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ARTICLE

The Effect of Protectionism and Competition on South Africa's Avocados: What Realistic Export Market Opportunities Can Be Explored?

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ABSTRACT

South Africa's avocado industry largely relies on the European Union (EU) as its main export market. However, this presents a significant level of competition from other suppliers in the EU as well as protectionism, especially in terms of non-tariff barriers. We use a gravity flow framework to evaluate the effect of protectionism and competition as measured by the mean trade-weighted ad valorem equivalents on avocados originating from South Africa. Furthermore, the study finds feasible new export markets for South African avocados using the decision support model. The findings highlight that a unit increase in protectionism and competition towards avocados in South Africa's key export markets is associated with a 36.3% decline in revenue as well as a 31% decrease in the quantity exported. Findings based on the decision support model suggest that the United States, Japan, and China offer real-

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istic potential export opportunities to be explored by the avocado industry. It is recommended that South Africa, in partnership with authorities in the identified markets with realistic export opportunities, develop implementable market access protocols for the avocado industry, drawing much attention to sanitary and phytosanitary (SPS) market access concerns. There is also an urgent need for the Department of Agriculture (DoA), the Department of Trade, Industry, and Competition (DTIC), and industry stakeholders, among other relevant government departments, to explore the existing value chain round tables to review prioritized commodities to the identified markets.

Keywords: Decision Support Model (DSM); Gravity Model; International Trade; Ad Valorem Equivalents (AVEs)

1. Introduction

In recent years, the production and trading of avocados worldwide have experienced spectacular advancements, turning from a specialized commodity into a thriving global industry[1,2]. Between 2011 and 2020, production more than doubled[3], largely due to the growing market demand for the product. In 2022, predictions revealed that the global avocado market was worth USD 14.85 billion and is bound to increase at a compounded annual growth rate of 7.3% from 2023 to 2030[4]. This growth trajectory is primarily propelled by heightened consumer interest in wholesome foods, the rising middle class in emerging economies, and expanding production capabilities.

In South Africa, following the industry's slowed expansion observed between 2003 and 2008[5], a significant expansion has been recorded in the recent past[6]. The South African Avocado Growers' Association (SAAGA)[7] reports that currently, there are about 19,500 hectares planted with commercial avocado orchards, and an additional 800 hectares are planted per year, with an estimated 3-year annual production of 139,400 tons. Annual production grew from 117,571 tons in 2012 to 147,129 tons in 2022, equivalent to a 25.14% increase[8]. In Africa, South Africa is the fourth leading avocado producer after Malawi, Kenya and Ethiopia, which are ranked the first and second, respectively[2]. From a trade perspective, about 50% South Africa's annual production is exported while the remaining proportion is either consumed domestically or processed into oil and other products[6,7]. The above-stated dynamics in the avocado industry have spurred an intensified examination of market dynamics, supply chains, and trade patterns, all aimed at optimizing the benefits derived from this burgeoning global industry. For instance, from the trade performance perspective, Scheepers et al.[9] adopted a gravity model to evaluate the influence of strict maximum residue limits on South African avocados destined for the European Union (EU). The authors found that more stringent maximum residue levels, when compared to the baseline provided by CODEX Alimentarius, erode the export revenue generated from avocados. Bulagi et al.[10] used a Granger causality approach to evaluate the nexus between the agricultural production of avocados, among other fruits and the diversification of South Africa's exports. The authors note that there are both unidirectional and bidirectional correlations between avocado production and diverse exports, suggesting that exports and agricultural output push each other in various directions. Bulagi et al.[5] found in a comparable analysis that the gross domestic product (GDP) share of agriculture increased unidirectionally because of the chosen horticultural exports (avocados inclusive). Zwane[6] investigated the competitiveness of South Africa's avocado value chain and reports that the industry is struggling to out-compete major producing countries, including Peru, Mexico, and Kenya in the European Union (EU) market. Another trade-related strand of recent literature focuses on avocados' packaging systems. However, it is worthwhile noting that packing is outside the purview of this paper.

Despite the various studies done to understand trade performance drivers of the avocado industry, there is a knowledge gap on the effect of protectionism and competition faced by the avocado industry, as well as South Africa's realistic export market opportunities for avocados. The need for new, realistic export markets is critical since avocados from South Africa are finding it difficult to compete with their international rivals in

the EU market, particularly Peru, Mexico, and Kenya [7]. Moreover, Chisoro-Dube et al. [11] report that avocado exports originating from the Americas, including Peru, Mexico and Colombia, increased at a much faster rate unlike South Africa's exports. Whereas work by Zwane [6] somehow relates to our study, the author does not evaluate the realistic export markets for South Africa's avocados but rather focuses on the competitiveness of the local industry.

Moreover, Scheepers et al. [9] limit their work to maximum residue levels in the EU, yet there are other barriers at play. Thus, this study attempts to close the gap in two ways. First, to investigate the effect of protectionism and competition on South Africa's avocado exports to the top 10 destinations. Second, to assess the industry's realistic export market opportunities.

1.1. Contribution

First, we use the Decision Support Model (DSM) to identify countries that are most likely to import avocados from South Africa, thereby offering fresh avenues for market diversification. Authors are not aware of any other work in the avocado industry that has used DSM. Second, unlike Scheepers et al. [9], whose analysis was anchored on the gravity model, we use trade-weighted average ad valorem equivalents (AVEs) applied to avocados originating from South Africa to capture both tariff and non-tariff barriers as well as competition faced by South Africa. Trade weights are based on reference group imports, and the weighted AVEs account for competitors worldwide at the tariff line level [12–15]. Furthermore, the recent data used encapsulates the fast-growing market dynamics, including the fast-growing number of the middle class and changes in trade agreements. For instance, the Economic Partnership Agreement with the European Union in the context of Brexit. For a long time, South Africa's avocado trade has been highly concentrated in the United Kingdom [9].

1.2. Significance of the Industry

This work is of key significance to the economy since the avocado industry offers job opportunities for at least 11,500 people permanently in both the field and packhouses [16], but more people are employed as casual labourers during peak harvesting periods [7,17]. Moreover, Fresh Plaza [18] reports that the demand for avocados is increasing both domestically and internationally. Given that Peru supplies substantially more avocados than South Africa, the South African business community is concerned about the two countries' simultaneous supply of avocados [19,20], and this is bound to spur financial losses to the South African industry due to lower prices.

The remainder of the manuscript is structured as follows: An overview of the avocado industry in South Africa is presented in Section 2, while the detailed methodology is discussed in Section 3. The findings and discussion are presented in section 4 , while the conclusion is provided in section 5.

2. An Overview of South Africa's Avocado Industry

In South Africa, most avocado production, about 70%, is concentrated in two provinces, Limpopo (58%) and Mpumalanga (22%). These areas are particularly suitable for cultivating subtropical fruits due to their favourable climatic conditions. Over time, the cultivation area has extended to encompass the coastal provinces of KwaZulu-Natal (18%), the Eastern Cape (1%), and the Western Cape (1%) [21]. In the past decade, the avocado cultivation area has grown slightly above 12,000 hectares to 15,439 hectares in 2021 [22]. This marks a 28% expansion, translating to an average annual growth rate of 2.4%. By volume, avocado production recorded a 15% growth from 2012 to 2021. Beyond tonnage, the industry's impact on employment is striking—a ratio of 1 permanent worker for every 2.6 hectares underscores its role as a labour-intensive livelihood provider [23,24]. According to SAAGA [21], 45% of the volume of avocados produced domestically is exported, and it is anticipated that exports will increase at an average annual growth rate of 4% within a decade, a rise from the 3.4% annual growth realized during the previous decade [24]. **Figure 1** shows that the remaining proportion of avocados (55%) is marketed through National Fresh Produce Markets (NFPMs), accounting for about 16% of total production, while the rest is sold through other channels.

