Research article

Competitiveness of South Africa's agri-food commodities

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Abstract: This research aims to determine the competitiveness of South African agri-food products and the factors that influence them. The study applied a comparative advantage (RCA) index, Lafay Index (LFI), Export Diversification Index (EDI), Major export category (MEC), Hirschman index (HI), and regression analysis. The study revealed a mixed result of RCA and LFI of agri-food commodities during 2000–2018. Some commodities such as tobacco and rawhides have a comparative advantage. On the other hand, vegetables, fruit, and coffee showed a comparative disadvantage. At the same time, the LFI revealed a significant comparative advantage from 2000 to 2003 for agri-food commodities of fish and sugar, sugar preparations, and honey. EDI was near zero for all commodities, indicating that the trading structure was less concentrated. Hirschman index (HI) demonstrated that all commodities showed a reduced concentration throughout the study period. The results of regression analysis on factors that influence the competitiveness of agri-food commodities were varied. Agriculture productivity and GDP per capita had a favorable impact on comparative advantage. Macroeconomic stability had a mixed result, with agri-food commodities having positive and negative effects. South Africa had a less concentrated trade structure and did not depend on international trade from the agri-food industry. These evaluations provide policymakers with information on agri-food competitiveness and the factors that influence the industry's competitiveness.

Keywords: agri-food industry; competitiveness; revealed comparative advantage; Lafay Index; land productivity; labour productivity

1. Introduction

Integration into global markets, trade performance, value-added in production, and value chain

activities of a country depending on the competitiveness of an economy and its industries [1]. Global integration has shaped agricultural markets through promoting market liberalization, which in turn enforced competitiveness for survival. Therefore, the agri-food sector is usually the third sector based on many indicators, and the sustainable growth of a country relies on the competitiveness of agriculture.

Growth in competitiveness can benefit agribusiness, agriculture, and agro-enterprises to enhance their income levels and alleviate poverty in the long run, even when faced with challenges [2]. Challenges include technical, environmental, social, economic, uncertain weather conditions, and political change [3]. Therefore, strategies, programs, and policies are required to overcome challenges at the farm and industry levels.

According to South Africa's National Development Plan (NDP) [4], the agri-food industry is labour-intensive. It might help the country meet its NDP targets of creating 1 million employment by 2030 and growing its gross domestic product at a rate of 5.4% per year. Efficiency and ability to provide the necessary products on time determine the country's competitive status in the global market.

ANDE [5], Kotze and Rose [6], and von Bormann [7] highlighted that the South African agri-food system is characterized by formal and informal dynamics, which influence all sectors. This includes everything from a dense, industrialized commercial industry to many small-scale operators, such as farmers, distribution, and sales.

Domestically, population growth and rising middle-class incomes are significant drivers for the agri-food sector's development. According to the International Trade Centre [8], South Africa is a net exporter of agri-food. Fruit, which accounts for the majority of the country's exports, is the sole reason for this. In contrast, South Africa is a net importer of all other agri-food products. Most South Africa's agri-food imports are unprocessed commodities for further processing along the value chain from essential input to packaged products ready for sale.

Purchase [9] indicates five main trends in both global and South African agri-food systems. The first trend is consumers' purchasing power, including what and where they buy and what they will pay. The development of globally competitive value chains in the agro-food system is the second trend. The third trend is farm-level food production, sustainability, and proper resource management, such as land, water, and energy. The fourth trend is the fourth industrial revolution and the benefits the agri-food system gains through biotechnology, robotics, traceability, digital information systems, and drone technology. The fifth trend is big data management, which allows value chain actors to significantly increase efficiencies and obtain a competitive advantage.

The globalization of economic activities and survival by microeconomic units, sectors, and nations require competition in open domestic and international trade. Participation in international trade is essential to explore ways of improving efficiency and global competitiveness [10]. The performance in the agricultural sector is also affected by South Africa's participation in various trade agreements. South Africa is a signatory to several trade agreements that contributed to the agricultural sector's liberalization. Participation in global trade agreements reduced distortions from indirect export subsidies and induced substantial changes in the structures of agri-food trade flows and comparative advantages [11].

There are several reasons why agricultural commodities are continuous prospects for public protection. Stability, income, and foreign trade are the three fundamental problems that the business faces. There is vast, though not unanimous, agreement that markets for most agricultural products are

more unstable than necessary for efficient use of resources and efficient management of buyers' expenditures. Khor [12] explained that the world's most urgent problems are the distorting nature of global agriculture trade, including instability in the markets, income losses resulting from terms-of-trade declines, and international agricultural trade (trade negotiations). Sizable price, output, and income fluctuations occur in agriculture because of notorious inelastic demand and supply, uncertainties in foreign markets, and the vagaries of weather, insects, and diseases peculiar to farming. Most legislation to protect farmers and most programs dealing with the marketing of agricultural products usually involve the term "stabilization" in some respect. The question, however, is whether this goal is achieved through the set of policies that are in place and whether they are sufficiently integrated to create an environment that increases efficiency to enhance competitiveness. This study attempts to answer which factors affect agri-food comparative advantage of South Africa and which agri-food commodities have a comparative advantage and disadvantage.

Few studies examine competitiveness considerations in the agri-food sector in Sub-Saharan Africa in general and South Africa in particular. This has motivated research to determine the level of competitiveness of South African agri-food products and identify the factors that influenced agri-food competitiveness to derive broader policy implications for agro-food trade and sustainable agri-food sector development. The findings of this study provide information to policymakers on agri-food competitiveness and identify factors that affect the competitiveness of South African agri-food commodities. More specifically, previous research on competitiveness focussed on agribusinesses, specific commodities such as timber and soybeans, agro-processing, economic growth, and food supply chain [10,13–22]. These studies did not, however, concentrate on factors affecting agri-food competitiveness. Bahta and Willemse [13] used various metrics to examine South Africa's competitive advantage in soybean production and find out the nominal rate of protection was higher than the effective rate of protection, which implies that the tariff applied on the output is higher than the tariff applied on inputs. The structure of the tariff schedule may have an important bearing on the efficiency. Esterhuizen et al. [14] and Sharma et al. [15] evaluated the agribusiness and agro-processing sector's competitiveness, structure value addition using different indexes.

Esterhuizen et al. [14] found out that decreasing competitiveness exists in the value chains, implying that value-adding opportunities in the sector are restricted. Sharma et al. [15] discovered that the extent of value addition in the processing sector was approximately 53%, and financial viability ratios revealed a high current ratio but a lower quick ratio (acid test) in most of the processing industries, indicating that many sectors have significant unsold inventories. Hencion and McIntyre [16] examined the impacts of the food supply chain and found that consumers, followed by retailers, were identified as the most important influences on food supply chains. Mbai et al. [17] investigated Namibia's timber export competitiveness, and their findings revealed that Namibia's timber exports are not competitive, export patterns are heavily dependent on export volumes and values of timber exports, and timber export competitiveness is not sustainable, given Namibia's heavy reliance on natural forests. Louw et al. [18] identified factors constraining the development of agro-processing. They found that the small wheat-milling and baking industries have relatively high barriers to entry, including the ability to acquire the required capital to start operations; to establish a market; to gain knowledge of the wheat-milling and baking industries; to uphold a well-maintained infrastructure; to acquire marketing-management knowledge, and to have the necessary cash flow. Mlambo et al. [19] looked at how agricultural commodities exports contribute to economic growth, and the result revealed that processed agricultural exports have a positive relationship with economic

growth. In contrast, unprocessed agricultural exports have a negative relationship with economic growth. This shows that manufactured agricultural exports contribute significantly to economic growth.

