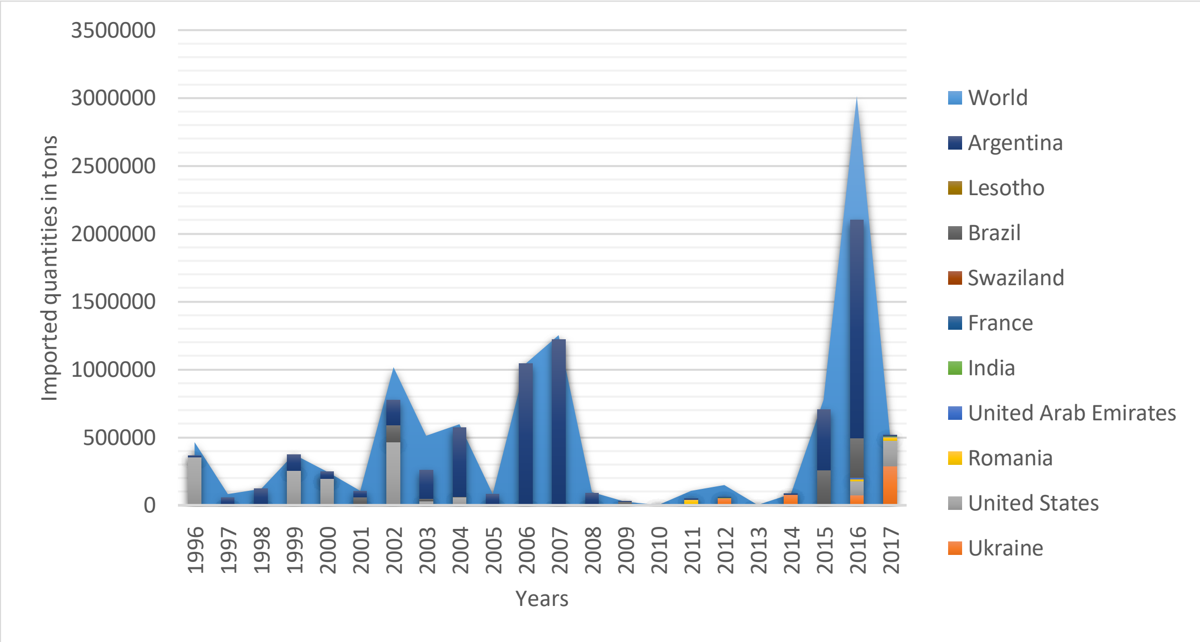

Figure 6.6: South Africa's maize imports between 1996 and 2017
Source: Global Trade Atlas 2018, SARS

South Africa had the largest spike in maize imports in 2016, which was largely attributed to the drought experienced in the country that resulted in the country having a negative maize trade balance during that year. Conversely, the period between 2008 and 2014 indicated the lowest maize imports by South Africa. The protracted low imports was explained by South Africa surplus maize production due to domestic farmers increasing the area for maize productions attributable to increases in average producer prices (Mogala, 2018). Moreover, improved yields and above normal rainfalls experienced during the period ensured higher maize volumes minimizing the requirements for imports (Mogala, 2018). Argentina, Brazil and the United States feature as South Africa's most preferred sources of maize.

2.4.3 South Africa's maize industry global competitiveness

The South African maize industry is relatively small in the global context and a price taker in the global market. **Figure 2.7** below illustrates South Africa's contribution to world maize production. South Africa faces stiff competition from major maize producing countries such as the United States, China, Brazil and Argentina. Maize grown around the world is generally classified into two groups, yellow maize predominantly used for animal feed and white maize which is generally considered a food crop (BFAP, 2015).

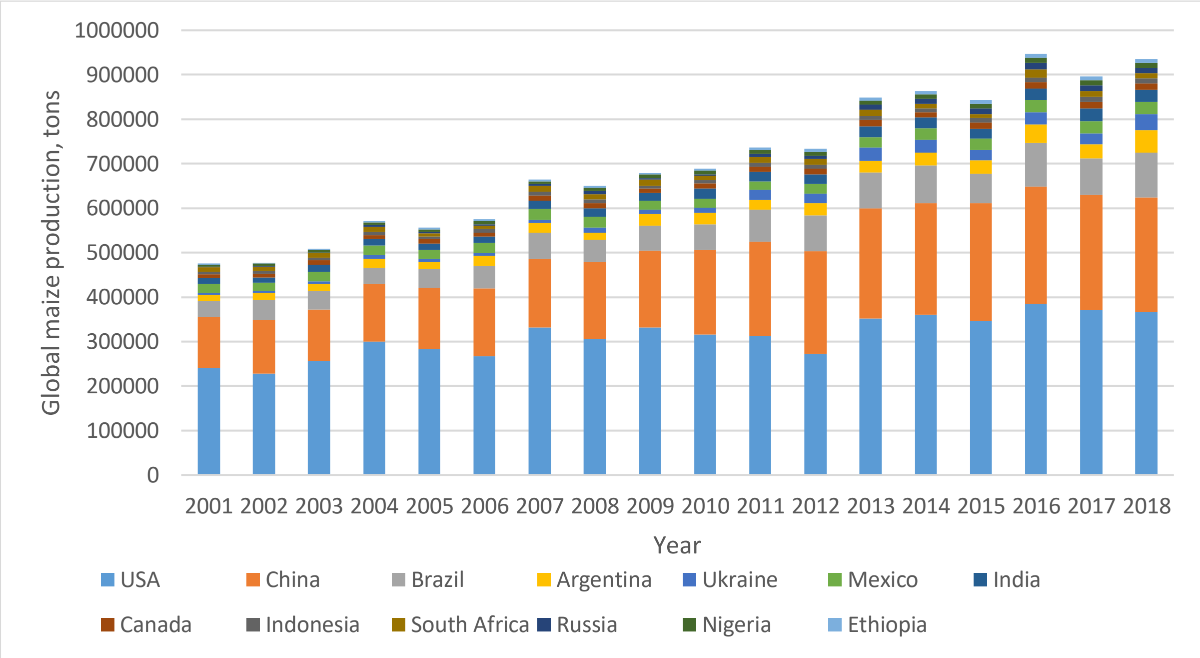

Figure 7.7: Global maize production between 2001 and 2018
Source: Index mundi, 2019

The United States is the largest maize producer of maize and exporter of maize in the world. This is largely attributed intensive use of technology in maize production and large area cultivated with maize in most states in the country (BFAP, 2015). South Africa is also global player in maize production, growing surplus maize for the export markets and value addition.

As illustrated in **Figure 2.8** below, South Africa participates in the global maize export markets. Global leaders in maize trade include the USA, Argentina and Brazil. This is not surprising as these countries are also leaders in global maize production. Since maize is categorised as either yellow or white maize, yellow maize generally constitutes a large share of total production and international trade. This is linked to the importance of yellow maize to livestock industry. Maize is an energy ingredient used in livestock and poultry feed with high levels of carbohydrates and fat which contribute to significant animal weight gain (BFAP, 2015).