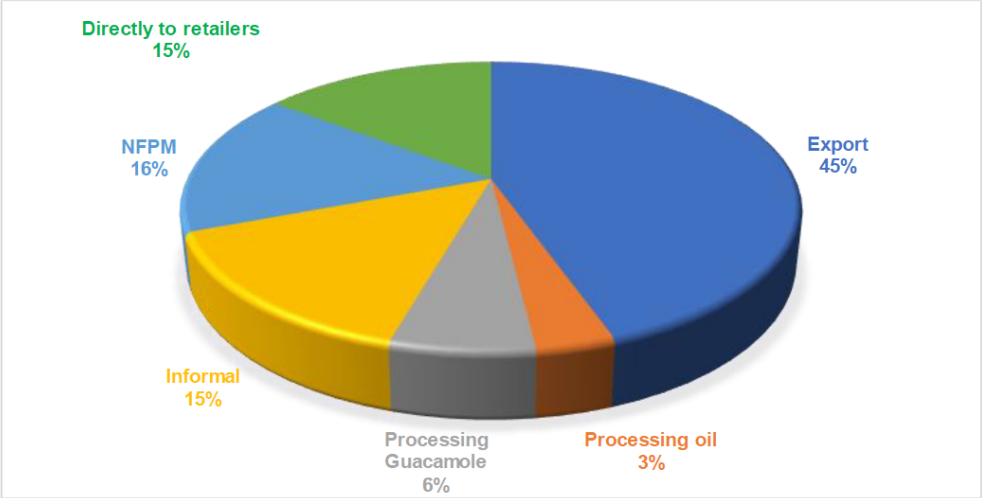

Figure 1. Percentage share of South Africa's avocados (2021 cycle) by marketing channel.

Source: SAAGA, 2023 [21].

As a result, South Africa has become a major player in the avocado trade. South Africa's agro-climatic zones provide a conducive environment for avocado cultivation, offering an opportunity to meet domestic demand while also contributing significantly to the international avocado market. As illustrated in **Figure 2**, South Africa's avocado industry has established robust markets within the European Union (EU). The Netherlands serves as the major entry point from where avocados are re-exported to other EU countries, including Germany, Portugal, Spain, France, Italy and Belgium. Given the current Economic Partnership Agreement (EPA) Free Trade Agreement and a Free Trade Agreement with the Economic Free Trade Area (EFTA) states, including Iceland, Norway, and Switzerland, the EU continues to be a crucial market for South African avocado exports. Over the years, the United Kingdom has also been a significant market for South Africa's avocados, notwithstanding that it is no longer a member of the EU.

Other countries importing avocados originating from South Africa include the United Arab Emirates Saudi Arabia, Qatar, Hong Kong, China, Japan, Indonesia, Namibia, Botswana, Lesotho, Mozambique and Australia, among others This burgeoning demand for avocados is in part influenced by health-conscious consumer preferences, the growing number of the middle class, the evolving dietary trends, as well as trade relationships that extend to other parts of the world as well. **Figure 3** presents a trend of fresh avocado exports originating from South Africa over a decade. Essentially, exports increased at an average annual growth rate of 20.94% from R506 million in 2012 to R1 631 million in 2021 [25].

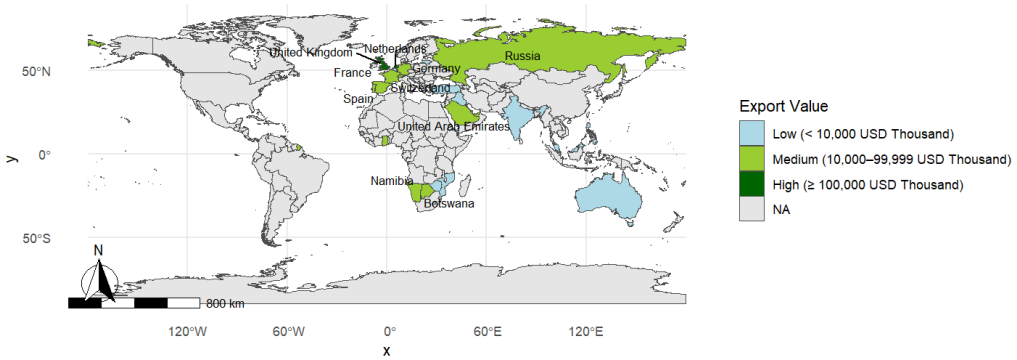

Figure 2. South Africa's avocado export destinations.

Source: International Trade Centre (ITC) [25].

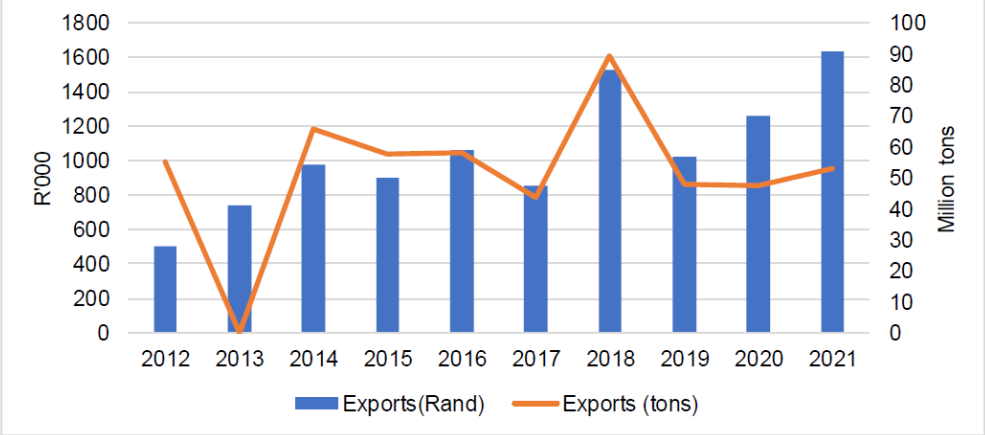

Figure 3. Avocado exports by South Africa (2012–2021).

Source: International Trade Centre (ITC) [25].

This persistent export growth underscores the nation's increasing ability to meet the global demand for avocados. The pattern suggests that South Africa has successfully positioned itself as a dependable supplier of avocados worldwide, substantiated by an export share of 2.1% [26]. The sustained expansion of exports signifies a growth trajectory in South Africa's avocado industry, potentially contributing to the country's agricultural and economic advancement. Hence, there is a need to identify market opportunities to cater for the increasing production of avocados.

3. Materials and Methods

In this section, we describe the gravity model framework, data used, estimation strategy, and the Decision Support Model.