Bojnec [20] measures the regional and global agricultural trade pattern and found out that trade and revealed comparative advantage indicators are distorted by trade and other policy impediments, which may enhance exports artificially through export subsidies or shield domestic production using tariffs and non-tariff trade measures. Bojnec and Ferto [10,21,22] investigate the level, composition, complementarities, agri-food trade specialization pattern, and differences in agro-food relative trade advantage/disadvantage and their implications to food policy. Bojnec and Ferto [10] found that higher and more stable comparative trade advantages are found for bulk primary raw agricultural commodities and less for consumer-ready foods, implying competitiveness shortcomings in food processing and international food marketing. Bojnec and Ferto [21] highlighted that Southeastern European trade specialization patterns have seen an increase in trade deficits in agrofood products, and agrofood export markets are highly concentrated in bulk raw commodities, with a lack of export specialization. Bojnec and Ferto [22] found that Central European countries experienced a more significant number of products with relative trade disadvantages and greater significance of one-way imports.

The article contributes to the existing literature to better understand the relative trade advantages of South Africa's agri-food products markets. The results might be of broader relevance to those with direct involvement in agri-food trading. Also, to strategy and policymakers in the agri-food industry, the empirical results might help evaluate policy implications for competitive agri-food trade. Baena-Rojas and Herrero-Olarte [23] highlighted that the non-participating countries in multilateral trade negotiations and outside preferential trading arrangements are more likely to lose.

2. Materials and method

2.1. Description of the method, data, and sources

Various indicators and models were used to better understand the trade structure, pattern of (export and import), and the level of competitiveness of South African agri-food industries. These included the RCA, LFI, Export Diversification Index, Hirschman index (H), and MEC index's theoretical and empirical concepts. Furthermore, from 2000 to 2018, a model for identifying the drivers that give South African agri-food a competitive advantage was estimated using RCA as an outcome variable against explanatory variables and data from various sources.

Information on export, import of sectors, and countries obtained from United Nations commodity trade data were used [24]. Land and labour productivity (Value of agricultural production in US$ at constant price) was obtained from the Food and Agriculture Organization [25]. Gross Domestic Product per capita in current U$ (GDPpc) and macro-economic stability-inflation, consumer prices (annual%) was obtained from the World Bank [26]. Table 1 depicts a description of the variables.

The agri-food items and related division codes examined in this study (2000 to 2018) are based on the Standard International Trade Classification Revision 4 [27]. Namely, (i) Food and live animals: Live animals (00); Meat and meat preparations (01); Dairy products and birds' eggs (02); Fish, crustaceans, molluscs and aquatic invertebrates and preparations thereof (03); Cereals and

cereal preparations (04); Vegetables and fruit (05); Sugar, sugar preparations and honey (06); Coffee, tea, cocoa, spices, and manufactures thereof (07); Miscellaneous edible products and preparations (09), (ii) Tobacco (tobacco and manufactured tobacco substitutes (12), (iii) Crude materials, inedible (raw hides and skins (other than fur skins) (21) and leather; silk (26) and (iv) Animal vegetable oils, fats and waxes- Animal, vegetable fats and oils, cleavage products, etc. (43).

2.2. Revealed Comparative Advantage and Lafay Index

The relative trade performance of South African agri-food commodities is the subject of the RCA, LFI, and other indices theory and model. The RCA was used in this study to assess the competitiveness of agri-food in South Africa. Balassa [28] develops the comparative export advantage (RCA) index. This index is subject to criticisms in empirical trade analysis due to the distortion it introduces [29]. Lafay [30] proposes to solve these shortcomings by constructing weighted indicators of contribution to the trade balance that, even if they contain interesting information, are ambiguous in measuring trade specialization. Because of the growing importance of intra-industry trade in agro-food trade caused by the integration process, economic growth, and macroeconomic fluctuation in the analyzed period.

Despite several critical limitations, such as the distortion it introduces, the asymmetric value problem, and the problem with logarithmic transformation, the RCA index remains the popular tool in empirical trade analysis [29,31]. According to Balassa [28,32], the model to compute the Balassa RCA index is (Eq. 1):

$$
\text{RCA}_i = \frac{\dfrac{X_{ij}}{\sum_i X_{ij}}}{\dfrac{\sum_j X_{ij}}{\sum_i \sum_j X_{ij}}}
\tag{1}
$$

When RCA > 1, South Africa's agri-food commodity shares in the world export is lower than agri-food commodity shares in national exports, which means that South Africa had a comparative advantage in agr-food products. South Africa faced a comparative disadvantage when RCA < 1, agri-food commodity shares in world exports were higher than agri-food commodity shares in national exports. The RCA was used in a number of studies at the sector, commodity, and national levels [13,17,33,34].

There have been numerous attempts to overcome the shortcomings of RCA. Alternatives include trade-cum production indices (LFI), which include both trade and production variables, and export-only indices (such as the Export Diversification Index (DX), Hirschman (H) index, and Major Export Category (MX) indices, which include only export variables) [35].

Theoretically, trade-cum-production indices such as LFI would be suitable and robust measures in estimating comparative advantage. Bowen [36] suggests an alternative index including production variables, claiming that the RCA index is partly a "failure of the theoretical framework" since the RCA separates exports and imports when comparative advantage is properly a net trade concept. Also, Lafay [30] points out that the RCA method eliminates the influence of macroeconomic

variables; the reason why Balassa chose only export variables and excluded import variables can be applied in the same token to import variables. That is, while tariffs and other protective measures on the import side are accused of causing bias in trade performance measures, which have been reduced through successive multilateral negotiations, the same argument can be made on the export side, where subsidies or voluntary export restraint have been increased.

Table 1. Description and sources of data of variables.

Variables	Variable description	Data source
RCA (revealed comparative advantage index)	Calculated based on formula 1	UN Comtrade
X	Export in US$	
i	Commodity	
j	Country	
X_{ij}	Exports of the sector "i" of Country "j"	
$\sum_i X_{ij}$	Total exports of the country "j"	
$\sum_j X_{ij}$	World exports of the sector "i"	
$\sum_i \sum_j X_{ij}$	Total "world" export	
LFI (Lafay Index)	Calculated based on formula 2	UN Comtrade
m_j^i	Imports of the sector "i" of country "j"	
n	Number of items (agri-food product)	
EDX (Export diversification index)	Calculated based on formula 3	UN Comtrade
h_{ij}	Share of the commodity "i" in the total exports of country "j"	
h_i	Share of the commodity in world exports	
H (Hirschman index)	Calculated based on formula 4	
MEC (Major Export Category)	Calculated based on formula 5	
Land productivity (LAND)	Land productivity –Value of agricultural production in US$ (constant 2005 US$ prices) per hectare of agricultural land	Food and Agriculture Organization Statistical database (FAO STAT)
Labour productivity (LABOUR)	Labour productivity—Value of agricultural production in US$ (constant prices) per number employed in agriculture	
GDP per capita (GDPpc)	Gross Domestic Product per capita in current US$	World Bank database (WB)
Macroeconomic stability -INF	Macroeconomic stability—Inflation (INF), consumer prices (annual%)	

Source: Author observation.

While trade-cumulative-production indices have been more focused on better connecting themselves with theory, exports-only indices have been more focused on transforming and adjusting the existing RCA index to overcome its disadvantages, particularly its asymmetric property, while maintaining its practicality ease and simplicity [37].