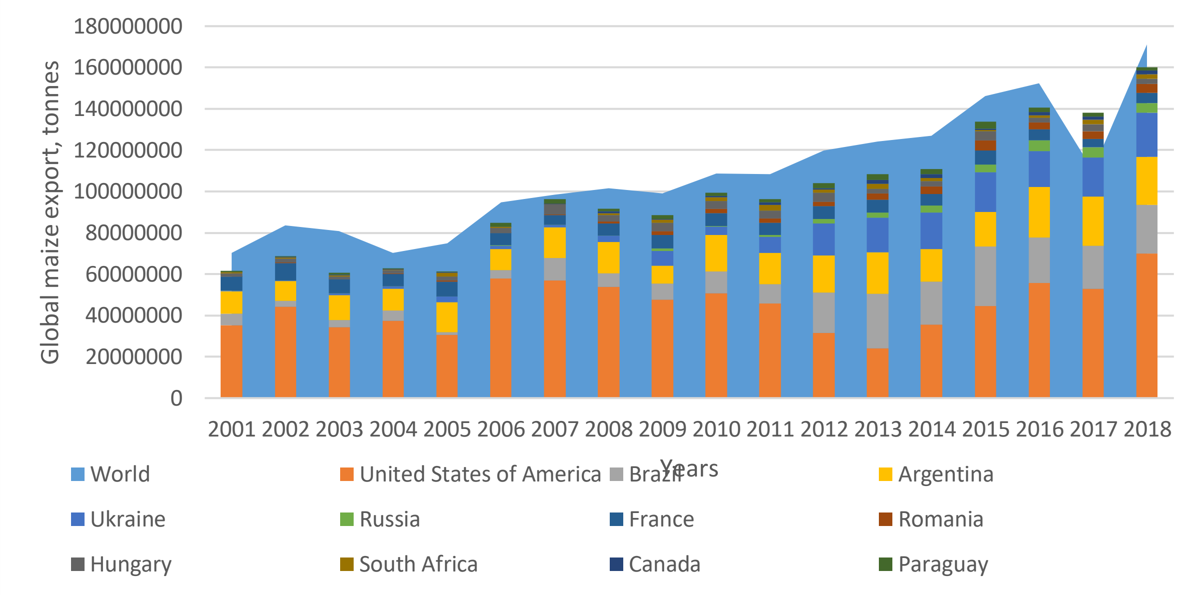

Figure 8.8: Global maize exports between 2001 and 2018
Source: Global Trade Atlas, 2019

The global maize export market has generally has an upward trend with the major export country, the United States displaying fluctuating trend through the period. However, despite the fluctuating export trend by the United States, it maintained its largest exporter status in all the years under consideration.

2.5.SUMMARY AND CONCLUSION

The preference of GM maize production over non-GM maize in South Africa is largely explained by the farmers potential economic and agronomic advantages associated with the production of GM maize over non-GM maize. The generally low GM premiums in South Africa coupled with the cost of separating GM and non-GM crops, have kept the ratio in favour of GM-maize. The market diversification for non-GM maize is largely confined to the human consumption market as there is generally no demand for non-GM maize for animal feed at a premium. The maize trade for South Africa is greatly concentrated within SADC and SACU countries with a fluctuating trend but South Africa has managed to largely maintain a positive maize trade balance with only exceptionally dry seasons necessitating imports from the main maize producing countries, yellow maize from Argentina, Brazil and the USA and white maize from Mexico.

CHAPTER 3: METHODOLOGICAL APPROACH

3. INTRODUCTION

The purpose of this chapter is to focus on the relevant literature to motivate the empirical methods selected for the three-pronged approach of the study, which will identify new markets, estimate the export potential and finally determine the forces that will stimulate or restrain trade in the markets. The methods include the growth-share matrix which will help address the objective of identifying and ranking potential and existing South Africa's maize markets, the indicative trade potential which will estimate South Africa's export potential, and the gravity model to examine forces that restrain or stimulate South Africa's maize exports. The conclusion of the chapter will provide a brief discussion on the relevance and appropriateness of the approaches to the study on South Africa's export potential of non-GM maize.

3.1. GROWTH-SHARE MATRIX

The growth-share matrix is a framework that has its origins in the field of business management. First developed by the Boston Consulting Group (BCG), the framework aimed to help firms with prioritising their resources (Henderson, 1979). The technique essentially views a firm as a portfolio of businesses, each offering a unique contribution to the overall growth and profitability of the firm. In the context of this study, the firms are viewed as different countries (markets) for South Africa to explore and their overall potential is based on their growth and share relationship.

		Market Share	
		High	Low
Growth Rate	High	**STARS**	**QUESTION MARKS**
	Low	**CASH COW**	**DOG**

Figure 3.1: Growth Share Matrix
Source: Henderson (1979)

The matrix basically groups each potential export market into four categories, with two axes of the matrix, the vertical axes represent the relative market share (ability to generate cash) and the horizontal axes represent the growth rate (need for cash). In accordance with the study objectives, the market categorization is made as follows (Kapuya, Chinembiri and Kalaba, 2014);

"Question marks" are markets with a *high growth and low market share* meaning that they have the potential to expand their growth and market share of South Africa's non-GM maize exports. In these market, the demand for South Africa's non-GM maize is growing at a faster rate than South Africa's exports to the rest of the world. Conversely, South Africa's share of exports to the market is lower than South Africa's share of total world non-GM maize exports.

"Cash cows" are markets with a *low growth and high market share* ratio. South Africa can generate sufficient export revenues to sustain future export presence in these markets. However, such markets present limited scope for further expansion of exports because that has a potential to result in diminishing marginal return to trade. In such markets, the demand for South Africa's non-GM maize is growing slower than South Africa's non-GM exports to the rest of the aggregated non-GM maize markets in the world. Simultaneously, the share of South Africa's non-GM maize exports to these markets is higher than South Africa's share of total world non-GM maize markets.

"Dogs" are markets with a *low growth and low market share* ratio. Kapuya *et.al.* (2014) have described these markets as being those which are fully matured or emerging markets. This means that less emphasis especially in the short-term should be placed on such markets given the stunted revenue generation potential of these markets. However, a long-term prioritization strategy might be adopted for such markets especially if identified as new or emerging markets**.** In these markets, the demand for South Africa's non-GM maize is growing at a slower rate than South Africa's exports to the rest of the world. Similarly, South Africa's share of exports to these markets is lower than South Africa's share of total world non-GM maize exports.

"Stars" are markets with a *high growth and high market share* ratio. In these markets, the demand for South Africa's non-GM maize is growing at a faster rate than South Africa's exports to the rest of the world. Similarly, South Africa's share of exports to these markets is higher than South Africa's share of total world non-GM maize exports.

The growth share matrix has been used by numerous studies to identify new markets for countries. These includes studies by Sihlobo (2016); Kapuya *et.al* (2014), used this approach to identify South Africa's potential export markets for maize and citrus, respectively. In these studies, the growth-share matrix was utilized to rank South Africa's markets based on their relative market shares and growth rates. This technique was preferred due to its effectiveness in identifying new markets to explore and existing markets for diversification. Moreover, the matrix offers an advantage of being an indicator of competitive strength for industries or commodities (Sihlobo, 2016, Gellynck and Viaene, 1993). For this study, this methodology is used to identify South Africa's potential and unexplored non-GM maize markets so as to allow for the facilitation of market prioritisation based on the classification of the identified markets. The trade data will be sourced from Trade Map.

3.2. INDICATIVE TRADE POTENTIAL

The concept of trade potential is generally defined as the trade that could be realized at an optimum trade frontier (Armstrong, 2007, Miankhel, Thangavelu and Kaliapaa, 2009). The optimum trade possible is subject to a country's current level of trade, transport and institutional technologies. In other words, it is considered as the maximum level of trade given the current level of determinants of trade as well as the least level of restrictions within the economic system (Miankhel et.al. 2009). There is thus an existing disparity between potential and actual trade. The gap is directly proportional to various socio-economic and institutional factors (i.e. such as weak economic growth, poor trade infrastructure and restrictive trade policies) which inhibits the actual trade to achieve the maximum level of trade.

The importance of estimating trade potential is premised on the ability for countries to undertake bilateral and multilateral processes or domestic reforms to reduce any existing restrictive measures to trade growth (Miankhel *et.al,* 2009). Therefore in pursuit of economic prosperity and reform, attaining maximum trade is one of the objectives to be realized by countries.

Many studies have endeavoured to evaluate a country's export potential by using the gravity model (Zarzo and Lehmann 2003, Rahman, Shadat and Das 2006; Armstrong 2007; Isardi 2010 and Cassim 2010). This approach has been widely used by academics because of its simplicity and history. However, a recent study by Bothma and Cant (2010) indicated that a joint methodological approach using Indicative Trade Potential (ITP) and the Gravity Model for measuring trade potential provides a more complete analysis of trade potential. This because while the gravity model may be a useful tool to measure trade potential between two countries or identify the most suitable countries to trade with, the model usually fails to provide clarity on the nature of the potential trade between the two countries; for example, what products should be traded (Bothma *et.al*, 2010 and Armstrong, 2007). Therefore, the use of the indicative trade potential technique allows for product level trade data analysis to highlight products or product groups with a greater chance of success and countries which will offer the best opportunities for success.