3.1. The Augmented Gravity Model

In this study, South Africa's exports of avocados (by both value and volume) destined to the top 10 international markets are analyzed using the gravity model framework. Theoretically, the gravity model was validated within the context of utility theory by Niedercorn et al. [27]. Furthermore, the model's compatibility with neoclassical models is confirmed by Deardorff [28]. The gravity model framework is a widely used empirical tool in international trade analysis to explain and predict trade flows between countries [9,12,29–32]. It is based on the principle that trade flows are influenced by economic size (GDP), distance, and other factors that affect the costs and advantages of trade between countries [33].

This study was based on panel data from 2013 to 2022 for the top 10 importers of avocados originating from South Africa. According to International Trade Centre (ITC) [25], the Netherlands, the United Kingdom (UK), Russia, Germany, Portugal, Spain, Namibia, France, and Botswana were the leading importers by value. It is noteworthy that by volume, Saudi Arabia ranked 10th after Botswana, pushing France to the 11th position. However, for consistency based on exports by value, France was considered instead of Saudi Arabia.

Compared to cross-sectional and time series data, gravity panel data exhibit several advantages [34]. It can control heterogeneity, be more informative, study adjustment dynamics better, and identify undetectable effects using cross-sectional or time series data. It eliminates bias due to aggregation over countries and eliminates non-standard distributions in macro panel data. It also allows researchers to track changes in variables individually, making it a valuable tool for understanding economic systems and responding to shocks [35]. In this study, the reduced form of the augmented gravity model is expressed in the following equation:

$$y_{ijt} = \beta X_{ijt} + \alpha_{ij} Z_{ij} + \epsilon_{it}$$

where: y denotes the natural logarithm of avocado exports (volume and value) from South Africa. Subscripts i, j and t represent the exporting country (South Africa in this case), the importing country, and the year, respec-

tively. B represents a (1×k) coefficient matrix, X_{ijt} is a (k×1) matrix of covariates in logarithm presented in **Table 1**, α_{ij} denotes a (1×n) matrix of intercepts while Z_{ij} is a (n×1) matrix of dummy variables signaling the specific variability between South Africa and country j. The error term, denoted by ϵ_{it}, is assumed to have a normal distribution with a zero mean. Here, n is the total number of countries (10) considered in this study, and k is the number of explanatory variables apart from the constant term.

Table 1. Data sources and variables.

Variable	Description	Data Source
*exp_va1**	Value of fresh avocado exports (R '000)	International Trade Centre (ITC)
*exp_vo2**	Volume of fresh avocado exports (Tons)	ITC
*Wgt_avp**	Level of protectionism and competition faced by South Africa in any given export destination *j* (%).	Trade Analysis Information System (TRAINS) database
Rate	Real exchange rate per US Dollar (R/US$). According to Choga and Mashao [36], the impact of exchange rate fluctuations on avocado exports varies across countries.	South African Reserve Bank
gdpc1_2015	GDP per capita of South Africa (Constant US$2015)	World Development Indicators (WDI)
gdpc2_2015	GDP per capita of trade partner *j* (Constant US$2015)	WDI
*gscpi**	Global Supply Chain Pressure Index. It is a monthly index, but it was transformed to annual averages to match the annual export data for avocado.	Bank Reserve Bank of New York
Dist	Distance in kilometers (km) between the Cape Town port and each major economic centre of the trading partners considered in this study	CEPII gravity database by Conte et al. [37]
LPI _1	Logistics performance index for South Africa. The index is compiled biannually; thus, an average value was used for the year during which the index is not compiled. For instance, if the index was compiled in 2012 and then in 2014, the value for the year 2013 was computed as the average of the values for 2012 and 2014.	WDI
Yield_1	Avocado yield in South Africa (100 g/ha). Whereas a trading partner's production capacity might influence imports by that specific country, yield data was only available for Portugal (partially), Spain, and France. Thus, the yield amongst importing countries was dropped from the analysis.	FAOSTAT
GPR	Geopolitical Risk Index. It is constructed from a count of newspaper stories discussing geopolitical tensions. It is a gauge of unfavourable geopolitical events. The higher the index, the greater the risk of geopolitical tensions.	Caldara and Lacoviello [38]
*d_eu**	Dummy for membership to the European Union (=0 if neither of the countries is within the EU = 1 if one is within the EU, and = 2 if both are within the EU). According to the European Commission, 2023 [39], whereas deliberations on BREXIT started as far back as 2016, it only came into effect on 31 January 2020.	

Note: * Denotes that the variable was not log transformed due to either the existence of negative or zero values.

To capture the effect of protectionism and competition faced by South Africa's avocado exports, we use the trade-weighted average of ad valorem equivalents (AVEs) for the two tariff lines within the HS 6-digit code for fresh avocados. Except for capturing the effect of both tariffs and non-tariff measures, the variable takes into account the competition faced in a specific market. Literature indicates that trade weights are based on reference group imports, and the weighted AVEs account for competitors worldwide at the tariff line level [12–15]. For countries that applied different levels of protection within the same year, the highest value of the AVE was used to cater for the highest level of protectionism and competition faced by South Africa's avocados. For instance, in 2019, Russia's AVEs were both 3.85% and 3.75 [40], but 3.85% was considered in our analysis.

Following Yotov [41], who affirms that the gravity model is very flexible to the extent that it can be augmented with different variables for policy analysis, we complement the traditional variables with geopolitical risk (GPR), the World Bank logistics performance index (LPI_1), and the global supply chain pressure index (*gscpi*).

In the context of South Africa's avocado exports, the GPR affects trade through influencing trade costs. According to Gupta et al.[42], Kim and Jin[43], and Liu et al.[44], GPR is associated with reduced trade flows due to higher uncertainty and trade costs. Higher trade costs emanate from higher insurance premiums, rerouting risks, and risks of trade sanctions. All these directly reduce both the extensive and intensive trade margins. With respect to perishable products like avocado, which are time-sensitive, any disruption or rerouting compromises the market window and increases the likelihood of spoilage and deterioration in quality[45,46]. Therefore, a higher GPR is a precursor to deep-sea ship scheduling uncertainty or port congestion. This physically affects marketable volumes by limiting the ripening window and increasing the risks of rejection of the produce on the EU market.

Beyond distance, the "traditional" variable in the gravity model framework, the LPI_1, is also used as a proxy for trade costs. The index evaluates logistics performance in various ways, leading to two distinct viewpoints: (i) using international logistics experts' views of their partner nations, and (ii) employing real supply chain tracking data to determine the speed of trade globally. The higher the LPI_1, the lower the trade costs and the higher the trade flows[47–49]. Higher LPI_1 in South Africa reduces dwelling times and preserves cold chain integrity between the packhouse and the point of entry into the EU, thereby mitigating temperature abuse and shrinkage[46,47,50].

Following the Federal Reserve Bank of New York[51], Barbero et al.[52], and Burinskas et al.[53], the *gscpi* was augmented into the standard gravity model to capture time-varying global shocks, such as the recent COVID-19 pandemic. The index comprises measures for port congestion, freight costs, and delivery times, among others. Since these shocks affect trade costs across the entire supply chain, controlling for *gscpi* presents an opportunity to isolate common shocks affecting all dyads that are mostly punitive for perishable products. In the context of the avocado trade, global shocks prolong transit and increase reefer costs. The elongated transit compromises the shelf life of avocados in the market and increases the risks of non-compliance. All these factors reduce the volume and quality of avocado destined for the EU markets[46,48,53].