The Lafay Index (LFI) [30] was also used as an alternative measure of comparative advantage, as expressed in Eq. 2:

$$LFI_j^i = 100 \left(\frac{x_j^i - m_j^i}{x_j^i + m_j^i} - \frac{\sum_{j=1}^N (x_j^i - m_j^i)}{\sum_{j=1}^N (x_j^i + m_j^i)} \right) \frac{x_j^i + m_j^i}{\sum_{j=1}^N (x_j^i + m_j^i)} \tag{2}$$

The LFI provides a more thorough examination of South Africa's agri-food commodities export participation. The normalization of each product or sector is obtained by weighting each product's contribution regarding the respective importance in agrifood trade. Because the LFI measures each product's contribution to the overall normalized agrifood trade balance, the following relation holds $\sum_{j=1}^N LF_j^i = 0$. South Africa demonstrated comparative advantages when LFI > 0, and the higher the value of LFI, the higher the level of specialization in the agri-food trade or LFI > 0 holds for a certain product j, then trade specialization is revealed; the larger value indicates a higher degree of the product's trade specialization. Similarly, negative values imply trade de-specialization.

2.3. Export Diversification Index/Concentration Index

The Export Diversification Index (EDX) was used to measure the agri-food sector's export performance and competitiveness in South Africa, as indicated in Eq. 3:

$$EDX_j = \frac{\sum_i \left| h_{ij} - h_i \right|}{2} \tag{3}$$

An analogous export diversification metric, the Hirschman (H) index, was used by the United Nations Conference on Trade and Development (UNCTAD) [38]. Eq. 4 shows the H index as the shares of South Africa's agri-food commodities:

$$H_j = \sqrt{\left(\sum \left(x_i / X \right)^2 \right)} \tag{4}$$

The World Bank [39] highlighted that the EDX and H index range from 0 to 1. The lower value, the less concentrated are the South African agri-food exports; thus, a value close to zero indicates that South Africa has a less concentrated agri-food trade structure.

2.4. Major Export Category

The major export category (MEC) classifies agri-food commodities that account for 50% or more of total agri-food exports and account for the majority of South Africa's j exports. A share of total country j exports is computed and rated for each exporting agri-food product i. (Eq. 5); South Africa's exports are said to be overly reliant on a single agri-food commodity category.

$$MX_i = \frac{x_{ij}}{\sum_{i=1}^{n} X_{ij}} *100 \tag{5}$$

The economy is classed as diversified if no single agri-food commodity accounts for 50% or more of total exports.

2.5. Determinants of RCA

The impact of RCA determinants was studied from 2000 to 2018. The outcome variable is RCA, while macroeconomic stability, GDP per capita, land, and labour productivity are independent variables. Figure 1 depicts the model's theoretical framework, and Eq. 6 empirically expresses the model:

$$RCA_{it} = \alpha_0 + \alpha_1 LAND_{it} + \alpha_2\, LABOUR_{it} + \alpha_3\, GDPpc_{it} + \alpha_4\, INF_{it} + \varepsilon_i \tag{6}$$
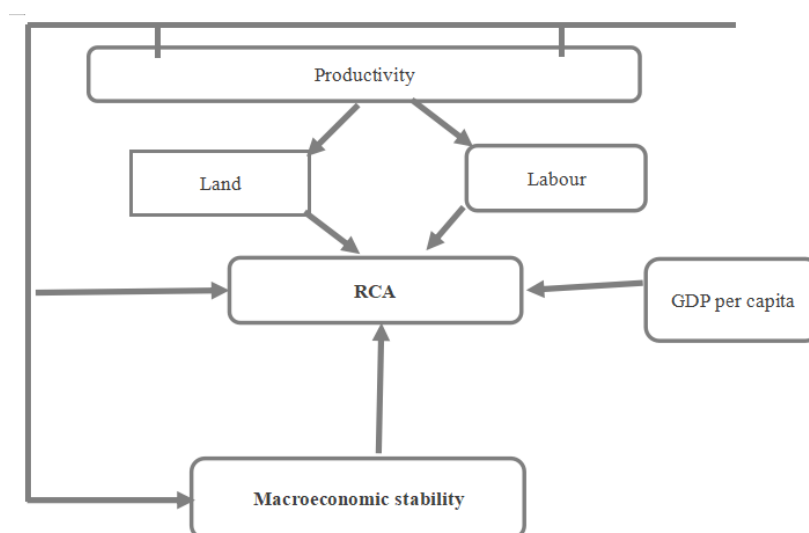
Source: Author observation.

Figure 1. Conceptual framework the determinants to the revealed comparative advantage (RCA).

In Figure 1, concepts are understood and developed based on the data patterns and not by collecting data to evaluate the hypothesis. Still, also, the study emphasizes the validity of the research through an empirical approximation. The model includes an RCA indicator as a dependent variable, while explanatory variables include land and labour productivity, GDP per capita, and macroeconomic stability. This study contains several hypotheses based on the objective of the study, which is defined as follows:

Hypothesis 1: Land productivity has a positive influence on South Africa agri-food comparative advantages;

Hypothesis 2: Labour productivity has a positive influence on South Africa agri-food comparative advantages;

Hypothesis 3: GDP per capita have a positive influence on agri-food comparative advantages;

Hypothesis 4: Macroeconomic stability has a positive impact on agri-food comparative advantages.

3. Results

3.1. Revealed Comparative Advantage (RCA) and Lafay Index (LFI) for food and live animals

The RCA for live animals in South Africa revealed a comparative disadvantage during the study period from 2000 to 2018 (Table 2). As Table 2 indicates, vegetables, fruit and coffee showed a comparative disadvantage from 2000 to 2009, and coffee revealed a comparative disadvantage again in 2011. The commodities of meat and meat preparations, fish, dairy, Sugar, sugar preparations, honey, cereals, and miscellaneous showed a comparative advantage. On the other hand, vegetables and fruit demonstrated a comparative advantage from 2010 to 2018, and coffee demonstrated a comparative advantage from 2012 to 2018 and in 2010 (Table 2). The LFI in Table 2 indicated fish and Sugar, sugar preparations, and honey showed a significant comparative advantage.

3.2. RCA and Lafay Index (LFI) for Tobacco, Crude Materials, and Animal and Vegetable oils

The RCA of tobacco and rawhides showed a comparative advantage from 2000 to 2018 (Table 3). The LFI also indicated that tobacco, except from 2016 to 2018 and rawhides showed a comparative advantage. However, the silk sector showed a comparative disadvantage, as noted in the RCA and LFI (Table 3). Animal and vegetable oils also showed a comparative disadvantage from 2001 to 2007 in RCA and a comparative disadvantage from 2000 to 2018 in LFI.

3.3. Export diversification and Major export categories Food and Live animals

The EDX values for all commodities under food and live animals (Tables 4 and 5) were close to zero, indicating a less concentrated trade structure. All of the commodities under food and live animal (Tables 4 and 5) exhibited low concentrations throughout the study period, according to the index of trade concentration (HI). From 2000 to 2018, the MEC for all commodities under food and live animals (Tables 4 and 5) was below 50%.

The EDX values for commodities under tobacco, crude materials, and animal and vegetable oils (Table 6) were nearly zero, indicating a less concentrated trade system. The index of trade concertation or HI revealed that these agri-food commodities had low concentrations throughout the study period. From 2000 to 2018, the MEC for tobacco, crude material, and animal and vegetable oils was less than 50%, indicating that South Africa was not overly reliant on these exports.

3.4. Model estimates and economic analysis

The economic analysis included descriptive statistics, diagnostics tests, and regression models. The descriptive results are presented in Table 7 and indicate significant differences in the level of RCA for different agri-food commodities. Sugar, sugar preparations, and honey had the highest RCA indicator values, with a mean of 21.94 and a range of 14.19–33.43, while silk had the lowest, with a mean of 0.01 and a range of 0.00–0.03. In terms of explanatory variables, GDPpc had the highest value indicator with 8007.41 (Max) and INF −0.69 had the lowest (Min).

Table 2. Revealed Comparative Advantage (RCA) and Lafay Index (LFI) for food and live animals during 2000–2018.