A complementary approach is able to account for all the deficiencies and inconsistencies presented by the sole utilization of the gravity model. Using Trade Map, an analysis of increased width and depth of information on products potential success in the different markets identified (Bothma *et.al*, 2010). Trade Map is an online trade database platform operated and maintained by the International Trade Centre (ITC) that makes it possible to analyse trading patterns between countries in the world (Alvarez and Bijl 2006). Bothma *et.al* (2010) argued that the ITP method provides a clearer insight and understanding of trade potential than what is possible with the use of the gravity model on its own. Since the ITP method allows for the examination of existing trade patterns, it can indicate the best chances for success for a product in various markets. The ITP indicator will be calculated to identify potential for both existing markets for expansion opportunities and new market to initiate market presence (Sihlobo, 2016, Kapuya *et al*, 2014; Helmers and Pasteels, 2005).

The ITP is presented by:

$$\text{ITP}_{ijk} = min(X_{ik}, X_{jk}) - X_{ij} \quad (3.1)$$

where; $X_{ik} = \sum_{j=1}^{j} X_{ijk}$ and $X_{jk} = \sum_{i=1}^{i} X_{ijk}$

Where, i and j are exporter and importer subscripts respectively, X_{ik} is the sum of South Africa's maize exports to the world, X_{jk} is the sum of maize imports from the world by the identified country/market and X_{ij} is the sum of South Africa's maize exports to the identified country/market. The data is sourced from ITC TradeMap.

The ITP of a country measures the capacity of that country to expand its bilateral trade, with both its unexplored and existing trading partners. Based on the ITP calculations, the identified countries were ranked from those with either high or low potentials. Countries identified as high or low potential are defined using critical values based on the trade-weighted average supply potential of South Africa to identified markets. That is, using Trade Map, an indicative trade potential view of the trade data flows is computed based on the following logic: The supply is presented by the exports of the selected country (South Africa) to the world, while the demand is represented by the imports of the selected partner country from the world. The minimum between the two from which the bilateral trade is subtracted is the indicative potential trade. The ITP thus provides a means for ranking potential markets based on their attractiveness and potential scope expansion in terms of trade (more specifically export).

3.3. GRAVITY MODEL

The gravity model is one of the predominantly used methodologies for estimating the determinants of trade. Therefore, this model will be used to address the objective of examining the forces that stimulate or inhibiting South Africa's non-GM maize exports. The gravity equation is a simple empirical model used for estimating the size of bilateral trade flows between countries by taking into account the supply conditions in the exporting country and the demand conditions in the importing country. This equation is described as the workhorse of international trade research (Eichengreen and Douglas, 1998). The gravity model for panel data has been used in numerous studies to analyse the determinants of the trade of a group of commodities exported by a country, and less frequently for specific commodity exports by countries (Wang and Badman, 2016 and Scheltema, 2013). The underlying rationale of the model is that the volume of trade between two countries depends on each country's trade potential and the trade attraction forces between them. The basic trade gravity model formulated by Tinbergen (1962) and Pöyhönen (1963) was specified as follows;

$$X_{ij} = \frac{KY_i^{\alpha}Y_j^{\beta}}{D_{ij}^{\Theta}} \quad \mu_{ij} \tag{3.2}$$

where X_{ijt} is the value of the bilateral trade between country i and j, and Y_{it} and Y_{jt} are country i and j's national incomes (GDP), respectively; D_{ij} is a measure of the bilateral distance between the economic centres of the two countries and K is a constant of proportionality; α refers to the potential to create exports, β refers to the importers potential to attract imports, Θ indicates the impedance of trade as distance changes and μ_{ij} is a random error term. Equation 3.2 can be converted into the linear form by taking the logarithms of both sides as follows;

$$lnX_{ij} = lnK + \alpha lnY_i + \beta lnY_J + \Theta D_{ij} + \delta Z + \mu_{ij} \quad (3.3)$$

In Equation 3.3, δZ represents all variables that are not in the model (such as population or colonial ties) but which can influence trade between country i and j, while μ_{ij} is the error term. As this is the traditional gravity model, an augmented gravity model of trade can also be presented to allow for a realistic representation of the trade relationship between countries. The augmented gravity model can thus be written as;

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} P_i^{\beta_3} P_j^{\beta_4} D_{ij}^{\beta_5} V_{ij}^{\beta_6} \varepsilon^{\mu_{ij}} \quad (3.4)$$

where P_i and P_j are the populations of the exporter and importer respectively, V_{ij} represents all other possible variables that could either restrict or stimulate exports between the trading partners such as common language, landlocked, applied tariffs, common borders, regional trade agreements, exchange rate and colonial ties and the variables Y and D still have the same representation as in Equation 3.2.

3.3.1. Critique on the Gravity Model

The gravity model as a flexible international trade model has been successful in explaining variations in bilateral trade patterns between pairs of countries. An important shortcoming of the gravity model relating to agricultural production is that it neglects supply side constraints (such as weather patterns, pests) evident in the agricultural sector (Idsardi, 2010). The primary criticism of the model has been its lack of theoretical foundation as revealed by Anderson, (1979), Bergstrand, (1985), Anderson and Van Wincoop, (2003) and Feenstra, (2004). However, since its development in 1962 by Tinbergen, the model has undergone various developments to account for the lack of theoretical foundations, correct specification, especially when dealing with panel and cross sectional data as well as interpretation issues relating to the empirical estimations of the gravity equation (Egger, 2000; Egger and Pfaffermayr, 2004). In the presence of zero-valued trade flows between pairs of countries, the traditional log-linear gravity equation has led to bias and inconsistent results. The traditional gravity equation assumes that trade between countries is always positive thus omitting or ignoring zero values in the regression estimates. Linders and De Groot, (2006) indicated the following issues regarding zero value trade:

i. Zeros do not indicate unobservable trade values
ii. Rounding of the trade flows as a cause of censoring is not an important explanation for zero flows because zero flows are a product of an individual country's potential profitability evaluation on bilateral trade.

Agricultural bilateral trade flows usually contains large amounts of zero-valued trade flows (Scheltema, 2013). These presents a problem when estimating log-linear gravity equations. Contestation still persists among scholars over empirical application concerns of the appropriate estimation technique and specification of the gravity equation. The most predominant of these concerns relates to the validity of the log linear transformation of the gravity equation in instances when heteroscedasticity and zero trade exist. In light of this fact, various techniques have rapidly been introduced to effectively deal with these concerns. These include truncated regression, Tobit estimation, the Extension and Intensive Trade Margins

Model, the Heckman Selection Model and Poisson Pseudo Maximum Likelihood (PPML) (Kareem, Zarzaso and Bruemmer, 2016).

The PPML technique is generally preferred over the usual Ordinary Least Square (OLS) technique because it is considered to be consistent in the presence of heteroscedasticity and zero trade flows (Silva and Tenreyro, 2006, Scheltema, 2013 and Kareem *et.al*, 2016). According to Silva *et.al* (2006), such observations are dropped from the OLS model because the logarithm of zero is undefined. The omission of this values results in a sample selection bias. For the purpose of this study, the PPML technique was used to estimate the gravity equation, as heteroscedasticity and zero trade values exist in the data used for the study. The use of PPML to estimate the gravity model will provide the lowest biased results for the study. Moreover, since the PPML gravity equation will be specified at levels, it allows for obviating the problems that arise using OLS under log-transformation.

The rationale for use of this method is based on the predominant zero trade flows between South Africa and most non-GM maize markets. Therefore, the ability of Poisson models to include zero trade values without any additions to the basic model is highly desirable for this research. This is because South Africa's non-GM maize has zero export values in many years amongst the non-GM markets. Furthermore, in order to explore the potential export penetration and diversification opportunities for South Africa's non-GM maize, both existing export markets and new markets need to be scanned to evaluate the trade stimulating and restraining effects.

