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Joseph L. Mawasha, Marnus Gouse, and Tracy Davids

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Corresponding author: mawashajl@gmail.com

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

Joseph L. Mawasha,*[1] Marnus Gouse,[1,2] and Tracy Davids[1,2]

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Abstract: 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. This study seeks 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 commercial maize farmers. First, the study identified South Africa's non-GM maize markets using a growth share matrix. Second, 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. Results suggest that markets such as Angola, Zimbabwe, Venezuela, Greece, Zambia and Austria exhibited the highest trade potential among the identified potential non-GM maize markets. However, country specific effects indicated that none of the non-GM maize markets had trade stimulating effects.

Key words: genetically modified and non-genetically modified maize, indicative trade potential analysis, growth share matrix and gravity model.

JEL classifications: F1, Q1

1 Introduction

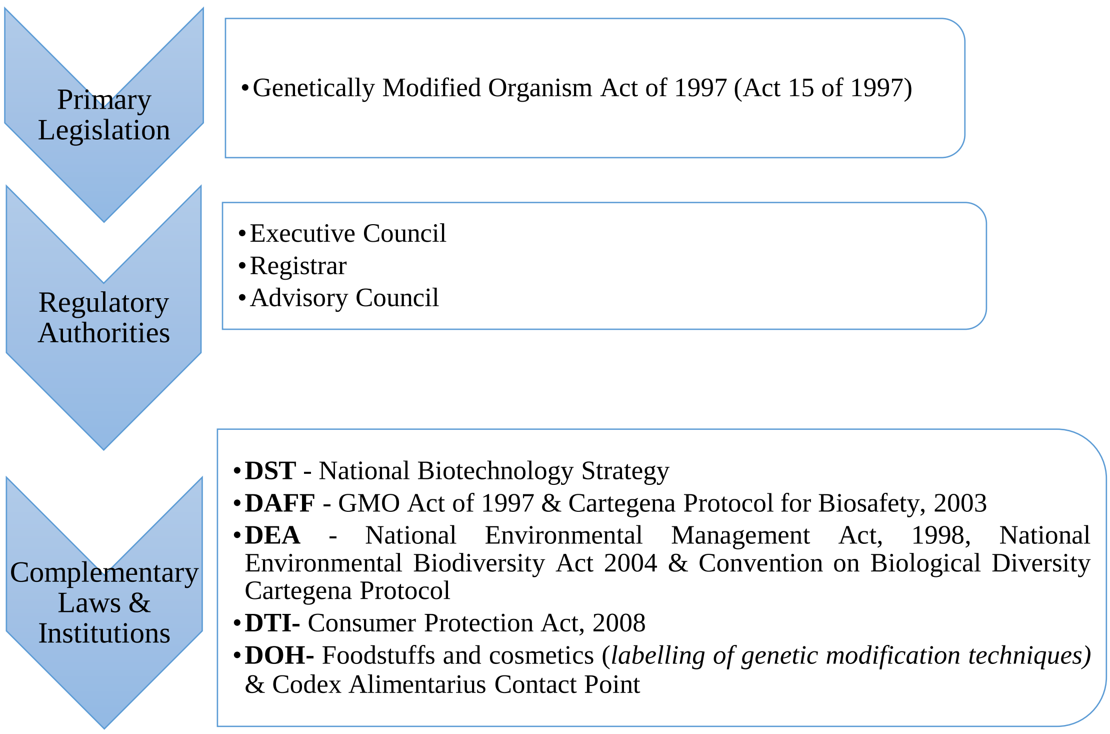
The maize industry in South Africa plays a significant role in the economy. The significance of the industry is reflected both through both backward linkages to the input industries and forward linkages to the milling, animal feed, and food processing industries. Furthermore, the maize industry's importance is derived from the role it plays as both an employer and earner of foreign currency (DAFF, 2018). South Africa's annual maize consumption requirements are predominantly satisfied by domestic production with limited imports

The Grain and Oilseed Supply and Demand Estimate Committee projected the total supply of white and yellow maize for the 2018/19 marketing season at 8,993,375 tons and 6,970,159 tons respectively (NAMC 2018). Consequently, the total demand for white and yellow maize, domestic and for export, is estimated at 7,300,000 tons and 5,658,000 tons, respectively, for the 2018/19 marketing season (NAMC, 2018). Since the first introduction in 1998, the national Genetically Modified (GM) maize area has gradually increased, reaching a level of around 90 per cent of the total maize area in 2016/17 (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.