Year	Live animals(00)	Meat & meat preparations (01)	Fish (03)	Dairy (02)	Vegetables & Fruit (05)	Sugar & Honey(06)	Coffee (07)	Cereals (04)	Miscellaneous (09)
2000	0.29 (0.01)	1.15 (−0.10)	6.89 (0.42)	1.06 (−0.01)	0.62 (0.09)	15.55 (1.04)	0.88 (−0.05)	2.50 (−0.34)	1.35 (−0.14)
2001	0.31 (0.01)	1.68 (−0.02)	7.05 (0.45)	0.83 (0.00)	0.66 (−0.13)	14.19 (1.00)	0.82 (−0.03)	3.39 (−0.09)	1.39 (−0.02)
2002	0.36 (0.01)	1.57 (0.01)	7.53 (0.58)	1.34 (0.05)	0.76 (−0.43)	15.17 (1.24)	0.86 (−0.02)	4.20 (−0.32)	1.46 (0.01)
2003	0.48 (0.02)	1.39 (−0.07)	8.03 (0.51)	0.98 (0.01)	0.95 (0.40)	19.6 (1.37)	0.67 (−0.03)	3.44 (−0.28)	1.64 (−0.02)
2004	0.30 (0.00)	1.12 (−0.13	7.42 (0.42)	0.78 (0.01)	0.82 (−0.83)	22.18 (1.41)	0.59 (−0.03)	2.47 (−0.36)	1.42 (−0.04)
2005	0.27 (0.00)	0.58 (−0.20)	6.77 (0.35)	0.44 (−0.04)	0.69 (−0.45)	20.87 (1.27)	0.43 (−0.05)	4.57 (−0.12)	1.49 (−0.04)
2006	0.19 (−0.01)	0.97 (−0.17)	5.69 (0.27)	0.51 (−0.02)	0.69 (0.75)	18.15 (1.04)	0.51 (−0.04)	2.48 (−0.23)	1.78 (−0.04)
2007	0.33 (0.00)	1.06 (−0.16)	5.90 (0.29)	0.46 (−0.05)	0.64 (2.38)	18.82 (1.10)	0.46 (−0.04)	0.66 (−0.44)	1.82 (−0.03)
2008	0.39 (0.01)	1.11 (−0.10)	5.78 (0.27)	0.65 (−0.02)	0.63 (1.47)	18.83 (1.02)	0.46 (−0.05)	8.05 (−0.09)	1.98 (−0.02)
2009	0.41 (0.02)	1.52 (−0.12)	5.13 (0.28)	0.99 (0.01)	0.66 (1.74)	21.39 (1.44)	0.56 (−0.06)	6.57 (−0.13)	2.46 (0.10)
2010	0.55 (−0.04)	2.79 (−0.13)	4.75 (0.17)	2.34 (0.08)	1.75 (−0.05)	22.07 (1.28)	1.03 (−0.04)	5.73 (−0.09)	3.79 (0.06)
2011	0.40 (−0.05)	1.79 (−0.24)	4.10 (0.12)	1.95 (0.05)	1.54 (0.42)	18.60 (1.01)	0.89 (−0.05)	8.92 (−0.07)	3.52 (0.03)
2012	0.44 (−0.03)	1.54 (−0.27)	3.83 (0.12)	2.23 (0.05)	1.56 (−0.27)	19.90 (1.14)	1.00 (−0.04)	6.19 (−0.26)	3.60 (0.08)
2013	0.44 (−0.03)	1.64 (−0.21)	3.88 (0.12)	2.57 (0.09)	1.66 (−1.10)	23.60 (1.33)	1.10 (−0.03)	8.41 (−0.05)	3.82 (0.08)
2014	0.50 (−0.01)	2.19 (−0.14)	4.15 (014)	2.55 (0.08)	1.63 (−0.85)	24.37 (1.46)	1.10 (−0.04)	6.91 (−0.06)	3.87 (0.09)
2015	0.68 (−0.04)	2.82 (−0.14)	4.09 (0.13)	2.48 (0.07)	1.69 (−0.97)	28.59 (1.73)	1.15 (−0.05)	3.82 (−0.41)	4.25 (0.13)
2016	0.66 (−0.03	3.00 (−0.17)	4.72 (0.13)	2.35 (0.06)	2.13 (−0.12)	30.88 (1.85)	1.22 (−0.07)	4.73 (−0.62)	4.38 (0.12)
2017	0.55 (−0.09)	2.67 (−0.24)	4.04 (0.08)	2.40 (0.04)	1.93 (1.00)	30.59 (1.82)	1.24 (−0.06)	5.25 (−0.28)	4.02 (0.04)
2018	0.65 (−0.08)	2.42 (−0.23)	4.92 (0.12)	2.24 (0.03)	1.93 (0.20)	33.43 (1.87)	1.32 (−0.03)	5.05 (−0.24)	4.09 (0.03)

The bracket values denote the Lafay Index (LFI). Source: Author calculation.

Standard International Trade Classification, Revision 4 United Nations [27] division codes: Live animals (00); Meat and meat preparations (01); Dairy products and birds' eggs (02); Fish, crustaceans, molluscs and aquatic invertebrates and preparations thereof (03); Cereals and cereal preparations (04); Vegetables and fruit (05); Sugar, sugar preparations and honey (06); Coffee, tea, cocoa, spices, and manufactures thereof (07); Miscellaneous edible products and preparations (09).

Table 3. RCA and Lafay Index (LFI) for tobacco, crude materials, and animal vegetables during 2000–2018.

Year	Tobacco	Crude materials		Animal and vegetable oils
	Tobacco (12)	Raw hides (21)	Silk (26)	Animal and vegetable oils (43)
2000	2.96 (0.12)	6.05 (0.23)	0.01 (−0.01)	1.14 (−0.22)
2001	3.64 (0.16)	4.83 (0.18)	0.01 (−0.01)	0.95 (−0.24)
2002	2.24 (0.06)	4.48 (0.24)	0.01 (−0.01)	0.97 (−0.30)
2003	1.93 (0.02)	3.75 (0.13)	0.01 (−0.01)	0.87 (−0.32)
2004	2.27 (0.01)	3.62 (0.11)	0.01 (−0.01)	0.69 (−0.34)
2005	2.78 (0.08)	3.01 (0.11)	0.00 (−0.01)	0.67 (−0.26)
2006	2.94 (0.10)	2.92 (0.11)	0.00 (0.00)	0.58 (−0.26)
2007	2.15 (0.06)	2.78 (0.09)	0.01 (0.00)	0.51 (−0.38)
2008	1.74 (0.02)	2.08 (0.06)	0.00 (0.00)	1.46 (−0.37)
2009	2.93 (0.02)	1.78 (0.07)	0.00 (0.00)	1.44 (−0.32)
2010	3.39 (0.07)	1.89 (0.04)	0.01 (0.00)	2.66 (−0.34)
2011	2.56 (0.05)	2.10 (0.07)	0.01 (0.00)	2.86 (−0.36)
2012	2.86 (0.08)	2.13 (0.08)	0.02 (0.00)	3.19 (−0.32)
2013	2.56 (0.08)	3.69 (0.16)	0.02 (0.00)	2.60 (−0.24)
2014	2.17 (0.04)	3.02 (0.13)	0.02 (0.00)	2.42 (−0.23)
2015	2.37 (0.04)	2.86 (0.12)	0.03 (0.00)	2.50 (−0.19)
2016	2.17 (−0.01)	2.70 (0.12)	0.02 (0.00)	2.91 (−0.27)
2017	2.07 (−0.01)	2.44 (0.11)	0.02 (0.00)	2.43 (−0.31)
2018	1.95 (−0.02)	2.23 (0.10)	0.03 (0.00)	2.22 (0.23)

The bracket values denote the Lafay Index (LFI). Source: Author calculation.