3.3.2. Model specification

For this study, the gravity model will estimate South Africa's trade flows to major non-GM maize markets (i.e. as identified in Chapter 2 table 2.1) to determine the standard trade flow determinants and fixed effects estimations for the period from 2001 to 2017. The specification of the multiplicative gravity model applied to the study is outlined below:

$$Y_i = \beta_0 Cons_{jt}{}^{\beta_1} Prod_{it}{}^{\beta_2}\, Tariff_{ij}^{\beta_3}\, GDPcap_{jt}{}^{\beta_4}\, Dist_{ij}{}^{\beta_5}\, Land_j^{\beta_6} ComL_{ij}^{\beta_6} ai\, \mu_{ij} \quad (3.5)$$

Where;

Yi = is South Africa's non-GM maize exports,

$Cons_{jt}$ = is the importer's non-GM maize consumption,

$Prod_{it}$ = is South Africa's non-GM maize production,

$Tarriff_{ij}$ = is the tariff applicable to South Africa for maize in the trading partner's market,

$GDPcap_{jt}$ = is the import's GDP per capita,

$Dist_{ij}$ = is the distance to trading partner,

$Land_{jt}$ = is a dummy for being landlocked (1 = landlocked, 0 = otherwise),

$ComL_{ij}$ = is a dummy for common language (1 = English speaking nations, 0 = otherwise),

ai = is the fixed effect,

u_{it} = is the random error.

3.3.2.1. *South Africa's non-GM maize production, importer's income per capita and importer consumption*

The traditional gravity models use the Gross Domestic Product (GDP) to represent the demand for all tradable products in the import market and the supply of all tradable goods in the export market (Scheltema, 2013). However, since this study focuses on a single commodity, using GDP will not provide an accurate representation of the supply and demand for the specific single commodity. Therefore, more suitable proxies used to represent demand for non-GM maize by the importer would be non-GM maize consumption and income per capita. Moreover, the supply capacity of South Africa will be represented by non-GM maize production. Based on this, it is expected that the relationship between non-GM maize production, importer's income per capita and importer consumption and South Africa's non-GM maize exports is to be positive. The data for these variables were obtained from the World Bank Indicator (2018), the United States Department of Agriculture Foreign Agricultural Service's Production, Supply and Distribution database (USDA FAS,2019) and the International Monetary Fund (IMF,2019).

3.3.2.2. *Applied tariff*

The applied tariff indicates the tax charged or levied by the importing country on all imported products. The *ad valorem tariff*, expressed as a percentage of the value of the imported good was used for the study. The expectation is that there will be a negative relationship between the *ad valorem tariff* and the volume of trade. The tariff data was obtained from ITC market access map (2018).

3.3.2.3. Distance, common language and being landlocked

The distance between trading partners serves as a proxy for transport costs. The expectation is that a negative relationship exists between distance and exports, meaning that the further away trading partners are from one another, the less the trade between the countries will be. Countries that share a common language are generally expected to trade much easier and also incur lower information cost, which in turn facilitate trade (Scheltema, 2013). The dummy variable of one indicates that English is spoken in the selected country and zero for otherwise. Landlocked countries are those without access to ports and thus rely on transit to gain access to imported products. The expectation is that there will be a negative relationship between landlocked countries and trade. The data for both distance and landlocked status of a country will be obtained from CEPII (2018).

Taking the natural logarithm of both sides of equation (3.5), yields a log linear gravity model as outlined below;

$$lnY_i = \beta_0 + \beta_1 lnCons_{jt} + \beta_2 lnProd_{it} + \beta_3 lnTariff_{ij} + \beta_4 lnGPDcap_{it} + \beta_5 Dist_{ij} + \beta_6 Land_j + \beta_7 ComL_{ij} + \alpha_i + \mu_{it} \quad (3.6)$$

In the process of deriving the country-specific effects, the sample average for each of the variables per country was computed to get the following:

$$\bar{Y}_i = \beta_0 + \beta_1 \overline{Cons}_{jt} + \beta_2 \overline{Prod}_{it} + \beta_3 \overline{Tariff}_{ij} + \beta_k \bar{X}_{ik} + \alpha_i + \bar{\mu}_{it} \quad (3.7)$$

The equation was transformed by subtracting (3.6) from (3.7) to eliminate both the fixed effect α_i and constant to get the following equation;

$$(Y_i - \bar{Y}_i) = \beta_1 (Cons_{jt} - \overline{Cons}_{jt}) + \beta_2 (Prod_{it} - \overline{Prod}_{it}) + \beta_3 (Tariff_{ij} - \overline{Tariff}_{ij}) + \beta_k (X_{ik} - \bar{X}_{ik}) + (\mu_{it} - \bar{\mu}_{it})$$

(3.8)

Following the estimation of (3.8), the country level effects were drawn from the fixed effect residual to estimate the unobservable effects of bilateral trade between South Africa and its trading partners;

$$\hat{\alpha}_i = Y_1 - \hat{\beta}_1\overline{Cons}_{jt} - \hat{\beta}_2\overline{Prod}_{it} - \hat{\beta}_3\overline{Tariff}_{it} - \hat{\beta}_k\bar{x}_k \qquad (3.9)$$

This model thus gives us a complete understanding of South Africa's maize trade in non-GM maize markets. The gravity model completes the three-pronged approach of the study by serving as a market evaluation tool. That is, subsequent to the identification of potential markets and measuring of trade potential (high/low), the econometric construct of the gravity model provides a complete analysis of trade potential by determining the forces that will either stimulate or restrain trade in the various markets.

3.4. THREE-PRONGED METHODOLOGICAL APPROACH

The decision to use the three-pronged methodological approach was primarily based on the need to provide a complete analysis of South Africa's trade potential. A schematic representation of the complementary relationship between the three techniques is outlined in **Figure 3.2** below. The gravity model is most commonly used to measure the trade potential of many countries, as it is considered to be the workhorse for quantitative studies on international trade that determine trade potentials and trade flows (Eichengreen *et.al*, 1998). However, there are numerous shortfalls associated with this model, as outlined by various scholars (Zaman, 2001 and Armstrong, 2007). The main drawback of the gravity model as identified by Armstrong (2007) is that it provides no clear and in-depth description of the nature of the trade potential between trading partners by indicating which products should be traded. As suggested by Bothma *et.al* (2010), examining the current trade patterns between trading patterns can help off-set this drawback.

To obtain a complete analysis of a country's trade potential, various scholars have used the Indicative Trade Potential methodology to derive an objective measure of trade potential based on the trading partner's trading patterns at a product level. These scholars include Sebei (2006); Meyer and Breitenbach (2004); Bothma *et al.* (2010); Kapuya *et al.* (2014) and Sihlobo (2016).

Although not a perfect trade forecasting measure, it has been argued by Bothma *et al*. (2010) to provide information on products with substantial trade potential. Given the successful use of this approach, this study will use this approach together with the gravity model to explore potential trade opportunities in non-GM maize markets.