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 and possible identification of non-GM maize production areas.

2 Background of GM regulation and maize industry

Figure 1: South Africa's GM legislative framework



Source: compiled from various sources.

South Africa’s regulatory framework for maize is dual in nature, although not explicitly so stated in terms of the legislation. The dual nature of the regulation of maize is observed with the introduction of Genetically Modified crops and products, which warranted the introduction of 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. Figure 1 depicts the details of all items of current legislation in South Africa that regulate all activities relating to GMOs. South Africa features as one of only a few of African countries that have successfully adopted the Cartagena Protocol. According to the recommendation of the protocol, South Africa has drafted, and implemented a Biosafety Strategy that enables it to import and export GM maize in both GM-rejecting and GM-accepting countries.

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 result, both public and private sector policies on GMOs and food derived from GM crops are topical issues in contemporary agri-food chains. 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.

2.1 South Africa's maize production patterns

Maize is produced under a two-fold system in South Africa, represented by non-GM and GM maize production. In this section, the aim is to reflect on the production patterns observed in each production system.

2.1.1 Emerging GM and non-GM maize trends in South Africa

In a report by BFAP (2018) to the Maize Trust, it was revealed that the total commercial GM maize area is estimated at 93.8 per cent, however, with the inclusion of smallholder farmers, the national GM percentage fell to 83.6 per cent for the production season 2016/2017. The general maize production trend is skewed towards GM maize and this has mainly been explained by the economic benefits linked to GM maize, the low non-GM premium relative to inflated grain prices and the area specific yield potential of non-GM maize (BFAP, 2018). Moreover, GM maize production has been associated with improved enterprise competitiveness through the impacts it has on yields, the cost of production and product prices (Jones, McFarlane, Park, and Tranter 2017). It is worth noting that, 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. Table 1 indicates the GM and conventional maize area proportions for both yellow and white maize in South Africa for 2016/17.

The stacked GM trait for both yellow and white maize constitutes the highest share of the total commercial maize area at 76 per cent for white maize and 66 per cent for yellow maize. Interestingly, the yellow conventional (non-GM) maize accounted for a greater share of the total yellow maize area than the insect tolerant trait at 10 per cent relative to 8 per cent. The maize production trend 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 put under production. The prevailing maize production trajectory in South Africa indicates that farmers currently derive higher economic benefits, primarily at farm level, which incentivise them to rapidly adopt GM maize, in preference to non-GM maize. 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.

Table 1: Commercial GM and non-GM maize areas under production in South Africa 2016/17

Trait	Area (ha)	% of total commercial maize area	% of commercial GM maize area
Yellow maize			
Herbicide tolerant (HT)	160,391	16	18
Insect tolerant (IT)	78,178	8	9
Stacked (IR*IT)	646,186	66	73
Conventional	100,745	10	
White maize			
Herbicide tolerant (HT)	153,085	9	10
Insect tolerant (IT)	175 1	11	11
Stacked (IR*IT)	1,252,729	76	79
Conventional	61, 856	4	

Source: BFAP (2018).

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 (ACB, 2010). Non-GM maize producers employ the segregation, identity preservation and traceability systems to separate the non-GM maize from GM maize.

