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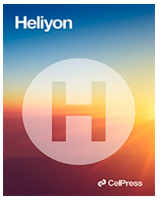

Research article

# Matching comparative advantages to special economic zones for sustainable industrialization

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ABSTRACT

African countries are consistently trying to leverage industrialization to advance their economic development. Despite possessing favorable factors such as abundant natural resources, a surplus of low-cost labor, and an increasing number of established Special Economic Zones (SEZs), African countries are yet to fully maximize their potential and achieve sustainable and inclusive industrialization. This study explores the comparative advantages of African countries to determine the types of SEZs that can effectively accelerate industrialization. By leveraging the unique strengths and resources of each country, customized strategies for SEZs can be developed to attract investments, promote technological advancements, and foster sustainable economic growth. The research utilizes the Revealed Comparative Advantage (RCA) matrix, which is grounded in Ricardian trade theory, examining trade data spanning from 2011 to 2021 to evaluate the competitive export capabilities of various countries. The findings consistently reveal that the selected countries (Ghana, Ethiopia, and South Africa) possess a significant and consistent comparative advantage in natural and agricultural resources compared to other sectors. Establishing SEZs that focus on these sectors can generate substantial socio-economic impacts, including attracting investments, creating employment opportunities, enhancing export capacities, stimulating economic growth, fostering linkages, facilitating skills and technology transfer, promoting spillover effects, encouraging specialization, developing infrastructure, and supporting value addition in agribusinesses. The result of this study will contribute to policy discussions and aid decision-making processes for policymakers, investors, and development practitioners in their efforts to advance industrial development across Africa.

## 1. Introduction

Industrialization is a critical element in achieving economic growth and must be an integral part of every country's development strategy. This viewpoint is shared by global and regional development frameworks such as Agenda 2063 and the Sustainable Development Goals, which recognize industrialization as a key solution to address Africa's economic vulnerabilities and promote successful implementation of the agendas (A2063, SDGs 2030) [1]. Industrialization is a vital component in the development of physical and human resources. It serves as a bridge linking the informal and formal sectors of the economy, and generate linkages and connections with other sub-sectors creating numerous opportunities for suppliers, distributors, retailers and business services [2].

Earlier research has underscored the capacity of industrialization to propel sustainable and inclusive growth across Africa, fostering

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economic metamorphosis, creating job prospects, aiding income distribution, fostering inter-sectoral connections, and bolstering the growth of small and medium enterprises (SMEs).

Industrialization is pivotal for Africa's economic progress, offering numerous benefits including diversification of the economy, job opportunities, transfer of technology, value addition, promotion of exports, development of infrastructure, integration of economies, and improvement of human capital. Previous studies have highlighted the potential of industrialization to drive sustainable and inclusive growth in Africa, facilitate economic transformation, generate employment opportunities, support income distribution, promotes linkages between different sectors, and bolstering the growth of small and medium enterprises (SMEs) [3–5]. African industrialization witnessed growth in the post-independence era, largely influenced by government-led protective measures. However, by the mid-1980s, the region's industrial sector faced a decline due to a combination of external factors, including increase in oil price, decrease in commodity price, rising real interest rates, constrained public resources, and limited domestic market opportunities [2]. Currently, African leaders are recognizing the importance of industrialization as a key driver in advancing the continent's economic development. The African Union has placed significant emphasis on the sector within its Agenda 2063, recognizing its central role in their strategic vision [2].

Africa boasts a wealth of favorable elements, such as a surplus of low-cost labor and abundant natural resources, pointing towards an imminent industrial revolution [6]. The region's manufacturing sector is benefitting from its favorable demographics and rich resources, leading to a concentration in labor-intensive and locally sourced raw material industries [2]. As a result, recent FDI in Africa has significantly boosted manufacturing sub-sectors such as software, auto components, industrial machinery, and chemical production. The COVID-19 pandemic has laid bare Africa's susceptibility and inadequacies concerning economic growth and development. As a response, African governments are actively exploring innovative and sustainable approaches to attract investment and foster industrial development. These strategies involve selected infrastructure investments, enhanced regional integration, and the establishment of more SEZs for selected subsectors.