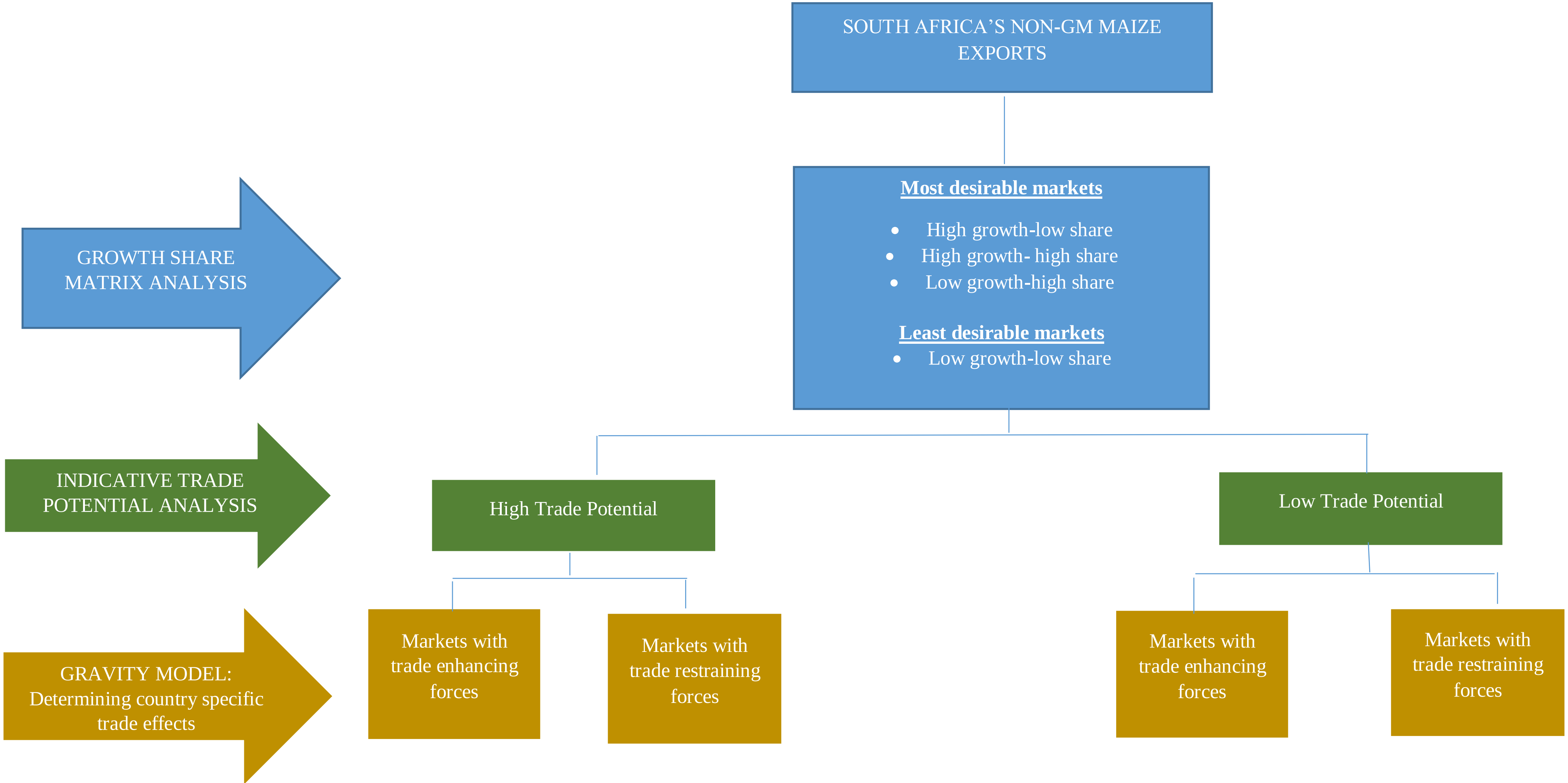

Figure 3.2: Schematic representation of the relationship between the three pronged methodological techniques of the study

Source: Author, 2019

In **Figure 3.2,** a complementary link of the three pronged methodological approach is outlined. To address the objective of exploring South Africa's potential markets, the growth share matrix is used to classify markets based on the relative growth rate and South Africa's share of total exports. Secondly the indicative trade potential will be calculated for each market identified in the growth share matrix and then categorized as either offering high potential or low trade potential based on their import demand of the non-GM maize. Finally, the gravity model establishes the country specific trade enhancing or restricting forces in the non-GM maize markets.

3.5. CONCLUSION

The studies in the literature on export potential usually only apply one of the methodological approaches outlined for this study. The growth share matrix identifies potential and existing maize markets, the indicative trade potential estimate South Africa's export potential in identified maize markets, while the gravity model examines forces that stimulate or restrain maize trade. However, given the various shortfalls of each method, a more complete trade potential analysis is made possible by the three-prolonged approach, which gives a comprehensive understanding of trade potential. The complimentary approach thus provides the best possible results to enable the formulation of precise policy considerations and decision-making. It is the aim of this study to thus aid in ascertaining the correct policy route to pursue for export markets and expansion prospects.

CHAPTER 4: DISCUSSION AND INTERPRETATION OF RESULTS

4. INTRODUCTION

In this chapter, the primary focus is placed on presenting the results of the study and in providing an interpretation of the findings to answer the fundamental question asked by the study, namely: Is there any additional trade potential for South Africa's non-GM maize? The growth-share matrix analysis results will answer the question on unexplored or potential markets, while the indicative trade potential analysis findings will provide an answer regarding South Africa's trade potential in the identified markets. Finally, the determinants of South Africa's trade in different identified markets will be addressed by the gravity model analysis. It is important to highlight that due data limitations, the study considered trade partners for which data on the independent variables were available. Therefore, not all the non-GM markets identified in Chapter 2 were included in the growth share, indicative trade potential and gravity model analysis.

4.1. GROWTH SHARE ANALYSIS OF SOUTH AFRICA'S NON-GM EXPORT MARKETS

South Africa's GM status has been noted by BFAP (2014) as being at the centre of a lack of market penetration within major maize importing countries. In attempting to navigate through this challenge, the study employs the growth share matrix analysis to explore possible non-GM markets that the country can target for establishing or increasing its market presence as identified in Chapter 2 Table 2.1.

The growth share analysis explored potential non-GM markets as characterised by their GM policies (i.e. Table 2.1 in Chapter 2). The markets are ranked on the basis of their relative market share and growth rates, as outlined in Chapter 3. The markets were classified as having a high (low) growth and or a high (low) share based on the variable benchmark values. The ideal markets based on the categories would be those that have a high growth-high share, high growth-low share and low growth-high share characteristics.

The data available at the time of the study on Trade Map was only from 2001 to 2017. Therefore, for the purpose of this study, the high (low) growth markets were defined as non-

GM market with import growth of South Africa maize greater (less) than South Africa's maize export to the world of 9%. Conversely, a high (low) market share markets were defined as non-GM markets with share in South African maize exports export above (below) South Africa's share in the rest of the world of 1,4% (ITC, 2018b). **Figure 4.1** below outlines South Africa's growth share matrix quadrants for non-GM maize markets as defined by the critical values.

Market Share			
Growth Rate		*>1,4%*	*>1,4%*
	>9%	**STARS**	**QUESTION MARKS**
	<9%	**CASH COWS**	**DOG**

Figure 4.1: South Africa's non-GM maize classification based on critical values
Source: Author's calculation results from SARS (2018)

The quadrants outlined in **Figure 4.1** indicate four distinct markets categorised based on the growth rate and market share. The categorization of the markets is as follows;

- *Cash cows*: Growth rate less than 9% and market share greater than 1,4%
- *Stars*: Growth rate greater than 9% and market share greater than 1,4%
- *Question marks*: Growth rate greater than 9% and market share less than 1,4%
- *Dog*: Growth rate less than 9% and market share less than 1,4%

Table 4.1 below sets out a list of identified non-GM markets for South Africa's maize exports. The ideal markets based on the growth share matrix would be those that exhibit high-growth share *(stars)*, high growth-low share *(question marks)* and low growth-high share *(cash cow)* attributes. As discussed in Chapter 3, it is in these markets where South Africa can generate sufficient export revenues, due to increased maize import demand by these countries. Markets in these markets are characterised by a growing demand for maize and high import share globally.