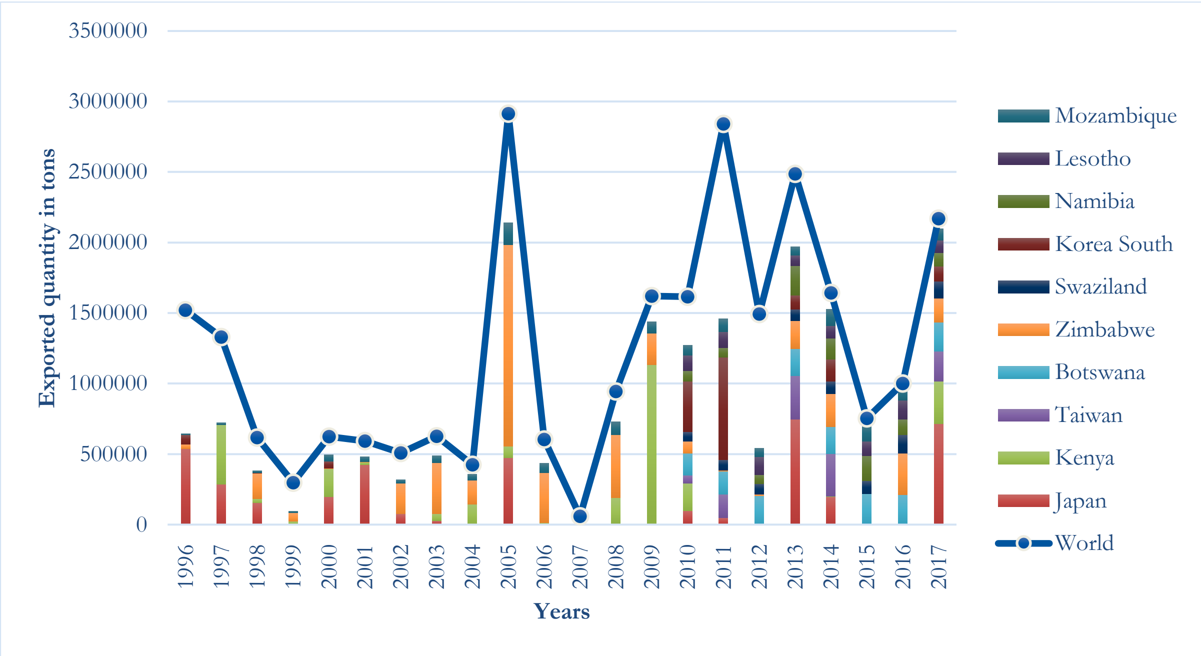
2.2 South Africa's maize trade environment

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 environment through following trends in exports and imports of maize over a specified period.

2.2.1 Maize exports from South Africa

South Africa's maize export trend is depicted in Figure 2 and denotes an erratic, but slow declining export pattern. The periodic fluctuations can be explained by adverse climatic conditions being experienced and consequent below average domestic maize production to allow for surplus production for export. The highest maize quantity exported by South Africa was in 2005, at approximately 2.9 million tons whereas the lowest exported quantity was observed in 2007, at approximately 58 thousand tons (it is worth noting that this was a year before the financial crisis in 2008). Japan, Zimbabwe, Lesotho 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, preferential market treatments, unfavourable climatic conditions and favourable inter-market exchange rates. Furthermore, the export trend reveals that South Africa mostly exports maize to SADC and SACU countries which constituted 60 per cent of the major maize export destinations between 1996 and 2017.