Descriptive summary statistics of untransformed variables presented in **Table 2** reveal that the mean level of protectionism and competition faced by South Africa in any given export destination (*Wgt_avp*) was 0.35%, with a maximum and a minimum of 5% and 0%, respectively. The logistics performance and geopolitical risk indexes averaged at 3.49 and 100.6, respectively, while the global supply chain pressure index (*gscpi*) had a mean value of 0.54 and a maximum of 2.97.

Table 2. Summary statistics of the variables.

Variable (Observations = 100)	Mean	Std. Dev.	Minimum	Maximum
exp_va1	116,126.14	244,328.5	0	1,322,172
exp_vo2	5617.84	11,941.99	0	60,274
gdpc1_2015	6131.19	160.98	5748.89	6263.10
gdpc2_2015	28,113.48	16,156.18	4152.18	50,546.79
Dist	8844.72	5397.49	12.57	13,568.2
Rate	13.54	1.97	9.67	16.46
gscpi	0.54	1.19	−0.65	2.97
LPI_1	3.49	0.14	3.38	3.78
Yield_1	51,272.8	1031.12	50,197	53,588
gpr	100.6	22.16	77.29	160.17
Wgt_avp	0.351	1.129	0	5

In terms of volume, South Africa exported a maximum of 60,274 tonnes of avocados during the period under review, but with an average of 5618 tonnes per year, an equivalent of about R116.126 million. On average, the distance in kilometers (km) between Cape Town port, the major harbor through which avocados are exported to major economic hubs for the selected trading partners, was estimated at 8844.72 km, but the farthest is approximately 13,568.2 km from Cape Town. The mean exchange rate for South Africa's Rand per the United States (US) Dollar was on average 13.54, but with a maximum of 16.46.

3.2. Estimation Strategy

In this study, we use highly disaggregated data, but Helpman et al.[54] and Martin et al.[55] warn that it is susceptible to zero trade flows; thus, traditional estimators such as the ordinary least squares (OLS) are not appropriate. When using a multiplicative gravity model, Silva and Tenreyro[56] reckon that the OLS estimates are biased and inconsistent. Since the natural logarithm of zero is unknown, the dependent variables (*exp_va1* and *exp_vo2*) were therefore stated in a semi-log form following Fally[57,58] and Silva & Tenreyro[56]. Moreover, the number of zero trade flows was negligible (less than 1% of the total number of observations); thus, the Poisson-type estimation technique was employed following[57]. Furthermore, this estimation technique is advantageous as it does not require transforming the dependent variable(s), either by dropping the zero trade flows or adding arbitrarily small constants[56–59]. Fally[58] and Weidner & Zylkin[60] commend that Poisson-type estimation techniques are theoretically consistent when the time dimension is short, concur with the multiplicative structural specification of the gravity model, and are robust to heteroskedasticity. While the use of highly disaggregated data minimizes the problem of endogeneity bias as reported by Anderson et al.[61] and Cardamone[14], the dummy variable (*d_eu*) controls for variability among nations[62,63]. To control multicollinearity, the product of log per capita GDPs of South Africa and trading partner *j* (constant US$2015) was used.

3.3. Decision Support Model

This study employs Decision Support Models (DSMs) to evaluate realistic export opportunities for South Africa's avocados. The DSM is a tool used by exporting countries to determine the feasible export opportunities in a target economy or target economies, or in the global market[64–66]. It stems from research on international marketing. It filters out undesirable countries and export products using macroeconomic performance statistics and global trade data for those nations where data is available. An elaborate explanation of the weighting and combining of filters is presented in Appendix A. The application of DSMs has seen an increasing trend in pinpointing export prospects for countries, industries, and enterprises[66–71]. This model is adept at assessing the market size, expansion prospects, accessibility, and the implications of trade agreements on export capabilities. Furthermore, DSMs facilitate scrutinizing specific industry segments' export potential and selecting suppliers for ventures oriented towards exports. For instance, Grater et al.[72] underscore the utility of two complementary DSMs for products and services, illustrating their value in identifying practical export opportunities in these domains. To assist export promotion agencies in finding feasible markets for export promotion initiatives, the model was further modified.

Work by Viviers et al.[71] also utilized a DSM to pinpoint realistic export avenues for the pharmaceutical industry in South Africa. DSM has made it easier to identify unexplored markets and develop strategies to make the industry more globally competitive. Other applications of the DSM include work by Cameron et al.[72], among others. In line with these precedents, the present study employs DSMs to assess the most realistic export market opportunities for avocado originating from South Africa. To achieve this, the study employs the six filtering mechanisms:

3.3.1. Concentration

This filter evaluates supply diversification and market concentration. According to Cameron et al.[73], this filter in part captures trade barriers in a target market. It is more challenging to enter a market of interest with highly concentrated import supply patterns than one with less concentration. Thus, due to a reduced probability of success, it may be counterproductive for an exporting nation to concentrate on a small number of consumers. It is calculated as follows:

$$\mathrm{C} = 1 - \sum_i \left(\frac{\text{Exports of supplier}}{\text{Total export to the market}} \right)^2$$

When the value is closer to 0, it suggests that multiple exporting countries have access to the target market, whilst a value of 1 implies that just a single exporting country serves the importing market[64].

3.3.2. Accessibility

This filter evaluates the impact of tariffs and logistics routes on trade. This filter considers trade cost as a measure of trade barriers in addition to tariffs, estimates of international shipping costs, domestic and international transit periods, transit country-border cost approximations, and the domestic cost of import in the various target markets. According to Edewa[74], the total ad valorem equivalent of trade cost per product–country combination is determined by adding each of these, which is calculated as an ad valorem equivalent (percentage) of the value of the goods. The zero tariffs under the existing free trade agreements between South Africa and its various trading partners are based on the ad valorem equivalent of the trade cost per product-country combinations. It is calculated as follows:

$$\text{A} = \frac{\text{Maximum tariff rate}}{\text{Average tariffs on imports}}$$

3.3.3. Import Demand

This filter measures the market's receptiveness to imports. This filter looks for product-country pairings that have a sizeable import market and a growth rate for the import market over both short and long terms, while taking cognizance of the product's relative global trends[64]. It is calculated as follows:

$$\text{ID} = \frac{\text{Total imports to the market}}{\text{Imports from all suppliers}}$$

3.3.4. Export Maturity

The Relative Comparative Advantage (RCA) index is used as a proxy. This filter evaluates the competitiveness and maturity of an industry in South Africa in global trade for a certain product. The size of the import market and the cut-off points for import market growth are determined by the extent to which the country that exports specializes in exporting the goods. The Relative Comparative Advantage (RCA) index for country *c* in product *p* is given by:

$$\text{RCA}_{cp} = \frac{\frac{X_{cp}}{\sum_p X_{cp}}}{\frac{\sum_c X_{cp}}{\sum_c \sum_p X_{cp}}}$$

where: X_{cp} is product *p*'s exports by country *c*, $\sum_p X_{cp}$ is country *c*'s total exports across all products, $\sum_c X_{cp}$ is the world's exports of product *p*, $\sum_c \sum_p X_{cp}$ is the total world exports.