Standard International Trade Classification, Revision 4 [27] division codes: Tobacco and tobacco manufactures (12); Hides, skins and fur skins, raw (21); Textile fibres (other than wool tops and other combed wool) and their wastes (not manufactured into yarn or fabric) (26); Animal or vegetable fats and oils (processed), waxes of animal or vegetable origin, inedible mixtures or preparations of animal or vegetable fats or oils (43).

Table 4. Export diversification and major export categories for food and live animals.

Year	Live animals (00)			Meat and meat preparations (01)			Fish (03)			Dairy (02)			Edible vegetables & Fruit (05)	
	MEC (%)	EDX	HI	MEC (%)	EDX	HI	MEC (%)	EDX	HI	MEC (%)	EDX	HI	MEC (%)	EDX
2000	0.0004	0.0002	0.0000	0.0016	0.0008	0.0000	0.0097	0.0048	0.0001	0.0015	0.0007	0.0000	0.0009	0.0004
2001	0.0005	0.0002	0.0000	0.0024	0.0012	0.0000	0.0103	0.0051	0.0001	0.0012	0.0006	0.0000	0.0010	0.0005
2002	0.0006	0.0003	0.0000	0.0027	0.0013	0.0000	0.0127	0.0063	0.0002	0.0023	0.0011	0.0000	0.0013	0.0006
2003	0.0007	0.0003	0.0000	0.0020	0.0010	0.0000	0.0115	0.0057	0.0001	0.0014	0.0007	0.0000	0.0014	0.0007
2004	0.0004	0.0002	0.0000	0.0015	0.0007	0.0000	0.0098	0.0049	0.0001	0.0010	0.0005	0.0000	0.0011	0.0005
2005	0.0003	0.0002	0.0000	0.0007	0.0004	0.0000	0.0086	0.0043	0.0001	0.0006	0.0003	0.0000	0.0009	0.0004
2006	0.0002	0.0001	0.0000	0.0012	0.0006	0.0000	0.0069	0.0034	0.0000	0.0006	0.0003	0.0000	0.0008	0.0004
2007	0.0004	0.0002	0.0000	0.0013	0.0006	0.0000	0.0072	0.0036	0.0001	0.0006	0.0003	0.0000	0.0008	0.0004
2008	0.0004	0.0002	0.0000	0.0013	0.0006	0.0000	0.0066	0.0033	0.0000	0.0007	0.0004	0.0000	0.0007	0.0004
2009	0.0006	0.0003	0.0000	0.0021	0.0011	0.0000	0.0072	0.0036	0.0001	0.0014	0.0007	0.0000	0.0009	0.0005
2010	0.0007	0.0003	0.0000	0.0034	0.0017	0.0000	0.0057	0.0028	0.0000	0.0028	0.0014	0.0000	0.0021	0.0010
2011	0.0005	0.0002	0.0000	0.0020	0.0010	0.0000	0.0047	0.0023	0.0000	0.0022	0.0011	0.0000	0.0018	0.0009
2012	0.0005	0.0003	0.0000	0.0018	0.0009	0.0000	0.0046	0.0023	0.0000	0.0027	0.0013	0.0000	0.0019	0.0009
2013	0.0005	0.0003	0.0000	0.0019	0.0010	0.0000	0.0046	0.0023	0.0000	0.0030	0.0015	0.0000	0.0020	0.0010
2014	0.0006	0.0003	0.0000	0.0028	0.0014	0.0000	0.0052	0.0026	0.0000	0.0032	0.0016	0.0000	0.0020	0.0010
2015	0.0009	0.0004	0.0000	0.0036	0.0018	0.0000	0.0052	0.0026	0.0000	0.0032	0.0016	0.0000	0.0021	0.0011
2016	0.0008	0.0004	0.0000	0.0038	0.0019	0.0000	0.0060	0.0030	0.0000	0.0030	0.0015	0.0000	0.0027	0.0013
2017	0.0007	0.0003	0.0000	0.0033	0.0017	0.0000	0.0051	0.0025	0.0000	0.0030	0.0015	0.0000	0.0024	0.0012
2018	0.0008	0.0004	0.0000	0.0028	0.0014	0.0000	0.0058	0.0029	0.0000	0.0026	0.0013	0.0000	0.0023	0.0011

Source: Author calculation.

MEC: major export category; EDX: export diversification index; HI: Hirschman index.

Standard International Trade Classification, Revision 4 [27] division codes: Live animals (00); Meat and meat preparations (01); Dairy products and birds' eggs (02); Fish, crustaceans, molluscs and aquatic invertebrates and preparations thereof (03); Vegetables and fruit (05).

Table 5. Export diversification and major export categories for food and live animals.

Year	Coffee (07)			Cereals (04)			Miscellaneous (09)		
	MEC (%)	EDX	HI	MEC (%)	EDX	HI	MEC (%)	EDX	HI
2000	0.0012	0.0006	0.0000	0.0035	0.0017	0.0000	0.0019	0.0009	0.0000
2001	0.0012	0.0006	0.0000	0.0049	0.0025	0.0000	0.0020	0.0010	0.0000
2002	0.0015	0.0007	0.0000	0.0071	0.0035	0.0001	0.0025	0.0012	0.0000
2003	0.0010	0.0005	0.0000	0.0049	0.0025	0.0000	0.0024	0.0012	0.0000
2004	0.0008	0.0004	0.0000	0.0033	0.0016	0.0000	0.0019	0.0009	0.0000
2005	0.0005	0.0003	0.0000	0.0058	0.0029	0.0000	0.0019	0.0009	0.0000
2006	0.0006	0.0003	0.0000	0.0030	0.0015	0.0000	0.0022	0.0011	0.0000
2007	0.0006	0.0003	0.0000	0.0008	0.0004	0.0000	0.0022	0.0011	0.0000
2008	0.0005	0.0003	0.0000	0.0092	0.0046	0.0001	0.0023	0.0011	0.0000
2009	0.0008	0.0004	0.0000	0.0092	0.0046	0.0001	0.0035	0.0017	0.0000
2010	0.0012	0.0006	0.0000	0.0069	0.0034	0.0000	0.0046	0.0023	0.0000
2011	0.0010	0.0005	0.0000	0.0102	0.0051	0.0001	0.0040	0.0020	0.0000
2012	0.0012	0.0006	0.0000	0.0074	0.0037	0.0001	0.0043	0.0021	0.0000
2013	0.0013	0.0006	0.0000	0.0099	0.0049	0.0001	0.0045	0.0022	0.0000
2014	0.0014	0.0007	0.0000	0.0087	0.0043	0.0001	0.0049	0.0024	0.0000
2015	0.0015	0.0007	0.0000	0.0049	0.0024	0.0000	0.0054	0.0027	0.0000
2016	0.0015	0.0008	0.0000	0.0060	0.0030	0.0000	0.0055	0.0027	0.0000
2017	0.0015	0.0008	0.0000	0.0066	0.0033	0.0000	0.0050	0.0025	0.0000
2018	0.0016	0.0008	0.0000	0.0059	0.0030	0.0000	0.0048	0.0024	0.0000

Source: Author calculation.

MEC: major export category; EDX: export diversification index; HI: Hirschman index.

Standard International Trade Classification, Revision 4 [27] division codes: Cereals and cereal preparations (04); Coffee, tea, cocoa, spices, and manufactures thereof (07); Miscellaneous edible products and preparations (09).