SEZs play a significant role in driving industrial growth and development by attracting foreign direct investment (FDI). China's experience with SEZs demonstrates their effectiveness in fostering industrialization, expanding export capabilities, and achieving substantial economic growth. SEZs have been instrumental in transforming China into a major global manufacturing and exporting powerhouse [7]. Furthermore, SEZs contribute to infrastructural development. A good example is South Korea's establishment of the Saemangeum Industrial Complex to stimulate industrial growth and regional development. The development of the complex has been accompanied by infrastructure enhancements, including the construction of ports, roads, and utilities, to support industrial activities [8].

SEZs play a crucial role in generating employment opportunities and facilitating skills development. Costa Rica's Free Trade Zones (FTZs) serve as an excellent example, by attracting high-tech industries like electronics manufacturing and medical device production, the zones successfully created jobs and enhanced skill acquisition among the local workforce [9]. Also, to support industry demands, the government and private sector have collaborated to establish training programs and vocational schools, nurturing a skilled labor force [9]. SEZs also foster technology transfer and innovation. The Gwangyang Bay Free Economic Zone in South Korea stands out as a notable example. The zone has effectively attracted technology-intensive industries and enabled collaboration between domestic and foreign companies. This collaboration has led to the transfer of advanced technologies and knowledge, contributing to industrial growth and innovation in sectors such as shipbuilding, steel production, and petrochemicals [8].

SEZs are considered a viable and realistic approach for overcoming economic constraints in developing countries [2]. However, it is essential to tailor each SEZ to the local context, considering each country's unique resources and specific development objectives. While SEZs have been successful in attracting investments and creating jobs, particularly drawing inspiration from the Chinese model, It is important to acknowledge that a uniform approach may not be appropriate for African nations. While there are numerous existing policy briefs and expert documents on the assessment and establishment of SEZs, this study distinguishes itself by focusing on the strategic placement of these zones in areas with a comparative advantage. We recognize that many SEZ initiatives have been implemented across Africa based on general economic principles and development strategies. However, this study highlights the importance of identifying and leveraging areas with specific comparative advantages, whether they be in terms of natural resources or factors of production. By pinpointing these areas of comparative advantage, our research aims to provide policymakers with targeted insights that can maximize the benefits of SEZs, particularly in terms of enhancing manufacturing capabilities and facilitating international trade. Customized SEZ strategies can be developed to attract investments, promote technological advancements, and foster sustainable economic growth, thereby benefiting SMEs, entrepreneurs, and local communities. The objective of the study is to explore the comparative advantages of African countries to determine the types of SEZs that can effectively accelerate industrialization. The findings of this research will enhance the current body of knowledge by underlining the importance of customizing SEZs to suit the specific circumstances of African nations. This will inform policy dialogues and aid decision-making for policymakers, investors, and development practitioners, thereby advancing industrial growth throughout Africa.

## 2. Literature review

Exporting new products and enhanced versions of existing commodities are presently considered key markers of productive transformation in developing nations [10–12]. Recent research indicates that this transformation has notably bolstered economic growth in developing countries [12–17]. However, the existing empirical data on the factors influencing export diversification provide only limited understanding of which policies are most efficacious in promoting productive transformation in developing nations [18].

The concept of comparative advantage entails a country's capacity to produce and export a specific product or service not only more efficiently, as Ricardo initially suggested, but also with more distinct product features compared to other countries within a

particular trade area [19]. Studies conducted by later scholars like Heckscher-Ohlin (1919) and Samuelson (1948) established the foundation for comprehending how countries can gain from trade by leveraging their distinct resources, capabilities, and technology. Following the successful industrialization of East Asian countries in the late 1980s, SEZs emerged as potent instruments for driving economic development and industrial growth in numerous nations worldwide [20–22].

Matching comparative advantages to SEZs is essential for leveraging the strengths of specific regions or countries and maximizing the benefits of industrialization while ensuring sustainability. For instance, China's industrialization can be attributed to leveraging its advantages in both human and physical development. With a history of investing in capital- and technology-intensive industries alongside human capital, China possesses a distinct potential to pioneer sophisticated, technology-intensive products even at an earlier stage of development [23]. While some investments may have resulted in resource misallocation, once human capital investment and accumulated knowledge are effectively utilized for commercial production and services, they become a source of comparative advantage, especially in the production and exportation of certain capital-intensive manufactured products with advanced technology.