Table 4.1: Classification of South Africa's non-GM maize export markets

Country	Growth rate of country *i* imports (2001-2017)%	SA's share in country *i* (%) 2017	Overall Assessment	Market classification
Japan	-50	27,3	Low growth-High share	Cash cow
Italy	17	0,0	High growth-Low share	Question mark
Spain	-20	0,0	Low growth-Low share	Dog
Venezuela	-7	0,0	Low growth-Low share	Dog
Thailand	23	0,6	High growth-Low share	Question mark
Zimbabwe	19	14,1	High growth-High share	Star
Madagascar	107	0,0	High growth-Low share	Question mark
Russia	22	0,1	High growth-Low share	Question mark
Kenya	11	15,2	High growth-High share	Star
Zambia	23	0,2	High growth-High share	Star
Algeria	0	0,0	Low growth-Low share	Dog
France	198	0,2	High growth-Low share	Question mark
Malawi	228	0,0	High growth-Low share	Question mark
Mauritius	350	0,0	High growth-Low share	Question mark
Portugal	-23	0,0	Low growth-Low share	Dog
Germany	-20	0,0	Low growth-Low share	Dog
Angola	65	0,2	High growth-Low share	Question mark
Greece	-23	0,0	Low growth-Low share	Dog
Ireland	-33	0,0	Low growth-Low share	Dog
Austria	0	0,0	Low growth-Low share	Dog
Saudi Arabia	-7	0,0	Low growth-Low share	Dog
Bulgaria	0	0,0	Low growth-Low share	Dog
Luxembourg	-7	0,0	Low growth-Low share	Dog

Source: Analysis results

The analysis results reveal that only eleven (12) of the twenty two (23) non-GM export markets exhibited favourable growth- share relationship for South Africa to prioritise. The penetration of this market would mean increasing market share in the identified markets and also initiating market presence in markets currently not exporting to. According to Sihlobo (2016), the determination is based on the growth and market share relationships which is a subjective measure of determining market attractiveness based on the growth share matrix does not take into account other demand factors (i.e. such price, trade agreements and import country's absorptive capacity). Nevertheless, the growth share matrix is an effective technique to identify markets that should be prioritised for export purposes (Kapuya *et.al.* 2014). The markets are classified as follows:

- *Cash cows:* Japan was found to have high growth and low share relationship. Therefore presenting an opportunity for South Africa to increase its maize exports to the country.
- *Stars:* Zimbabwe, Kenya and Zambia were found to have high growth and high share relationship. These are established markets and present further opportunities for export growth.
- *Dogs:* Algeria, Saudi Arabia, Spain, Venezuela, Portugal, Germany, Bulgaria, Greece, Ireland and Luxembourg were found to have low growth and low share. These are generally new markets were South Africa has weak market presence.
- *Question marks:* Mauritius, Malawi, France, Angola, Russia, Madagascar and Italy were found to have low growth and high share. Despite being well established markets, the capacity for further growth in these markets is limited. This is due to competing imports from markets such as the United States, India, Argentina and Brazil (ITC, 2018).

4.2. SOUTH AFRICA'S EXPORT POTENTIAL IN IDENTIFIED NON-GM MAIZE MARKETS

The methodology adopted to determine South Africa's export potential in the identified non-GM markets was implemented by using the trade indicators 'option' within Trade Map for maize. The analysis was done from the perspective of South Africa's exports to non-GM maize markets; and South Africa's imports from non-GM maize markets were ignored for this study, as the focus of the study was on determining export potential.

The countries that were identified using the growth share matrix were ranked as high or low potential markets based on the indicative trade potential calculations. The critical values that defined export potential as being either low or high used a trade weighted average export potential of South Africa in the identified existing and potential market. Trade Map produces an indicative trade potential of the trade data flows which has been computed based on the following logic: The supply is represented by the exports of the selected country (South Africa) to the identified non-GM markets, while the demand is represented by the imports of the selected partner country from the world. The minimum between the two from which the bilateral trade is subtracted is the indicative potential trade. **Table 4.2** below denotes the characterisation criteria of identified market potentials. The export potential is calculated using the ITP as described by equation 3.2 in Chapter 3.

Table 4.2: South Africa's maize export potential in non-GM markets critical value.

Product	**Export Potential, 2017 (US$'000)**	
	Low	**High**
Maize	<64	>64

Source: Own calculations based on ITC (2018) statistics.

The critical value that defines the identified market as having either, a low or high trade potential stands at US$64 thousand. The defined critical value of US$64 thousand is based on an average of the estimated unexplored potential trade as discussed in chapter 3, equation 3.1. The estimated untapped potential trade is the difference between the actual trade and the expected potential trade (ITC, 2018). The actual export value may be higher or lower than the expected potential value and therefore the untapped potential trade can be positive or negative.

However, for the purpose of the study, only the positive values of the unexplored potential trade were considered. This is because those are the markets which present the greatest opportunity for trade. The markets with high export potential are considered to be desirable for South Africa to prioritise as the countries that can generate the largest gains from expanding exports to these existing markets. The low export potential, although less desirable, is also vital in expanding the export base for South Africa's non-GM maize. The unexplored export potential, serves to indicate the size of the import market that is yet to be completely explored (Sihlobo, 2016). Therefore, it will provide a guide for identifying markets that offer trade opportunities for South Africa's non-GM maize exports.

Table 4.3: South Africa's unexplored non-GM maize export potential

Countries	Share in South Africa's exports (%) 2017	Share of partner countries in world imports (%) 2017	Average tariff faced by South Africa (%)	Estimation of untapped potential trade, USD thousand	Overall Assessment
Japan	8.7	10.1	16.7	5	Low potential
Italy	5.7	3.3	0	66	High potential
Spain	4.2	5.5	0	18	Low potential
Venezuela	1.4	0.8	20	148	High potential
Thailand	0.7	0.10	34.4	-	Low potential
Zimbabwe	0.5	0.1	0	107	High potential
Madagascar	0.2	0	10	-	Low potential
Russia	0.2	0.01	0	-	Low potential
Kenya	0.2	0.04	50	68	High potential
Zambia	0.1	0	0	278	High potential
Algeria	0	2.2	5	16	Low potential
France	0	0.4	0	-	Low potential
Malawi	0	0	0	-	Low potential
Mauritius	0	0.06	0	3	Low potential
Portugal	0	1.5	0	5	Low potential
Germany	0	2.1	0	6	Low potential

Angola	0.1	0.01	30	155	High potential
Greece	0	0.4	0	328	High potential
Ireland	0	1	0	2	Low potential
Austria	0	0.6	0	206	High potential
Saudi Arabia	0	2.1	0	4	Low potential
Bulgaria	0	0.01	0	21	Low potential
Luxembourg	0	0.01	0	7	Low potential

Source: Own calculations based on ITC (2018) statistics and Market Access Map (2018)

The indicative trade potential basically indicates those markets that could be explored and thereby prioritised. Moreover, it identifies the expected potential export value for any exporter in a given product and target market based on an economic model that combines the exporter's supply with the target market's demand corrected for market access conditions and the bilateral ease to trade (ITC, 2018). **Table 4.3 above** summarises the indicative trade potential of the various potential markets and indicate that Kenya, Venezuela, Zambia, Austria, Italy, Zimbabwe, Angola and Greece as ideal export markets that South Africa could prioritise. Classified as *"stars"* in the growth share analysis, Kenya, Zambia and Zimbabwe are revealed as most desirable markets. However, it is worth noting that Zambia is a predominantly non-GM maize producer (BFAP, 2016), it may thus not be the most attractive market to pursue despite the high trade potential. Interestingly, Italy and Venezuela despite exhibiting low growth and low share relationship by the growth share matrix analysis, it is revealed as having high trade potential. As outlined in Figure 3.1, this determination within least desirable markets was expected.

Conversely, despite also having positive estimated unexplored trade potential, markets such as Mauritius, Japan, Ireland, Bulgaria, Germany, Portugal, Luxembourg, Malawi, Madagascar, Saudi Arabia, Algeria and France were revealed as low trade potential markets. However, despite the relatively potential low export gains derivable from these markets, they still remain significant and can be explored by South Africa to widen its export market spectrum.

4.3. DETERMINANTS OF SA'S MAIZE EXPORTS TO NON-GM MARKETS

The potential non-GM maize markets are different and thus require deeper understanding in order to determine the trade restricting and stimulating forces in each market. The gravity model analysis gives country specific trade determinants of each market which will then inform prioritisation of the markets.

4.3.1. Gravity model analysis of SA maize trade determinants

The gravity model approach was used for South Africa's non-GM maize exports using panel data for the period from 2001 to 2017 to estimate country-specific effects that either stimulate or inhibit trade. The PPML method for estimating the gravity equation was used to account for the presence of heteroscedasticity and zero trade values inherent in the data used for this study. However, since the study's objective was to establish the unobserved time invariant country specific effects that predict whether an identified market contains the attributes that promote or restrain South African non-GM maize exports, the fixed effects model was used. This is because the fixed effects model allows for the heterogeneity of countries thus allowing for the estimation of country-specific effects, over time. The determinants of South Africa's non-GM maize exports were estimated by using the fixed effects gravity model of Equation 3.4, the results are thus summarised in **Table 4.4** below.