Table 6. Export diversification and major export categories tobacco, crude material, and vegetables.

| | Tobacco | | | | | | Crude materials | | | Animal and vegetable oils | | |
| | Tobacco (12) | | | Raw hides (21) | | | Silk (26) | | | Animal, vegetable fats (43) | | |
Year	MEC (%)	EDX	HI	MEC (%)	EDX	HI	MEC (%)	EDX	HI	MEC (%)	EDX	HI
2000	0.0042	0.0021	0.0000	0.0085	0.0042	0.0001	0.0000	0.0000	0.0000	0.0016	0.0008	0.0000
2001	0.0053	0.0026	0.0000	0.0070	0.0035	0.0000	0.0000	0.0000	0.0000	0.0014	0.0007	0.0000
2002	0.0038	0.0019	0.0000	0.0075	0.0038	0.0001	0.0000	0.0000	0.0000	0.0016	0.0008	0.0000
2003	0.0028	0.0014	0.0000	0.0054	0.0027	0.0000	0.0000	0.0000	0.0000	0.0013	0.0006	0.0000
2004	0.0030	0.0015	0.0000	0.0048	0.0024	0.0000	0.0000	0.0000	0.0000	0.0009	0.0005	0.0000
2005	0.0035	0.0018	0.0000	0.0038	0.0019	0.0000	0.0000	0.0000	0.0000	0.0009	0.0004	0.0000
2006	0.0036	0.0018	0.0000	0.0035	0.0018	0.0000	0.0000	0.0000	0.0000	0.0007	0.0003	0.0000
2007	0.0026	0.0013	0.0000	0.0034	0.0017	0.0000	0.0000	0.0000	0.0000	0.0006	0.0003	0.0000
2008	0.0020	0.0010	0.0000	0.0024	0.0012	0.0000	0.0000	0.0000	0.0000	0.0017	0.0008	0.0000
2009	0.0041	0.0021	0.0000	0.0025	0.0012	0.0000	0.0000	0.0000	0.0000	0.0020	0.0010	0.0000
2010	0.0041	0.0020	0.0000	0.0023	0.0011	0.0000	0.0000	0.0000	0.0000	0.0032	0.0016	0.0000
2011	0.0029	0.0015	0.0000	0.0024	0.0012	0.0000	0.0000	0.0000	0.0000	0.0033	0.0016	0.0000
2012	0.0034	0.0017	0.0000	0.0026	0.0013	0.0000	0.0000	0.0000	0.0000	0.0038	0.0019	0.0000
2013	0.0030	0.0015	0.0000	0.0043	0.0022	0.0000	0.0000	0.0000	0.0000	0.0031	0.0015	0.0000
2014	0.0027	0.0014	0.0000	0.0038	0.0019	0.0000	0.0000	0.0000	0.0000	0.0030	0.0015	0.0000
2015	0.0030	0.0015	0.0000	0.0036	0.0018	0.0000	0.0000	0.0000	0.0000	0.0032	0.0016	0.0000
2016	0.0027	0.0014	0.0000	0.0034	0.0017	0.0000	0.0000	0.0000	0.0000	0.0037	0.0018	0.0000
2017	0.0026	0.0013	0.0000	0.0031	0.0015	0.0000	0.0000	0.0000	0.0000	0.0031	0.0015	0.0000
2018	0.0023	0.0011	0.0000	0.0026	0.0013	0.0000	0.0000	0.0000	0.0000	0.0026	0.0013	0.0000

Source: Author calculation.

MEC: major export category; EDX: export diversification index; HI: Hirschman index.

Standard International Trade Classification, Revision 4 [27] division codes: Tobacco and tobacco manufactures (12); Hides, skins and fur skins, raw (21); Textile fibres (other than wool tops and other combed wool) and their wastes (not manufactured into yarn or fabric) (26); Animal or vegetable fats and oils (processed), waxes of animal or vegetable origin, inedible mixtures or preparations of animal or vegetable fats or oils (43).

Table 7. Descriptive statistics of the Revealed Comparative Advantage (RCA).

	Outcome variable -RCA				
		Mean	Std. dev	Min	Max
Food and live animals	Live animals (00)	0.43	0.14	0.19	0.68
	Meat and meat preparations (01)	1.74	0.71	0.58	3.00
	Fish (03)	5.51	1.40	8.03	8.03
	Dairy (02)	1.53	0.83	0.44	2.57
	Edible vegetables &Fruit (05)	1.21	0.56	0.62	2.13
	Sugar, sugar prepartions & honey (06)	21.94	5.49	14.19	33.43
	Coffee (07)	0.86	0.29	0.43	1.32
	Cereals (04)	4.91	2.23	0.66	8.92
	Miscellaneous (09)	2.74	1.19	1.35	4.38
Tobacco	Tobacco (12)	2.51	0.51	1.35	4.38
Crude materials	Raw hides (21)	3.07	1.11	1.78	6.05
	Silk (26)	0.01	0.01	0.00	0.03
Animal and vegetable oils	Animal and vegetable oils (43)	1.74	0.93	0.51	3.19
	Explanatory variables				
		Mean	Std. dev	Min	Max
	LAND	9.03	5.11	1.01	16.75
	LABOUR	0.09	0.02	0.06	0.12
	GDPpc	5528.46	1574.52	2502.28	8007.41
	INF	5.36	2.37	-0.69	10.06

Source: Author calculation.

The impact of macroeconomic stability, GDP per capita, land, and labour productivity on the RCA level of agri-food commodities was estimated for the period 2000–2018. Table 8 displays the results of the Akaike, Schwarz, Hannan-Quinn, and Durbin-Watson statistical tests for each RCA. The variables validated the null hypothesis that individual variables contained unit root (H0: Individual variables include unit root) and accepted the alternative hypothesis (H1: Individual variable stationary). All variables with a statistical significance of 0.01, 0.05, and 0.1 critical values met the criteria of stationary at least two-thirds of the time.

Table 8. Individual unit root tests.

Commodities	Dependent Variable	Deterred	ADF	Test critical value			Akaike	Schwarz	Hannan-Quinn	Durbin-Watson
				1% level	5% level	10% level				
Food and live animals	RCA00	D(RCA00, 2)	−4.81 (0.002)	−3.89	−3.05	−2.67	−1.55	−1.46	−1.54	2.05
	RCA01	D(RCA01, 2)	−3.90 (0.036)	−4.62	−3.71	−3.30	1.81	1.96	1.82	1.97
	RCA03	D(RCA03, 2)	−3.36 (0.03)	−3.89	−3.05	−2.67	1.86	1.95	1.86	1.80
	RCA02	D(RCA02, 2)	−4.42 (0.004)	−3.89	−3.05	−2.67	1.26	1.36	1.27	1.8
	RCA05	D(RCA05, 2)	−4.95 (0.001)	−3.89	−3.05	−2.67	0.57	0.67	0.58	2.07
	RCA06	D(RCA06, 2)	−3.49 (0.022)	−3.89	−3.05	−2.67	4.62	4.72	4.63	1.86
	RCA07	D(RCA07, 2)	−4.23 (0.005)	−3.89	−3.05	−2.67	−0.80	−0.70	−0.79	1.96
	RCA04	D(RCA04, 2)	−5.19 (0.001)	−3.92	−3.05	−2.67	4.65	4.79	4.66	1.73
	RCA24	D(RCA24, 2)	−4.00 (0.008)	−3.89	−3.05	−2.67	1.02	1.12	1.03	2.01
Tobacco	RCA12	RCA12	−4.69 (0.002)	−3.89	−3.05	−2.67	1.16	1.30	1.17	1.44
Crude materials	RCA21	RCA21	−3.40 (0.023)	−3.86	−3.04	−2.66	1.32	1.42	1.33	2.20
	RCA26	D(RCA26, 2)	−4.90 (0.001)	−3.89	−3.05	−2.67	−7.63	−7.53	−7.62	2.09
Animal and vegetable oils	RCA43	D(RCA43, 2)	−3.90 (0.010)	−3.89	−3.05	−2.67	1.44	1.54	1.45	1.98
	Explanatory variables									
	GDPPC	D(GDPPC, 3)	−5.06 (0.001)	−3.96	−3.08	−2.68	16.00	16.14	15.98	1.92
	INF	INF	−3.67 (0.015)	−3.89	−3.05	−2.67	4.56	4.71	4.57	1.94
	LABOUR	D(LABOUR, 3)	−4.25 (0.020)	−4.80	−3.79	−3.42	5.24	5.47	5.22	1.98
	LAND	D(LAND, 2)	−5.71(0.001)	−4.62	−3.71	−3.30	−6.18	−6.03	−6.17	2.06

Source: Author calculation. H_0: Individual variable contain unit root; H_1: Individual variable stationary—If T-calculated less than T-tabulated—should deter or differentiated.