Several studies have explored the relationship between RCA and economic growth [24]. explores the comparative advantage between ASEAN countries and China using 2010 export and import data from the UN COMTRADE database. The study reveals that China excels in manufacturing products while ASEAN nations like Indonesia and Malaysia have strengths in primary products and some manufactured goods. This discrepancy has played a crucial role in China's rapid industrialization and emergence as a global economic powerhouse, contrasting with the varied economic paths taken by ASEAN countries. Similarly [25], compares the revealed comparative advantage (RCA) of India and China across different levels of product classification. Their findings indicate that India holds a comparative advantage in a significant number of product groups (9 out of 16 product groups of the Harmonized System (HS) classification, 41 out of 97 HS chapters at the HS 2-digit level) and traded commodities (2377 out of 4163) at various classification levels, while China also maintains its comparative advantage in several areas (6 out of 16 HS product groups, 45 out of 97 HS chapters at the HS 2-digit level, and 2075 out of 4381 traded commodities). This strong performance in manufacturing and other specific products has led to GDP and export growth over the years.

Additionally [26], study on Southern African Development Community (SADC) countries revealed comparative advantage unveils South Africa as the leader, specializing in exporting 727 product lines. Zimbabwe, Tanzania, Mauritius, and Botswana also show significant specialization in certain export goods. This showcases how specialization in certain export goods, particularly evident in South Africa, contributes to their economic development [27,28]. focuses on relationship between Revealed Comparative Advantages and regional specialization of Colombia. They find that Colombia predominantly exports primary commodities, such as petroleum oils, coal, coffee, crude vegetable materials, and non-monetary gold. These five products accounted for nearly 50 % of Colombian exports in 2001, a figure that rose to 75 % in 2011, 2012, and 2013, remaining above two-thirds in 2017. The sustained dominance of these commodities in Colombian exports over the years reflects their importance to the country's economy and development.

The discourse surrounding industrial development strategies regarding comparative advantage can be divided into two schools of thought: adhering to a country's comparative advantage and defying comparative advantage. The former adheres to conventional trade theory, which asserts that export diversification results from the interaction of capital accumulation and comparative advantage in competitive goods [18]. Conversely, the latter perspective, defying comparative advantage, corresponds with the second-best theory of economic policy. This perspective implies that factor price equalization and market incentives may not efficiently drive productive transformation due to challenges such as information and coordination failures [29], or deficiencies in goods and factor markets [30].

As advised in Ref. [18], developing countries are urged not to defy their comparative advantage, but rather to enact policies aligning their export activities with their specific resources. However, over the past three decades, many of these nations have pursued strategies challenging their comparative advantage, attracting foreign direct investment (FDI) into specific manufacturing sectors [31]. This has led to integration into global value chains (GVCs) overseen by advanced economies' transnational corporations (TNCs) [32,33]. Despite policies aimed at challenging comparative advantage, these countries paradoxically export capital-intensive goods, raising doubts about the sustainability of their productive transformation [18].

Effective matching of comparative advantages to SEZs involves identifying and aligning the specific strengths of regions or countries with the requirements and objectives of industrialization within these zones. Research by Ref. [34] emphasizes the importance of considering factors such as natural resources, human capital, infrastructure, institutional capacity, and market access when designing SEZs tailored to local comparative advantages. Similarly, another study by Ref. [35] underscores the significance of integrating environmental sustainability, social inclusiveness, and economic efficiency into industrial development strategies, including those implemented within SEZs. However, despite the potential benefits, matching comparative advantages to SEZs for sustainable industrialization entails several challenges and considerations. These include issues related to infrastructure development, human capital formation, regulatory coherence, environmental sustainability, social inclusiveness, and governance. Research by Ref. [36] emphasizes the need for comprehensive policy frameworks and institutional mechanisms to address these challenges effectively.