Figure 2: South Africa's maize exports 1996–2017

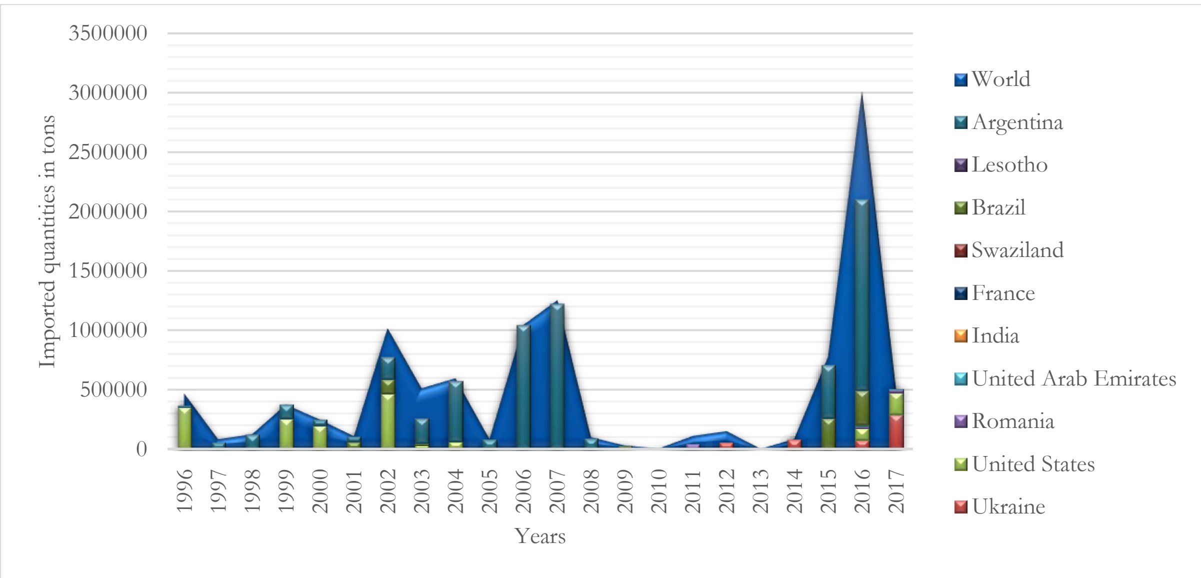


Source: Global Trade Atlas 2018, SARS.

2.1.2 *Maize imports by South Africa*

Figure 3 highlights South Africa's maize import trends between 1996–2017. 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. Over the period under analysis, South Africa only had a 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. However, the general trend indicates irregular imports. Argentina, Brazil and the United States feature as South Africa's most preferred sources of maize.

Figure 3: South Africa's maize imports 1996–2017



Source: Global Trade Atlas 2018, SARS.

3 Methods for exploring new markets and establishing export potential

The purpose of this section is to evaluate the empirical methods selected for the three-pronged approach of the study, which will firstly identify new markets, estimate the export potential and finally determine the forces that will stimulate or restrain trade in the markets.

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.

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).

Figure 4: Growth share matrix

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

Source: Adapted from Henderson (1979).

3.2 Indicative trade potential

Numerous studies have endeavoured to evaluate a country's export potential by using the gravity model approach (Zarzo and Lehmann 2003; Rahman, Shadat and Das 2006; Armstrong 2007; Isardi 2010; Cassim 2010). However, a more complete analysis of trade potential is made possible by the complementary use of indicative trade potential analysis and the gravity model. 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 trade potential between countries and regions is made possible (Bothma et al. 2010). Since this method allows for the examination of existing trade patterns, it can indicate the best chances for success in various markets. The Indicative Trade Potential (ITP) is presented by:

$$\mathrm{ITP}_{ijk} = min(X_{ik}, X_{jk}) - X_{ij} \tag{1}$$

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

Where 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 ITP of a country measures the capacity of that country to expand its bilateral trade, both imports and exports, with its potential or 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. 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 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: 33-57). 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;

$$X_{ij} = \frac{KY_i^{\alpha}Y_j^{\beta}}{D_{ij}^{\theta}} \qquad (2.1)$$

Where X_{ij} is the value of the bilateral trade between country i and j, and Y_i and Y_j 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. Equation 2.1 can be converted into log-linear form as follows;

$$lnX_{ij} = lnK + \alpha lnY_i + \beta lnY_j + \theta D_{ij} + \delta Z + \mu_{ij} \qquad (2.2)$$

In Equation 2.2, δZ represents all variables that are not in the model 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 transaction environment between countries. The augmented gravity model can thus be written as;

$$X_{ij} = \beta_0 Y_i^{\beta_1} Y_j^{\beta_2} P_i^{\beta_3} P_j^{\beta_4} D_{ij}^{\beta_5} V_{ij}^{\beta_6} \varepsilon^{\mu_{ij}} \qquad (2.3)$$

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, and the variables Y and D still have the same representation as in Equation 2.1.