Table 4.4: Fixed effects gravity model for South Africa's maize exports to non-GM markets

Explanatory variable	**Coefficient**	**P value**
South Africa's non-GM maize production	0,018*** (2.47)	0.000
Importer's income per capita	5,86*** (8.97)	0.000
Distance	-0.0004** (0.0002)	0.05
Tariff applied	-0,52*** (0.001)	0.000
Importer's non-GM maize consumption	1,59*** (4.05)	0.000
Common language	0,05*** (0.45)	0.003
Landlocked	-2,21*** (2.49)	0.009
Adjusted R^2	0.46	-
Prob > chi2	0.0000	-
Log pseudo likelihood	-1.827	-

Note ***, **,* are level of significance at 1%, 5% and 10% respectively and value in brackets () are the standard deviations
Source: Model results (Eviews)

The overall significance, as revealed by the Wald Chi-Square test of fixed effects Poisson gravity model employed for the study, indicates that the independent variables included in the model were not zero, and thus jointly significant. The Probability>Chi-Square of 0.0000 indicates that the selected explanatory variables are appropriate for the model, and the overall regression is significant. However, the explanatory power of model as denoted by the R-squared is low at 0.46. Low R-squared are commonly reported for panel data studies with many near zero values used for the analysis (Scheltema, 2013, Ishutkina and Hansman, 2009, Schaefer, Anderson and Ferrantino, 2008). Given the model overall model's significance, individual explanatory variables results are explained below

4.3.1.1. South Africa's non-GM maize production, Importer's income per capita and importer consumption

It was expected that the model will estimate a positive relationship between the volume of South Africa's non-GM exports, production, importer's income per capita and importer consumption. The model output was in accordance with the expectations. A non-GM maize production coefficient of 0.018 was estimated, indicating that a 10 percent increase in South Africa's non-GM maize production will result in a 0.18 percent increase in the volume of South Africa's non-GM maize exports, *ceteris paribus*. The model further estimated an importer consumption coefficient of 1.59, indicating that a 10 percent increase in non-GM maize consumption in the import market increases the value of South Africa's non-GM maize exports by 15.9 percent, *ceteris paribus*. Moreover, an income per capita coefficient of 5.86 was estimated, indicating that a 10 percent increase in the income per capita in the importer, the volume of exports on South Africa's non-GM maize exports increase by 58.6 percent, *ceteris paribus*.

4.3.1.2. Distance, common language and being landlocked

The expected relationship between the distance from South Africa to a trading partner and exports was negative. This is because distance is a proxy for transportation cost. The results are thus in accordance with expectations with a distance coefficient of -0.0004, indicating that a 10 percent increase in distance between South Africa and its trading partners decreases the volumes of non-GM maize exports by 0.004 percent, *ceteris paribus*. Since the variables representing common language and landlocked are dummy variables, the estimated results cannot be interpreted as elasticities and thus are interpreted in level form. Exports to landlocked countries were expected to indicate a negative relationship due to challenges of high transaction costs and problematic market access to the country due no harbours (Ishutkina *et.al*, 2009). The landlocked coefficient was estimated at -2.21, indicating that if the importing market is landlocked, the volume of South Africa's non-GM maize exports decline by 2.21 tons, *ceteris paribus*. The model estimated common language coefficient of 0.05, signifying that if trading partners use English as their official language to facilitate trade, the volume of South Africa's non-GM maize exports increase by 0.05 tons, *ceteris paribus*. This relationship is in accordance with expectations.

4.3.1.3. Applied tariff

The model was expected to estimate a negative relationship between the volume of South Africa's non-GM maize export volumes and level of applied tariffs (*ad valorem*) faced by South Africa in the importing market. In accordance with expectations, the model estimated an applied tariff coefficient of -0.52, indicating that a 10 percent increase in the level of applied tariff faced by South Africa decreases the volume of non-GM maize exports by 5.2 percent, *ceteris paribus.*

4.3.2. Country-specific effect estimation analysis

The potential export market specific effect shows an indication of the trade environments in each of the potential markets. Countries with positive signs indicate trade stimulating effects in the market, while a negative sign indicates trade-restraining effects in the market. **Table 4.5** below summarises the results of the analysis based on Equation 3.7 which drew out the country-level effects from the fixed effect residual to estimate the unobservable effects of bilateral trade between South Africa and its potential export partners. The positive signs show trade-enhancing effects and the negative signs show trade-inhibiting effects for each market.

The country-specific effect analysis, based on the specific gravity model, conducted for the study revealed that none of the identified markets exhibited trade-encouraging attributes. The implication of this is that South Africa will have to intensify any export penetration strategy they adopt for these markets in order to thrive in the relatively difficult markets. Nevertheless, given the results, prioritisation can still be drawn from these markets with African markets or smaller economies given preference over larger economies, because South Africa's productive dominance and comparative advantage in maize production, indicate that there is a scope for South Africa to tap into these markets.

Table 4.5: South Africa's potential non-GM maize market specific effects

Country	Country Specific effect	Overall Assessment
Japan	-1.61	Trade restricting
Italy	4.11	Trade stimulating
Spain	-8.43	Trade restricting
Venezuela	6.18	Trade stimulating
Thailand	3.38	Trade stimulating
Zimbabwe	8.86	Trade stimulating
Madagascar	-7.14	Trade restricting
Russia	-1.66	Trade restricting
Kenya	8.79	Trade stimulating
Zambia	-1.06	Trade restricting
Algeria	-1.58	Trade restricting
France	-2.22	Trade restricting
Malawi	-4.52	Trade restricting
Mauritius	-3.92	Trade restricting
Portugal	-4.11	Trade restricting
Germany	-1.21	Trade restricting
Angola	3.57	Trade stimulating
Greece	1.13	Trade stimulating
Ireland	-2.48	Trade restricting
Austria	5.28	Trade stimulating
Saudi Arabia	-1.81	Trade restricting
Bulgaria	-1.16	Trade restricting
Luxembourg	-2.32	Trade restricting

Source: Based on model results and author's own calculation

The country specific effect analysis indicates that export of non-GM maize between South Africa and its trading partners differs from country to country. Markets that exhibit trade stimulating effects include: Austria, Greece, Venezuela, Thailand, Zimbabwe, Angola, Italy and Kenya. However, of these markets, the most attractive are those that were revealed by the potential trade analysis in the previous section to exhibit high trade potential. This is because there is a greater export expansion opportunities these markets than those than exhibited low trade potential. Therefore markets such are Austria, Zimbabwe, Greece and Kenya should be priority non-GM maize exports for South Africa than Thailand and Italy which despite having trade stimulating effects, have low trade potential.

Conversely, markets that exhibit trade restricting forces include: Saudi Arabia, Japan, Luxembourg, Mauritius, Zambia, Russia, Algeria, Malawi, Portugal, Germany, Ireland, Madagascar, Spain and France. It is worth noting, that Zambia was identified as having high trade potential but has trade restricting effects. This is largely because Zambia is a predominantly non-GM maize producer (BFAP, 2016). These markets are least attractive export markets for South Africa's non-GM maize exports.

4.4. CONSOLIDATED THREE PRONGED RESULTS

The three pronged methodological approached set out to identify, estimate and examine South Africa's maize export potential in non-GM maize markets. **Table 4.6** consolidates the results of the three pronged methodological approach. The results of the different methodologies are combined to determine the prioritisation level for each market. Markets classified as *stars* or *question marks* or *cash cows*, with a high trade potential and trade stimulating forces will be regarded as desirable. Conversely, markets classified as *dogs*, with low trade potential and trade restraining forces will be classified as least desirable.