Standard International Trade Classification, Revision 4 (United Nations 2006) division codes: Live animals (00); Meat and meat preparations (01); Dairy products and birds' eggs (02); Fish, crustaceans, molluscs and aquatic invertebrates and preparations thereof (03); Cereals and cereal preparations (04); Vegetables and fruit (05); Sugar, sugar preparations and honey (06); Coffee, tea, cocoa, spices, and manufactures thereof (07); Miscellaneous edible products and preparations (09); Tobacco and tobacco manufactures (12); Hides, skins and fur skins, raw (21); Textile fibres (other than wool tops and other combed wool) and their wastes (not manufactured into yarn or fabric) (26); Animal or vegetable fats and oils (processed), waxes of animal or vegetable origin, inedible mixtures or preparations of animal or vegetable fats or oils (43).

Table 9. Model estimation of food and live animals.

Variables	Coefficient	Std. Err	t	P > t	Variables	Coefficient	Std. Err	t	P > t	Variables	Coefficient	Std. Err	t	P > t
D (RCA00, 2)					D (RCA01, 2)					D (RCA03, 2)				
C	−0.04	0.11	−0.38	0.71	C	0.16	0.36	0.45	0.66	C	−0.34	0.45	−0.75	0.47
D (GDPPC, 3)	0.0001	0.00	1.57	0.15	D (GDPPC, 3)	0.0001	0.00	3.68	0.00	D (GDPPC, 3)	0.0001	0.00	0.60	0.56
INF	0.01	0.02	0.49	0.64	INF	−0.03	0.06	−0.42	0.68	INF	0.07	0.08	0.90	0.39
D (LABOUR, 3)	−0.02	0.01	−1.57	0.15	D (LABOUR, 3)	−0.13	0.04	−2.93	0.01	D (LABOUR, 3)	−0.12	0.05	−2.17	0.05
D (LAND, 2)	1.83	4.28	0.43	0.68	D (LAND, 2)	17.12	14.44	1.19	0.26	D (LAND, 2)	40.37	18.29	2.21	0.05
R2	0.30				R2	0.60				R2	0.38			
Adj R2	0.04				Adj R2	0.46				Adj R2	0.16			
F statistics	1.17 (0.38)				F statistics	4.21 (0.03)				F statistics	1.69 (0.22)			
Residual	0.30				Residual	3.37				Residual	5.41			
D (RCA02, 2)					D (RCA05, 2)					D (RCA06, 2)				
C	0.11	0.41	0.27	0.80	C	0.04	0.20	0.19	0.85	C	−2.18	1.85	−1.18	0.26
D(GDPPC,3)	0.0001	0.00	1.72	0.11	D(GDPPC,3)	0.0001	0.00	4.50	0.00	D(GDPPC,3)	0.0001	0.00	1.02	0.33
INF	−0.03	0.07	−0.36	0.73	INF	0.00	0.04	−0.13	0.90	INF	0.46	0.33	1.38	0.19
D(LABOUR,3)	−0.04	0.05	−0.90	0.39	D(LABOUR,3)	−0.11	0.02	−4.58	0.00	D(LABOUR,3)	−0.21	0.22	−0.96	0.36
D(LAND,2)	1.09	16.44	0.07	0.95	D(LAND,2)	24.65	8.04	3.07	0.01	D(LAND,2)	−40.20	74.48	−0.54	0.60
R2	0.25				R2	0.72				R2	0.36			
Adj R2	−0.03				Adj R2	0.61				Adj R2	0.13			
F statistics	0.91 (0.49)				F statistics	6.88 (0.00)				F statistics	1.56 (0.25)			
Residual					Residual	1.05				Residual	89.70			

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Variables	Coefficient	Std. Err	t	P > t	Variables	Coefficient	Std. Err	t	P > t	Variables	Coefficient	Std. Err	t	P > t
D (RCA07, 2)					D (RCA04, 2)					D (RCA24, 2)				
C	0.08	0.13	0.57	0.58	C	−2.07	2.78	−0.74	0.47	C	0.03	0.25	0.12	0.91
D (GDPPC, 3)	0.0001	0.00	2.12	0.06	D (GDPPC, 3)	0.0001	0.00	−1.76	0.11	D (GDPPC, 3)	0.0001	0.00	3.74	0.00
INF	−0.01	0.02	−0.55	0.60	INF	0.37	0.50	0.74	0.47	INF	0.00	0.04	−0.04	0.97
D (LABOUR, 3)	−0.03	0.02	−1.94	0.08	D (LABOUR, 3)	0.24	0.33	0.72	0.48	D (LABOUR, 3)	−0.11	0.03	−3.74	0.00
D (LAND, 2)	3.55	5.36	0.66	0.52	D (LAND, 2)	44.93	112.14	0.40	0.70	D (LAND, 2)	17.77	9.88	1.80	0.10
R2	0.39				R2	0.33				R2	0.65			
Adj R2	0.17				Adj R2	0.08				Adj R2	0.52			
F statistics	1.75 (0.21)				F statistics	1.33 (0.32)				F statistics	5.10 (0.01)			
Residual	0.47				Residual	203.40				Residual	1.58			

Source: Author calculation.

Standard International Trade Classification, Revision 4 [27] division codes: Live animals (00); Meat and meat preparations (01); Dairy products and birds' eggs (02); Fish, crustaceans, molluscs and aquatic invertebrates and preparations thereof (03); Cereals and cereal preparations (04); Vegetables and fruit (05); Sugar, sugar preparations and honey (06); Coffee, tea, cocoa, spices, and manufactures thereof (07); Miscellaneous edible products and preparations (09); Tobacco and tobacco manufactures (12); Hides, skins and fur skins, raw (21); Textile fibres (other than wool tops and other combed wool) and their wastes (not manufactured into yarn or fabric) (26); Animal or vegetable fats and oils (processed), waxes of animal or vegetable origin, inedible mixtures or preparations of animal or vegetable fats or oils (43).

Table 10. Model estimation of tobacco, crude materials, and animal and vegetable oils.