3.3.1 Gravity model specification for the study

For this study, the gravity model will estimate South Africa's trade flows to major non-GM maize export markets to determine the standard trade flow determinants and fixed effects estimations for the period from 1996 to 2017. The specification of the gravity model applied to the study followed the functional form by Kapuya et al. (2014), as outlined below:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3} + \beta_4 x_{i4} + \beta_5 x_{i5} + \beta_6 x_{i6} + \beta_7 x_{i7} + \beta_8 x_{i8} + \alpha_i + \mu_{it} \qquad (2.4)$$

where y_i is South Africa's maize exports, x_{i1} is the GDP of the trading partner, x_{i2} is the GDP of South Africa, x_{i3} is the nominal exchange rate, x_{i4} is the tariff applicable to South Africa for maize in the trading partner's market, x_{i5} is a dummy for being landlocked (1 = landlocked, 0 = otherwise), x_{i6} is the population of trading partner, x_{i7} is the population in South Africa, x_{i8} is the distance to trading partner, *ai* is the fixed effect, and u_{it} is the random error.

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:

$$\bar{y}_i = \beta_0 + \beta_1\bar{x}_{i1} + \beta_2\bar{x}_{i2} + \beta_3\bar{x}_{i3} + \beta_k\bar{x}_{ik} + \alpha_i + \bar{\mu}_{it} \quad (2.5)$$

The equation was transformed by subtracting (2.5) from (2.4) to eliminate both the fixed effect α_i and constant to get the following equation;

$$(y_i - \bar{y}_i) = \beta_1(x_{i1} - \bar{x}_{i1}) + \beta_2(x_{i2} - \bar{x}_{i2}) + \beta_3(x_{i3} - \bar{x}_{i3}) + \beta_k(x_{ik} - \bar{x}_{ik}) + (\mu_{it} - \bar{\mu}_{it}) \quad (2.6)$$

Following the estimation of (2.6), 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;

$$\hat{\alpha}_i = y_1 - \hat{\beta}_1\bar{x}_{i1} - \hat{\beta}_2\bar{x}_{i2} - \hat{\beta}_3\bar{x}_{i3} - \hat{\beta}_k\bar{x}_k \quad (2.7)$$

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 rationale

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. 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 and Douglas 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.

4 Research findings and discussions

South Africa's GM status has been noted by BFAP (2014) as being at the centre of a lack of market penetration within major African 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 increasing its market presence on the African continent and other predominant non-GM maize markets, while addressing the problem of declining market shares in our major export markets

4.1 Growth share analysis of export markets

The growth share analysis explored potential non-GM markets as characterised by their GM policies. The markets were classified as having a high (low) growth and or a high (low) share based on the variable benchmark values. In Table 2 the critical values that explain the growth-share matrix classification of South Africa's non-GM maize export markets are outlined.

Table 2: South Africa's non-GM maize growth-share matrix classification criteria

	Average annual growth rate 1996-2017		Average market share 1996-2017	
	Low	High	Low	High
Maize	<51.5%	>51.5%	<6.8%	>6.8%

Source: Authors' calculations based on SARS (2018) statistics.

It is important to highlight that the growth share matrix analysis is subjective. Therefore, for this study the classification of South Africa's non-GM maize markets is based on South Africa's average maize export growth to non-GM maize markets, which determines the critical values of high or low export growth and high. The annual South Africa's maize export growth to non-GM maize market is calculated for the period 1996–2017. Based on the calculations, the high (low) export growth was defined as an average annual growth rate greater (less) than 51.5 per cent. Conversely, a high (low) market share was defined as the market average above (below) 6.8 per cent. Figure 5 outlines South Africa's growth share matrix quadrants for non-GM maize markets as defined by the critical values.