3.3.5. Export Production

This filter was proxied with the Relative Trade Advantage (RTA) index: This filter indicates South Africa's net export surplus for a product, reflecting its production capacity. It is calculated as follows:

$$\text{PTA} = \frac{\text{South Africa's total imports}}{\text{South Africa's exports} - \text{South Africa's imports}}$$

3.3.6. Size of the Realistic Export Opportunity in Rands (SEOR)

Upon identifying an opportunity through the above-described filters, its size was calculated by averaging the values of the top seven suppliers of avocados from South Africa in each target market. It is denominated in Rands (ZAR) and presumes that South Africa can get regulatory market access and possesses the competitiveness to expand and become a leading supplier in that market. By applying these filters, the DSM provides a comprehensive analysis of trade potential and identifies the most advantageous prospects for South Africa in the informal fresh produce market.

4. Findings and Discussion

The study's findings are presented in this section. First, results for the effect of protectionism and competition based on the gravity model are presented, followed by findings on the realistic export market opportunities emanating from the analysis using the DSM.

4.1. The Effect of Protectionism and Competition on South Africa's Avocado Exports

We employed a Poisson-type estimation technique, taking cognizance of zero trade flows, heterogeneity, and endogeneity problems associated with highly disaggregated panel data analysis. Overall, empirical results conform to the theoretical foundations of the gravity model. As anticipated, the distance between trading hubs is statistically negative, while the coefficient of the measure of purchasing power - that is, the product

of the log per capita GDPs of South Africa and trading partners - is statistically positive. Therefore, further focus is drawn on the variable that captures protectionism and competition. Results presented in **Table 3** reveal that protectionism and competition faced by avocados of South Africa's origin, as measured by the applied trade-weighted average AVEs, have negative and significant effects on both the value and volume exported. Given that this variable was not log-transformed, Lubinga and Mazenda[75] report that the estimates were exponentiated as ([exp(coefficient(β) − 1] × 100) to be interpreted as elasticities.

Table 3. Results on the effect of protectionism and competition on avocado exports.

Independent Variable	Dependent Variable	
	(1) Value (R'000)	(2) Volume (ton)
Product of Log Per capita GDPs of South Africa and trading partner *j* (constant US$2015)	0.503*** (0.000)	0.634*** (0.001)
Log Distance between Cape Town and the economic hub of partner *j* (km)	−1.082*** (0.001)	−1.306*** (0.004)
Log Real exchange rate per US Dollar (R/$)	0.407*** (0.004)	0.05*** (0.016)
Global Supply Chain Pressure Index (%)	0.28*** (0.00)	0.138*** (0.002)
Log Logistics performance index for South Africa (%)	−1.068*** (0.01)	−0.767*** (0.042)
Log Avocado yield in South Africa (100g/ha)	6.064*** (0.027)	7.195*** (0.113)
Log Geopolitical risk index (2019 = 100) (%)	0.156*** (0.001)	−0.072*** (0.007)
Dummy for membership in the European Union	1.362*** (0.001)	1.712*** (0.006)
Trade weighted average ad valorem equivalent applied (%)	−0.451*** (0.001)	−0.371*** (0.005)
Constant	−91.884*** (0.301)	−115.863*** (1.285)
Observations	100	100
Pseudo R Squared	0.522	0.562

Note: Standard errors are in parentheses, *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Therefore, the estimate of −0.451 ($p < 0.001$) when the value of avocado exports was used as the dependent variable implies that protectionism and competition in South Africa's top 10 export markets is generally associated with a 36.3% loss in revenue, while in terms of volume, the −0.371 ($p < 0.001$) estimate points to a 31% drop in volume.

4.2. South Africa's Realistic Export Market Potential for Avocados

This section delves into the findings on the realistic export market potential of avocados in South Africa. By examining key factors such as target countries, tariff rates, export values, actual exports, non-tariff measures, and market share, our analysis provides a nuanced understanding of realistic market opportunities and dynamics that shape South Africa's position in the global avocado trade. Panels in **Figure 4** provide insights into the realistic export opportunities of South Africa's avocados in various international markets, as assessed through the Decision Support Model (DSM) without applying filters. The total value of the realistic export potential for avocados originating in South Africa in all countries was estimated at R15,584.13 million. In particular, the United States of America (USA) presents a significant opportunity, with an export potential of R6508.48 million, although the actual exports to the USA remain minimal (worth about R0.25 million). Nonetheless, the EU is the biggest export market for South Africa's avocados, and the Netherlands stands out as a significant target market within the EU with a potential export value of R1524.17 million.

However, the total value of South Africa's actual exports to the Netherlands is R880.42 million, indicating a level of engagement in that market. Other European markets, including France and Germany, also exhibit noteworthy realistic export potentials, reflecting the appeal of South Africa's avocados in these countries. The United Kingdom also presents a big realistic market potential

for the avocados, valued at R566.02 million. The analysis further reveals that non-European markets, including Canada, Japan, Russia, and Australia, exhibit diverse realistic export market opportunities. It is essential to consider tariff implications, as seen with China imposing a 25% tariff, affecting the potential export opportunity. Similarly, with a 3.75% tariff, the Russian Federation presents a significant export potential, yet the actual exports from South Africa account for R87.11 million. These findings underscore the multifaceted landscape of South Africa's avocado exports, where various factors, including tariffs, existing trade volumes, and target market imports, influence the country's export opportunities. The DSM analysis provides valuable insights into the potential avenues for South African avocados to expand their presence in the global market.

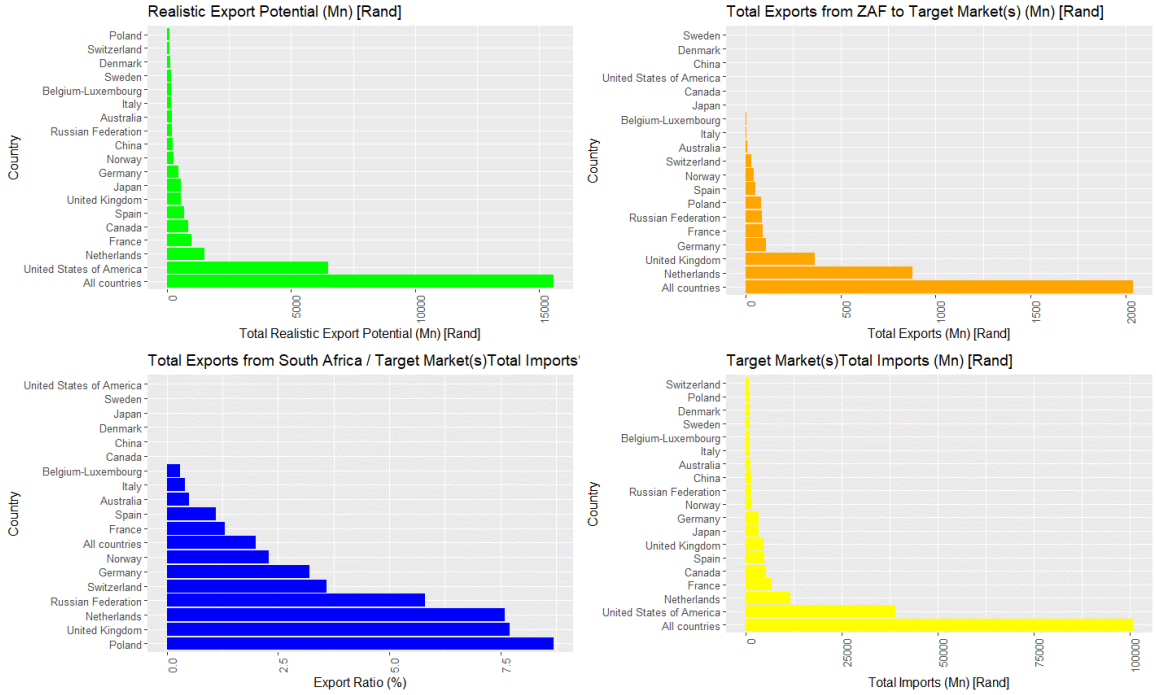

Figure 4. Realistic global export opportunities for avocados from South Africa (DSM with NO filters).