Table 4.6: Summary of three pronged methodological results

Country	Growth Share Matrix	Trade potential	Gravity Model	Prioritisation
Japan	Cash cow	Low potential	Trade restricting	Least desirable
Italy	Question mark	High potential	Trade stimulating	Highly desirable
Spain	Dog	Low potential	Trade restricting	Least desirable
Venezuela	Dog	High potential	Trade stimulating	Desirable
Thailand	Question mark	Low potential	Trade stimulating	Least desirable
Zimbabwe	Star	High potential	Trade stimulating	Highly desirable
Madagascar	Question mark	Low potential	Trade restricting	Least desirable
Russia	Question mark	Low potential	Trade restricting	Least desirable
Kenya	Star	High potential	Trade stimulating	Highly desirable
Zambia	Star	High potential	Trade restricting	Highly desirable
Algeria	Dog	Low potential	Trade restricting	Least desirable
France	Question mark	Low potential	Trade restricting	Least desirable
Malawi	Question mark	Low potential	Trade restricting	Least desirable
Mauritius	Question mark	Low potential	Trade restricting	Least desirable
Portugal	Dog	Low potential	Trade restricting	Least desirable
Germany	Dog	Low potential	Trade restricting	Least desirable
Angola	Question mark	High potential	Trade stimulating	Highly desirable
Greece	Dog	High potential	Trade stimulating	Desirable
Ireland	Dog	Low potential	Trade restricting	Least desirable
Austria	Dog	High potential	Trade stimulating	Desirable
Saudi Arabia	Dog	Low potential	Trade restricting	Least desirable
Bulgaria	Dog	Low potential	Trade restricting	Least desirable
Luxembourg	Dog	Low potential	Trade restricting	Least desirable

Based on the consolidated results, South Africa has to prioritise markets such as Italy, Zimbabwe, Zambia, Angola, Venezuela, Greece and Austria. This is because these markets exhibit favourable characteristics of high growth-high market share, estimated to have high trade potential and have trade stimulating effects. South Africa should thus prioritise these market for maize exports.

4.5. SUMMARY AND CONCLUSION

This chapter presented and discussed the results of the three pronged methodological approach each addressing the specific objectives set by the study to achieve the main objective. The growth share matrix identified the unexplored non-GM export markets for South Africa's maize based on their growth and relative share relationship. This resulted in markets being classified as *cash cows*, *question marks*, *dogs* and s*tars*. Subsequent to the market identification, an indicative trade potential analysis was conducted categorizing markets as either having high trade potential or low trade potential. The results of which saw markets such as Italy, Austria, Venezuela, Zambia, Greece, Zimbabwe and Kenya as having high trade potential. A further analysis of the individual markets indicated the country-specific effects using the fixed effects gravity model, which indicated individual market's trade-stimulating effects and trade restricting effects. The top four markets based on the three pronged methodology to pursue were Zimbabwe, Kenya, Italy and Angola. These markets were classified under desirable markets by the growth share matrix analysis, the markets further were high trade potential, moreover, the markets exhibited trade stimulating effects.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5. INTRODUCTION

The overall objective of this thesis was to determine whether South Africa could benefit from increased non-GM maize production, and export to markets to non-GM maize. This was addressed through employing a three pronged methodological approach which included: the growth share matrix analysis to identify South Africa's potential and unexplored non-GM markets, the indicative trade potential which estimated the South Africa's untapped export potential within the non-GM markets and then the fixed effects gravity model to determine the country specific forces that stimulate or inhibit trade. This chapter is thus organised as follows: Firstly, a brief overview and key findings of the study are outlined, followed by drawing out of the implications of the findings for relevant stakeholders and finally suggests recommendations for future research.

5.1. OVERVIEW AND SUMMARY OF KEY FINDINGS

This study set out to determine if there are export opportunities for South Africa's maize in non-GM markets. The study used three specific objectives to achieve this overall objective. Firstly, the study sought to explore South Africa's potential non-GM maize export markets. This objective was addressed by using the growth share matrix analysis to classify markets based on their growth and share relationship. As outlined in Figure 3.1, markets with *high growth-high share*, *high growth-low share* and *low growth-high share* were regarded as most desirable markets. These markets included: Japan, Italy, Madagascar, Thailand, Zimbabwe, Russia, Kenya, Zambia, Angola, France, Malawi and Mauritius. These markets were regarded as most desirable owing to their growth and share relationship. Conversely, markets such as Germany, Ireland, Greece, Bulgaria, Algeria, Venezuela, Portugal, Spain and Luxembourg were the least desirable markets due to their low growth and low share of South Africa's maize exports.

Subsequent to identifying potential markets, the second objective of the study which sought to estimate the South Africa's export potential in the potential non-GM maize markets was addressed using the indicative trade potential. The analysis included both most desirable and least desirable markets for a complete analysis. In both markets, possibilities of untapped trade potential being high or low exists and thus the study attempted to identify those markets. Through this analysis, markets with high unexplored trade potential were revealed as Italy, Venezuela, Zimbabwe, Kenya, Greece, Zambia and Austria. It is within this markets were South Africa has the greatest opportunity to expand export gains, through increased export volumes. Despite, being amongst the least desirable export markets, Venezuela and Greece still presented an opportunity for potential exports. However, they cannot be considered as priority or strategic markets as South Africa will derive the least export gains if actively pursuing these markets owing to their growth and share relationship revealed by the growth share matrix analysis. Conversely, markets such as Russia, Mauritius, Thailand, Madagascar, Algeria, France, Malawi, Portugal, Germany, Ireland, Saudi Arabia, Luxembourg and Bulgaria had low trade potential based on the ITP estimate.

The gravity model was used to address the third specific objective of the study of examining the forces that stimulate or restrain South Africa's maize exports in non-GM markets. The fixed effects Poisson gravity model estimated the forces that stimulate or restrain South Africa’s maize exports to non-GM markets. Variables such as South Africa’s non-GM maize production, applied tariff faced by South Africa in importing market, maize consumption in importing country, importer’s income per capita and distance between trading partners (South Africa and importing market) were estimated to determine their effects on South Africa’s maize export volumes to non-GM markets. Subsequently, country specific effects were then calculated manually in Excel from Equation 3.9. Countries such as Italy, Angola, Venezuela, Zimbabwe, Thailand, Kenya, Greece and Austria had trade stimulating effects whereas countries such as Japan, Luxembourg, Bulgaria, Portugal, Mauritius, Germany, France, Algeria, Zambia, Russia and Spain were revealed as having trade restricting effects.

South Africa’s non-GM maize markets are categorised into two groups: most desirable and least desirable (See figure 3.2). Based on the three pronged methodology used in the study, markets that found to be most desirable and priority markets for exports were; Zimbabwe, Austria, Venezuela, Italy, Zambia, Greece, Kenya and Angola.

5.2. IMPLICATIONS FOR POLICY MAKERS

South Africa's GM status, having been noted as an obstacle for further market expansion in major importing maize countries, creates a need for evaluation of maize production patterns in the country and exploration of potential maize export markets. Moreover, the geographically scattered and unfavourable market dynamics in major non-GM maize markets require market specific export promotion strategies for each individual market to be pursued.

This study found that there is generally no need for substantial maize production shifts from GM to non-GM maize production given the current limited scope for market expansion. However, as illustrated in Table 4.6, there are market which can be prioritised for non-GM maize exports as they exhibit favourable for trade. It is therefore recommended that farmers who choose to engage in large scale non-GM maize production should be guided by the forces of demand and supply in the non-GM maize export market and take favourable opportunities as presented. Therefore, farmers should react to export opportunities as they avail themselves where grain traders can contract farmers to produce for the identified market – basically do as they have being doing. Moreover, the government of South Africa needs to improve and maintain a regulatory system that will progressively accommodate segregation of non-GM and GM maize along the maize value chain to allow for preference for South African non-GM maize by major non-GM maize importers.

5.3. STUDY LIMITATIONS AND RECOMMENDATIONS

Given that there is no formal database providing data on imports and exports of non-GM products by country, the study thus had to make a key assumption of categorising countries based on their domestic GM policies. Although not ideal as sometimes countries act in contrast with their policies, this approach is considered to be sound.

Due to data limitations, the study considered trade partners for which data on the independent variables were available. Therefore, not all identified non-GM maize trading partners were included in the growth share, indicative trade potential and gravity model analysis. Moreover, the study confined its exploration to primary non-GM maize produced without including the products produced from the non-GM maize such as glucose and starch. There may be large scale and profitable markets for South Africa's non-GM based starch which is predominantly sourced from contract growers. Studies that look at South Africa's non-GM maize based starch export potential would be beneficial to determine if there are any possible export opportunities for processed non-GM maize.

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