Variables	Coefficient	Std. Err	t	P > t	Variables	Coefficient	Std. Err	t	P > t	Variables	Coefficient	Std. Err	t	P > t
Tobacco					Crude materials									
RCA12					RCA21					RCA26				
C	2.78	0.29	9.68	0.00	C	3.42	0.41	8.37	0.00	C	0.01	0.00	1.72	0.11
D (GDPPC, 3)	0.0001	0.00	1.53	0.15	D (GDPPC, 3)	0.0001	0.00	0.85	0.42	D (GDPPC, 3)	0.0001	0.00	1.79	0.10

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Variables	Coefficient	Std. Err	t	P > t	Variables	Coefficient	Std. Err	t	P > t	Variables	Coefficient	Std. Err	t	P > t
INF	−0.07	0.05	−1.29	0.22	INF	−0.14	0.07	−1.94	0.08	INF	0.00	0.00	−1.72	0.11
D (LABOUR, 3)	−0.02	0.03	−0.67	0.52	D (LABOUR, 3)	0.00	0.05	0.08	0.93	D (LABOUR, 3)	0.00	0.00	0.62	0.55
D (LAND, 2)	−2.13	11.56	−0.18	0.86	D (LAND, 2)	5.07	16.48	0.31	0.76	D (LAND, 2)	−0.32	0.16	−1.96	0.08
R2	0.30				R2	0.28				R2	0.55			
Adj R2	0.05				Adj R2	0.01				Adj R2	0.39			
F statistics	1.19 (0.37)				F statistics	1.05 (0.43)				F statistics	3.40 (0.05)			
Residual	2.16				Residual	4.39				Residual	0.00			
Animal and vegetable oils														
RCA43														
C	−0.16	0.38	−0.42	0.68										
D (GDPPC, 3)	0.0001	0.00	0.83	0.42										
INF	0.03	0.07	0.44	0.67										
D (LABOUR, 3)	−0.12	0.05	−2.69	0.02										
D (LAND, 2)	32.53	15.50	2.10	0.06										
R2	0.41													
Adj R2	0.20													
F statistics	1.94 (0.17)													
Residual	3.89													

Source: Author calculation

Standard International Trade Classification, Revision 4 [27] division codes: Live animals (00); Meat and meat preparations (01); Dairy products and birds' eggs (02); Fish, crustaceans, molluscs, and aquatic invertebrates and preparations thereof (03); Cereals and cereal preparations (04); Vegetables and fruit (05); Sugar, sugar preparations and honey (06); Coffee, tea, cocoa, spices, and manufactures thereof (07); Miscellaneous edible products and preparations (09); Tobacco and tobacco manufactures (12); Hides, skins and fur skins, raw (21); Textile fibres (other than wool tops and other combed wool) and their wastes (not manufactured into yarn or fabric) (26); Animal or vegetable fats and oils (processed), waxes of animal or vegetable origin, inedible mixtures or preparations of animal or vegetable fats or oils (43).

According to the regression results in Tables 9 and 10, land productivity, labour productivity, inflation, and GDP per capita positively impacted cereal (04) RCA. The RCA of food and live animals (00), fish (03), vegetables and fruit (05), other edible goods and preparations (09), and animal and vegetable oils (43) were all positively affected by land productivity, inflation, and GDP per capita. GDP per capita and land productivity all had a positive impact on the RCA of meat and meat preparations (01), dairy (02), and coffee (07). Inflation and GDP per capita positively impacted the RCA of Sugar, sugar preparations, and honey (06). GDP per capita had a positive impact on the RCA of tobacco (12). GDP per capita, land productivity, and labour productivity all positively impacted the RCA of rawhides (21). GDP per capita, labour productivity, and inflation positively impacted the RCA of silk (26).

The influence of labour intensity and land productivity had the most significant impact on the RCA of grains (04) and rawhides (21), where a 1% increase in these factors elevated the corresponding RCA by 24 per cent and 45 per cent at a 1% and 5% significant level, respectively. Food and live animals (00), meat and meat products (01), fish (03), dairy (02), edible vegetables and fruit (05), coffee (07), miscellaneous edible products and preparations (09), and animal and vegetable oils (43) increased by 2 per cent, 17 per cent, 40 per cent, 1 per cent, 8 per cent, 4 per cent, 18 per cent, and 3 per cent, respectively, with a 1% increase in land productivity intensity. The RCA of silk (26) increased by 1% when the intensity of labour output increased by 1%.

The inflation rate had mixed results (Tables 9 and 10) where macroeconomic stability had a significantly positive and negative impact on agri-food competitiveness. A GDPpc had a positive influence on agri-food competitiveness.

4. Discussion

During the study period, the RCA and LFI of agri-food commodities revealed a mixed result. Tobacco and rawhides in South Africa displayed a comparative advantage. Vegetables, fruit and coffee showed a comparative disadvantage from 2000 to 2009. Based on the LFI fish and Sugar, sugar preparations and honey showed a significant comparative advantage. The findings attested that the higher the value of this index, the more specialized South Africa was in the trade of these two specific commodities. The RCA and LFI of tobacco and rawhides showed a comparative advantage, except from 2016 to 2018. The result implies that a net export and a greater level of specialization for these products. These findings concurred with Bahta and Willems [13], pointing out that the RCA explained how South Africa fits into the global trade picture and that the RCA is based on relative export shares, which could be skewed due to trade non-trade restrictions.

The EDX and HI result shows that all commodities under food and live animals were close to zero, indicating a less concentrated trade structure. Further, the result attested that lower trade concentrations would lessen the impact of international trade risk due to the likelihood of price fluctuation in the global market. Furthermore, the MEC result confirms that all commodities under food and live animals were below 50%; this is interpreted as South Africa not being overly reliant on food and live animal exports. These findings agreed with those of Nin-Pratt et al. [40], they discovered that South Africa's top agricultural export goods were sugar cane, wine, oranges, grapes, and fuelwood.

The estimated model result indicates that land productivity, labour productivity, inflation, and GDP per capita positively impacted RCA cereal. Land productivity, inflation, and GDP per capita all

positively impacted the RCA of food and live animals. The RCA of meat and meat preparations, dairy, and coffee positively affected GDP per capita and land productivity. Inflation and GDP per capita positively impacted the RCA of sugar, sugar preparations, and honey. GDP per capita had a positive impact on tobacco RCA. GDP per capita, land productivity, and labour productivity all positively impacted RCA rawhides. GDP per capita, labour productivity, and inflation all positively impacted the RCA of silk. The inflation rate had mixed results where macroeconomic stability had a significantly positive and negative impact on agri-food competitiveness. A GDPpc had a positive influence on agri-food competitiveness.

The findings revealed that agricultural productivity was a critical factor in defining South Africa's agri-food sector and competitiveness. Increased production and productivity are crucial to meet the ever-increasing demand for food and agri-food products while enhancing income and competitiveness.

Increased competitiveness in countries such as South Africa is critical because many people rely on agriculture, and smallholder farming is sustained as a result, and poverty and hunger are reduced, thereby achieving the SDGs 2030 agenda for ending hunger and poverty [33, 41]. The study findings contradict those of Matkovski et al. [33] and Jambor and Babu [42], who discovered a negative relationship between GDP per capita and agri-food competitiveness.

5. Conclusions

This research aims to determine the competitiveness of South African agri-food products and the factors that influence them. The study revealed that a mixed result of RCA and LFI of agri-food commodities. During the study period of 2000 to 2018, the food, live animal, and silk sectors had a comparative disadvantage, whereas the LFI had a comparative disadvantage from 2000 to 2003. The rest of the commodities showed a comparative advantage. The LFI showed that fish and Sugar, sugar preparations, and honey showed a significant comparative advantage.

The Export Diversification index was near zero for all commodities, indicating a less concentrated trading structure. The index of trade concertation, or HI, demonstrated that all commodities showed a reduced concentration throughout the study period. The MEC for all commodities was less than 50%, implying that South Africa was not reliant on overseas commerce from the agri-food sector.

The results of regression analysis on factors that influence the competitiveness of agri-food commodities were varied. However, it stressed the importance of agricultural productivity and South Africa's agri-food competitiveness. As a result, the South Africa government, with stakeholders in the industry, should strengthen the agri-food sector's competitiveness to endure global market pressure. Instead of exporting value-added products, South Africa could reduce its reliance on imported raw materials by developing a competitive food industry. This means that South Africa's future agriculture and agri-food policies should prioritize the development of a modern agribusiness industry.

Acknowledgments

Conflict of interest

I declare that this work is original academic research carried out by the author. I confirm that the manuscript has not been submitted elsewhere and is not under consideration by another journal. I declare no conflicts of interest.

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