Note: mn denotes million.

The results shown in **Table 4** reveal that, according to the DSM criteria discussed in the methodology section, the EU and the UK continue to be South Africa's greatest realistic export prospective markets, which respectively account for 72% and 10% of the total realistic export potential to targeted markets. Other identified realistic export potential markets include Russia, Switzerland, the United Arab Emirates (UAE), and Hong Kong. Whereas Russia and Ukraine do not grant duty-free access to avocados originating from South Africa, these markets command a 4% and 1% share of the total realistic export potential, while duty-free market access into Switzerland assumes a 2% share of the total potential. Therefore, this suggests that in the absence of preferential treatment, South African avocados have an opportunity to gain access to new markets.

Table 4. Realistic global export opportunities for avocados from South Africa (DSM with ALL FILTERS applied).

Country	Tariff (%)	A	B	C	D
	-	5809.1	1866.4	41,921.5	4.5
Netherlands	0.0	1524.2	880.4	11,580.6	7.6
UK	0.0	566.0	364.5	4711.2	7.7
Germany	0.0	473.5	106.1	3288.9	3.2
France	0.0	981.4	88.1	6698.9	1.3
Russia	3.8	218.8	87.1	1501.6	5.8

Table 4. *Cont.*

Country	Tariff (%)	A	B	C	D
Poland	0.0	108.0	81.8	937.8	8.7
Spain	0.0	700.9	52.4	4876.0	1.1
Ukraine	3.0	49.3	31.2	377.6	8.3
Switzerland	0.0	116.7	30.4	847.7	3.6
Portugal	0.0	40.6	28.8	276.7	10.4
Austria	0.0	105.9	27.9	760.6	3.7
Finland	0.0	74.3	27.3	611.8	4.5
UAE	0.0	67.4	16.8	477.9	3.5
Botswana	0.0	0.0	11.5	11.5	100.0
Hong Kong	0.0	74.5	7.6	481.8	1.6
Serbia	10.0	11.5	5.3	80.7	6.6
Italy	0.0	177.0	4.0	1118.8	0.4
Slovakia	0.0	21.1	3.9	161.4	2.4

Note: A = Total realistic export potential to target market(s) (Mn) (million Rands); B = Total exports from South Africa to target market(s) (Million Rands); C = Target market(s) total imports (Million Rands); D = B/C.

Even though South Africa lacks sanitary and phytosanitary (SPS) market access protocols with the US, Japan, and China, the most important new realistic export potential markets were found when SPS market access priorities were considered (see **Figure 5**). Recently, Zang [76] reported that South Africa's SPS requirements, as stipulated by China's general administration of customs, were approved, and the country was granted permission to export fresh avocados to China.

It is worthwhile to note that the USA market is heavily concentrated, with Mexico dominating as the leading supplier of avocados. Therefore, the USA may not be considered a realistic export potential market if the concentration criterion is put into consideration. However, if SPS market access protocols can be secured, the USA continues to be the most significant prospective market for South Africa's avocado globally, even when other criteria like seasonality and distance between the East and West of the USA are taken into account. Given ongoing tensions between the two countries, there is much uncertainty about whether the potential trade opportunities can be realized in the near future. Notwithstanding, there is a need for South Africa's avocado industry to come up with concrete strategies on how to deal with the dominance of Mexico in the USA market. Although the Generalized System of Preferences (GSP) has given South Africa access to the Russian market through preferential treatment, there is still considerable room to grow this market, with an additional R218 million in export potential, should geopolitical tensions subside. Therefore, in terms of scale, the USA, Japan and China offer the most promising practical export market potential.