Figure 5: South Africa's non-GM market classification based on critical values

		Market share	
		High	Low
Growth rate	High	**Stars** *(>51.5%, >6.8%)*	**Question marks** *(>51.5%, <6.8%)*
	Low	**Cash cow** (<51.5%, >6.8%)	**Dog** *(<51.5%, <6.8%)*

Source: Authors' calculation results from SARS (2018).

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. Table 3 sets out a list of countries non-GM maize markets that have been considered as being potential export markets for expansion and diversification.

The analysis results reveal that only four (4) of the fourteen (14) non-GM export markets exhibited features of favourable markets for export penetration and diversification. The determination was based on the growth and market share relationships which is a subjective measure of determining market attractiveness that does not take into account other demand factors. It is worth noting that all of the identified potential markets are within the African continent. Moreover, of the identified markets, Zimbabwe and Kenya were both classified as 'stars' while Zambia and Malawi classified as 'question mark' and 'cash cow' respectively. Accordingly, this implies that there is a need to increase South Africa's market presence in the identified markets through increased efforts in trade investments in order to penetrate these markets. Given that the growth share matrix is a subjective, the classification of the markets is solely based on growth and market share relationship, and, even markets classified as 'dogs' are evaluated for trade enhancing and restricting attributes.

Table 3: Classification of South Africa's non-GM maize export markets 1996–2017

Countries	Average market share, %	Average annual growth rate, %	Overall assessment	Classification
Kenya	22.0	5155.8	High; High	Star
Zimbabwe	45.0	105.2	High; High	Star
Angola	4.3	50.8	Low; Low	Dog
Zambia	7.6	2.0	High; Low	Question mark
Mauritius	2,4	-4.5	Low; Low	Dog
Malawi	4.5	4350.4	Low; High	Cash cow
Madagascar	3.2	41.4	Low; Low	Dog
Kazakhstan	0.0	0.0	Low; Low	Dog
Luxembourg	0.0	0.0	Low; Low	Dog
Greece	0.0	0.0	Low; Low	Dog
Austria	0.0	-4.5	Low; Low	Dog
Algeria	0.0	-4.5	Low; Low	Dog
Bulgaria	0.1	0.0	Low; Low	Dog
Venezuela	6.5	-4.5	Low; Low	Dog

Source: Authors' calculations based on ITC (2018) statistics

4.2 Indicative trade potential analysis of SA maize 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 supply potential as being either low or high used a trade weighted average export potential of South Africa in the identified unexplored and potential market. Table 4 denotes the characterisation criteria of identified market potentials.

Table 4: South Africa's maize export trade potential classification criteria.

Product	Export potential, 2017 (US$'000)	
	Low	High
Maize	<76,252	>76,252

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$76,252,000. Table 5 summarises the indicative trade potential of the various potential markets and indicate that Austria, Angola, Zambia, Greece, Zimbabwe and Venezuela are ideal export markets that South Africa could prioritise, as they yield the highest non-GM export gains. However, it is worth noting that Zambia is a predominantly non-GM maize producer, and that Greece and Venezuela are in economic recessions. Given these challenges, the markets that exhibit high trade potential exports present a barrier for export promotion and investment targeting, as the domestic terrain would increase the costs of participating in such markets, thus distorting the potential premium benefits of exporting to the markets. However, Austria, Angola and Zimbabwe present the best chances for export success with limited trade costs attached to the market owing to the favourable domestic socioeconomic conditions in these markets. Kenya, although a revealed as a 'star' in the growth share matrix analysis had a low overall relative trade potential. This can be explained by the fact that Kenya demands a high tariff for South Africa's maize exports to the country, currently at 50 per cent.