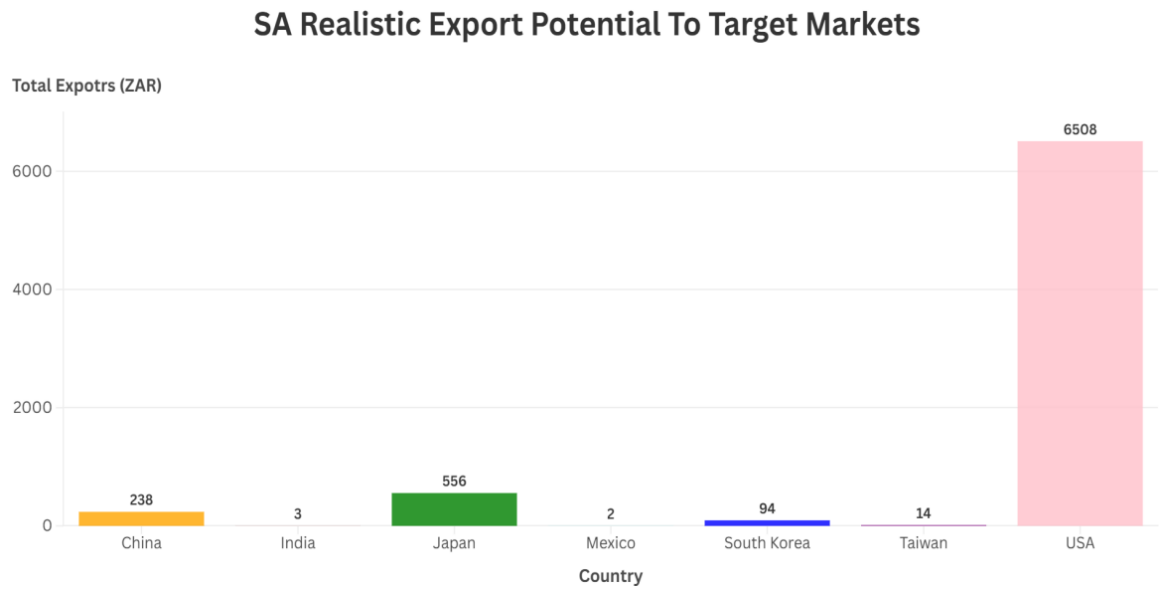

Figure 5. *Cont.*

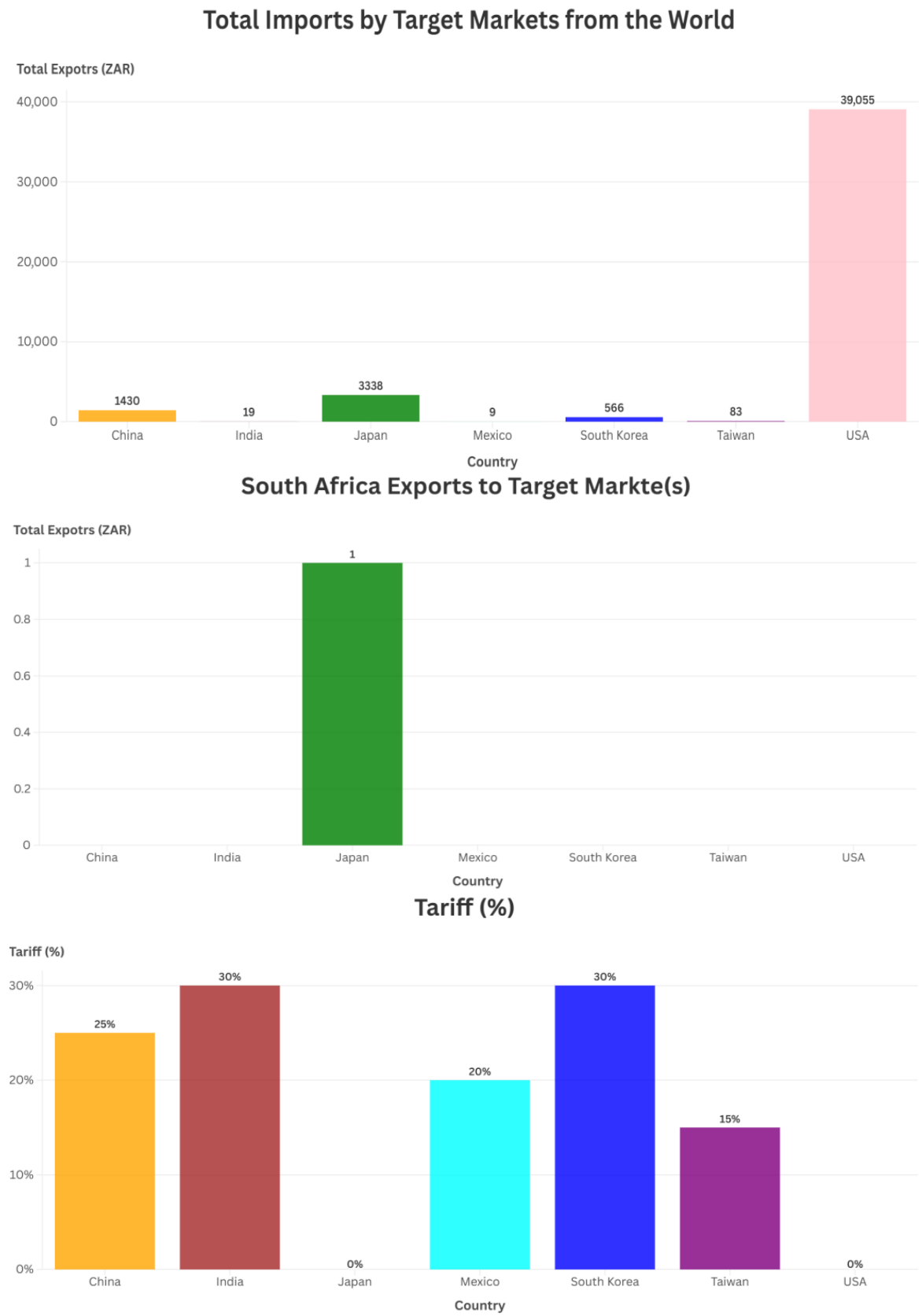

Figure 5. The value of realistic export opportunities for avocados from South Africa to new priority markets identified, taking into consideration SPS protocols.

4.3. Discussion

Concerning protectionism and competition, results suggest that protectionism and competition in South Africa's top 10 export markets compromise revenue generated from avocado exports by 36.3% while the volume decreases by 31% [77]. Our findings concur with work by Edwards & Chien [78] and Scheepers et al. [9], who contend that protectionism in the form of non-tariff barriers (e.g., SPS) is associated with a loss in revenue as global value chains are excluding exports on a growing basis, and regulatory restrictions are becoming more reactive than risk-based. This has become a significant hindrance to avocados, and Kenya is a vivid example [77]. Moreover, Ridley et al. [57] also report that trade in food products is extremely vulnerable to competition due to the significant level of substitutability for products acquired from other nations, particularly in the presence of both tariff and non-tariff obstacles in effect.

For realistic export market opportunities, it is clear that South Africa has markets into which to diversify, especially if SPS market access protocols are prioritized. The most important and feasible export market for avocados from South Africa is the USA. Over the years, the Agricultural Growth and Opportunities Act (AGOA) granted South Africa preferential tariff market access to the USA [78,79]. This unilateral Act of the USA replaced GSP preferences, and import tariffs are zero. Duty-free market access has a significant influence on export competitiveness. The USA's 0% tariff provides a distinct advantage over other markets, such as China and India, which impose a 25% and 30% tariff rate, respectively [40]. This is likely to contribute to the higher potential and actual exports to the USA.

However, the USA remains closed from a regulatory viewpoint, even after a decade of application review for market access to obtain an SPS Protocol in place to mitigate disease risks. Also, the USA market is very concentrated, with almost only Mexico supplying avocados to that market. This is due to the Free Trade Agreement between Mexico, the USA, and Canada, and USA investors in Mexico. South Africa is hopeful that a breakthrough could be made to access the USA market in the future, given the growing cooperation and investment ties between the two countries. However, during the new administration of President Trump, there is growing trade tension between South Africa and the USA, with concerns that South Africa might be excluded from the AGOA beneficiary list. This move presents detrimental effects on all exports from South Africa (avocados inclusive) [80,81].

The two most prospective markets for South Africa's avocados, aside from the USA, are China and Japan. Zang [76] confirms that South Africa's market access protocols were accepted in China; thus, the avocado industry was granted access to the Chinese market towards the end of the year 2023. Whereas South Africa was granted access into China, at the time the analysis was done for this study, no shipments had been exported to China, but this development is anticipated to stimulate avocado trade to China and relieve the overreliance on the EU market. In addition, countries like Japan and South Korea have relatively high "Total Realistic Export Potential" compared to the actual exports, thereby suggesting that there is room for growth if trade barriers can be addressed. South Korea imposes an exorbitantly high tariff of 30% as much as India. Markets such as India and Taipei—Taiwan exhibit shallow potential and actual exports. This could be due to challenges in market access, consumer preferences, or a lack of binding trade agreements with South Africa. Mexico exhibits high protectionism in its avocado industry as depicted by the high tariff rate (20%) it imposes on avocados originating from South Africa; hence it ranks at the bottom for the countries with realistic export potential (about R2 million), moreover, very negligible volumes of South Africa's avocados (less than R0.5 million) exports are destined to that market. Mexico's limited importation of avocados, whether from South Africa or elsewhere, is attributable to the high production of avocados within the country, considering that it is among the top five producers globally.

5. Conclusion

This study uses both the gravity model framework and the DSM to examine the effect of protectionism and competition on South African avocados and to find markets with realistic export opportunities. The work is an-

chored on the fact that industry is faced with increasing protectionism and competition (based on both tariffs and non-tariff barriers) from countries like Peru, Mexico, and Kenya in the EU market, which is the major export destination. Moreover, there are concerns that the EU market might soon become saturated. The results of the augmented gravity model affirm that protectionism and competition negatively impact South Africa's avocado exports to the top 10 destinations, dominated by the EU.

Considering the aforementioned, the DSM-based research reveals that avocados from South Africa have opportunities to access new markets, including the USA, Japan, and China, due to the high realistic export market potential. This will reduce the over-reliance on a single market (the EU). However, there is an urgent need for South Africa's regulatory authorities, in partnership with authorities in the identified markets, to develop realistic export market opportunities to develop implementable market access protocols for the avocado industry, among other agricultural commodities. The implementation of SPS market access protocols in these target markets must be South Africa's top priority. These protocols would facilitate smoother trade and provide a competitive advantage for avocados originating from South Africa, while allowing the avocado industry to tap into a more extensive consumer base and increase its export potential. On the to-do list, the USA, Japan, China, India, South Korea, and Taiwan ought to be given top priority. The relevant government departments (DoA, DTIC & DIRCO) and industry stakeholders are required to review priority commodities through the existing value chain round tables.

According to SAAGA[82], the false codling moth (Thaumatotibia leucotreta) and fruit flies (Tepharitidae) are the major pests of concern, associated with the delayed implementation of SPS market access protocols with international markets, despite the industry having put in place a systems approach and operational measures that are currently being used. SAAGA[82] affirms that the identified operational measures include cold chain integrity, trapping thresholds, orchard sanitation, and packhouse culling. Therefore, in accordance with the International Plant Protection (IPPC) standards, South Africa must adapt its SPS market access protocols to the regulatory requirements of each of the prioritized markets. For avocado, the most critical standards are: (i) International Standard for Phytosanitary Measures 11 (ISPM 11) used for pest risk analysis of quarantine pests, (ii) ISPM 14 used to monitor the use of integrated measures in a systems approach for pest risk management, and (ii) ISPM 35, which specifically focuses on the systems approach for pest risk management of fruit flies[83].

Thereafter, this information would be used during pest risk analyses (PRAs) and protocol negotiations with each targeted market. Nevertheless, before commencing protocol negotiations with the competent authority of each targeted market, South Africa must conduct domestic pilots during a production season to guarantee that the system(s) and operation measures meet the market requirements. Upon engaging with the respective competent authority in each country, South Africa can then undertake a pilot shipment(s) as per the required standards, but of key significance is verification of compliance following strict inspection upon arrival in each prioritized market.

Additionally, issues with market concentration, like Mexico's predominance in the USA avocado market, should be addressed through strategic industry collaborations and market diversification strategies. Whereas DSM provides an indication of realistic export markets with great potential to penetrate, it is crucial to recognize that the current competitors in the various markets, consumer preferences, and import regulations into targeted markets, among other factors, keep changing. Therefore, South Africa's avocado industry should relentlessly further build distribution networks and should consider developing a comprehensive export strategy encompassing tariff negotiations, market research, branding, quality assurance, and distribution enhancement to fully exploit potential in each target market. Comparative analysis of factors contributing to successful exports into lucrative markets (e.g., the USA) and markets with very minimal imports (e.g., Mexico) can offer valuable insights for refining export strategies.

Author Contributions

Conceptualization, M.H.L., B.M., and E.S.; methodology, M.H.L., E.S., C.D., B.M.; software, E.S., S.N. and T.N. (Thulani Ningi); validation, T.N. (Thulani Ningi), C.D., T.N. (Thabile Nkunjana) and F.S.; formal analysis, M.H.L., E.S., B.M. and T.N. (Thulani Ningi); investigation, S.N., M.H.L., C.D., F.S. and T.N. (Thulani Ningi); resources, M.H.L. and E.S.; data curation, B.M. and T.N. (Thabile Nkunjana); writing—original draft preparation, all; writing—review and editing, all.; visualization, B.M. and T.N. (Thulani Ningi); supervision, M.H.L.; project administration, M.H.L. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

The data underlying the results for the gravity model are available upon request. However, the data presented in the study on the Decision Support Model (DSM) are available from https://tradeadvisory.co.za/methodology/.

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Conflicts of Interest

The authors declare no conflict of interest.

Appendix A. Insights into the Decision Support Model (DSM) Filtering Process

To identify realistic export opportunities (REOs), the DSM uses a chronological filtering strategy when assessing product-country combinations. Products that exhibit high potential are then retained, while all the others are regarded. According to Cuyvers et al.[84] and Pearson et al.[85], the four (4) filters are:

i. **Country screening based on risk and macroeconomic size/growth**

At this level, a country's risk is operationalized based on commercial risk and credendo political indices compiled by the Credendo group. The indices reveal a country's commercial, political and investment risks. The average of the short, medium, and long-term political index is equally weighted with the commercial risk index to obtain a country's overall risk score. Cameron and Viviers[86] posit that countries exhibiting a very high risk are then dropped. Using the threshold of either the gross domestic product (GDP) or per capita GDP for a specified period (e.g., the previous 3 years) and above a given percentile (e.g., the 20th percentile of the last three years), the macroeconomic size and annual growth of countries are evaluated. For instance, if the macroeconomic threshold were set to be the global average for the past three years, then only countries that attain both the risk, with GDP and per capita GDP above the world's average, would be considered for the second level of filtering[86].

ii. **Product-country import demand, for both short- and long-term**

Filter 2 uses HS-6-digit level data to assess the import demand in the short term, compound growth (long term) over 5 years, and the size of the importing market. For each of the aforementioned assessments, each product-country combination must simultaneously pass the criteria. The thresholds are constrained by the exporting country's revealed comparative advantage (RCA). That is, if a product's RCA is greater than or equal to 1, then flexible thresholds are used and vice versa.

iii. Market accessibility and concentration

Product-country combinations that pass filter two are then subjected to two sub-filters. According to Cameron and Viviers [86], the first sub-filter uses the Herfindahl-Hirschman index to remove markets exhibiting high import-supply intensity, while the other generates a composite index called the Relative Market Access Index (MAI). Compilation of the MAI entails adding up the weighted ad valorem equivalents of the international shipping cost, the required time-to-ship, domestic import costs, and tariffs. The MAI evaluates the relative preferential treatment an exporting country enjoys in a target market for a given product in comparison to other countries (competitors) supplying the same market. An MAI value greater than 1 implies that the exporting country in question receives better-than-average access to the identified market, most especially due to preferential trade agreements. However, a value less than one implies that the exporting country is worse off than the average market access enjoyed by other competitors, suggesting either tariff or non-tariff disadvantages. A value of one suggests that, to a greater extent, product competitiveness is influenced by non-price factors. Therefore, product-country pairs with MAI values greater than one are retained since the target market(s) have favourable market access structures.

iv. Categorization and prioritization based on the exporting country's market share, revealed advantage, and a potential-value metric

At this level (filter 4), the available product-country combinations are subjected to the REO map with two axes: (i) the exporting country's current markets share and (ii) the target markets' size/growth rate. The average import value supplied by the top six competitors in the targeted market is then computed, and this serves as the benchmark for assessing additional export potential.

Throughout the four canonical filters, expert judgement is very instrumental, for instance, during the choosing of the most appropriate sources of risk indices and the aggregation thereof, the selection of weights for the MAI components, as well as the "Hummel's constant" which is used to transform ad valorem equivalents from time. Expert judgement is also important when setting RCA cut-offs, benchmark thresholds, and the timeframe used to measure economic growth.

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