Table 5: South Africa's maize export trade potential

Country	SA exports to country i (US$ millions), 2017	Average tariff faced by South Africa in country i, %	Indicative export potential (US$'000)	Overall relative potential
Kenya	897.6	50	41	Low
Algeria	0	5	16	Low
Angola	9.8	30	265	High
Austria	0	0	224	High
Bhutan	0	50	0	Low
Bulgaria	0	0	21	Low
Greece	0	0	330	High
Kyrgyzstan	0	0	0	Low
Luxembourg	0	0	6	Low
Madagascar	0.2	0	0	Low
Malawi	0.5	0	0	Low
Mauritius	0.5	0	3	Low
Peru	0	0	1	Low
Russia	3.4	0	0	Low
Venezuela	0	20	215	High
Zambia	9.6	0	353	High
Zimbabwe	832.0	0	80	High

Source: Authors' calculations based on ITC (2018) statistics.

5 Trade stimulating and restraining effects for South Africa's maize exports to non-GM markets

The potential non-GM maize markets are different and thus the market conditions in each market require deeper understanding in order to devise the right export promotion strategy. The gravity model analysis gives country specific trade determinants of each market which will then determine the appropriate export promotion strategy and inform prioritisation of the markets based on South Africa's resource endowments and competitive advantage. The determinants of South Africa's non-GM maize exports were estimated by using the fixed effects gravity model of Equation 2.4, the results are thus summarised in Table 6.

Table 6: South Africa's non-GM maize exports fixed effects Poisson gravity model results

Explanatory variable	Coefficient	P value
South Africa's GDP	8.96*** (1.72)	0.000
South Africa's population	6.73*** (4.71)	0.000
Distance	0.007*** (7.54)	0.000
Tariff applied	-3.30*** (6.42)	0.000
Nominal exchange rate	4.33*** (1.61)	0.000
Population in the importing country	5.64*** (1.14)	0.000
Importing country GDP	-2.64*** (6.58)	0.000
Landlocked	-0.46*** (3.73)	0.000
Adjusted R^2	0.32	-
Prob > chi2	0.0000	-
Log pseudo likelihood	-1.69	-

Note ***, **, * are level of significance at 1%, 5% and 10% respectively and value in brackets () are the standard errors

Source: Model results (Eviews).

5.1 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 7 summarises the results of the analysis based on Equation 2.7 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.

Table 7: South Africa's potential non-GM maize market specific effects

Country	Specific effect	Overall assessment
Algeria	-3.71	Trade restraining
Angola	-3.06	Trade restraining
Austria	-5.76	Trade restraining
Bhutan	-2.53	Trade restraining
Bulgaria	-2.87	Trade restraining
Greece	-4.74	Trade restraining
Kenya	-2.83	Trade restraining
Malawi	-2.56	Trade restraining
Luxembourg	-2.93	Trade restraining
Madagascar	-2.59	Trade restraining
Mauritius	-2.62	Trade restraining
Peru	-3.62	Trade restraining
Russia	-1.29	Trade restraining
Venezuela	-4.90	Trade restraining
Zambia	-2.65	Trade restraining
Zimbabwe	-2.60	Trade restraining

Source: Based on model results and authors' calculations.

6 Summary of key findings

The analysis results from the study revealed that markets such as Angola, Greece, Zimbabwe, Venezuela, Zambia and Austria had high export potentials for South Africa's non-GM maize. South Africa can explore these market opportunities by designing relevant export promotion and diversification strategies that are specific to each individual market based on their market characteristics. However, the limited scope for market penetration in the non-GM markets owing to limited number of non-GM markets and trade inhibiting conditions, it is recommended that the South African government should allow the market to react to export opportunities as they present themselves within the non-GM maize markets. Therefore, only playing the role of creating conducive trade and production environment through investment trade stimulating infrastructure such as roads, rail and harbours to improve South African farmer's comparative advantage in non-GM maize. The limited number of non-GM maize producers, globally, has resulted in a situation where the scarcity of non-GM maize is heightened, thus prompting the prices of non-GM maize to increase. This opportunity can only be effectively explored by farmers when the right export conditions and support are presented to them. Moreover, the government of South Africa needs to develop and maintain a regulatory system that will progressively segregate non-GM and GMO maize along the maize value chain to boost preference for South Africa's non-GM maize by major non-GM maize importers.

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