### *2.1. Overview of existing literature on SEZs and their role in industrialization*

Special Economic Zones (SEZs) are widely acknowledged globally as effective instruments for fostering economic development and industrialization. Extensive research has been conducted on various aspects of SEZs worldwide, particularly focusing on their ability to achieve key objectives such as attracting foreign direct investment (FDI), enhancing infrastructure, generating employment, stimulating manufacturing industries, promoting local innovation, facilitating skill development, technology transfer, and driving industrialization. A comprehensive review of existing literature underscores the significant role of SEZs in both national and regional industrialization and economic advancement [37]. However, the literature presents mixed findings regarding the actual impact of

SEZs. While some studies suggest that SEZs can contribute to economic growth, job creation, and increased exports [38], others argue that their effects depend on primary investment attractors such as a specific country's economic activity, infrastructure quality, industry concentration, and zone location [39].

Several studies have investigated the influence of SEZ policies on FDI inflows. For instance, research conducted in Indian states by Ref. [40] found that SEZ policies resulted in increased FDI inflows. Similarly [41], emphasized the crucial role of SEZs in China's evolution into a major FDI destination, particularly during the 1980s. Likewise [42], discovered that the establishment of SEZs in various municipalities in China positively impacted FDI, leading to an average per capita increase of 21.7 % and a 6.9 percentage point growth rate in FDI. Although employment generation and skills development are anticipated benefits of SEZ creation, multiple studies indicate minimal impact of SEZs on job creation [36,43–46]. Conversely, other studies have identified significant positive effects of SEZs on employment generation [47–49].

A study conducted by Ref. [36] investigated the impacts of SEZs on skills development and labor productivity in Malaysia and Honduras, concluding that SEZs positively affect productivity, especially through the establishment of Skills Development Centers. Furthermore [50], revealed that science and technological industrial parks play a significant role in fostering skills convergence and enhancement in their surrounding areas. Research has also examined the effects of spillovers and technology and knowledge transfer from foreign SEZ firms to local firms and suppliers. For instance Ref. [51], analyzed the Thilawa SEZ in Myanmar and found that it facilitated knowledge transfers or spillovers between foreign and local companies. Similarly [52], assessed SEZs in Panama and observed productivity enhancements resulting from spillover effects, particularly through the influx of high-skill immigrants.

Research conducted by Ref. [53] revealed that the clustering of foreign firms in Ireland had a positive impact on the productivity and employment of local manufacturing firms. Similarly [54,55], discovered that SEZs generated positive horizontal spillover effects through industrial clustering. However, certain studies suggest that some SEZs failed to achieve spillover effects. For instance Ref. [56], found insufficient technology transfer in Chinese SEZs, while [57] noted limited spillover effects in Indian SEZs. Likewise [47], observed that export processing zones in Asia were not highly effective in transferring knowledge and skills to domestic firms.

Studies focusing on the impacts and performances of SEZs in Africa indicate that the continent has yet to fully benefit from SEZs and effectively diversify and industrialize its economies [58]. identified the main problems in creating SEZs in Africa and concluded that urgent policy adjustments and fundamental reforms are needed to stimulate industrialization and encourage active participation in the global market [59]. examined the literature to understand the factors contributing to the failure of the SEZ model in Africa and proposed the charter cities model as a potential alternative for African countries. This suggests that Africa should explore alternative approaches to achieve economic development and attract investments beyond traditional SEZ frameworks.

A study conducted by Ref. [45] regarding the development of SEZs in Africa revealed that while African SEZs are increasing in number and evolving, their capacity to attract industrial activity and generate employment remains limited. They emphasized that governance policies for African SEZs heavily rely on fiscal incentives and performance requirements. Additionally [60], proposed initiatives to enhance co-development between Africa and Europe, such as establishing an Institute of Advanced Industrial Development Studies for Africa and forming consortia of African and European companies to drive Africa's productive transformation through SEZ programs [61]. studied SEZs in Southern Africa, specifically South Africa and Zambia. They found that while South African SEZs have growth and employment potential, they face challenges like inadequate infrastructure financing and weak local supplier capabilities. In Zambia, SEZs encounter similar issues but also lack sufficient business services, deal with burdensome regulations, and suffer from coordination failures and ineffective design, leading to lower success rates [40].

### *2.2. The revealed comparative advantages concept and its relevance to SEZ development*

Special economic zones have emerged as a popular development strategy for African countries trying to spur industrialization and attract foreign direct investment. To maximize the potential benefits of SEZs for sustainable industrialization in Africa, it is essential to identify and match comparative advantages with specific zones. For instance, African countries with a comparative advantage in manufacturing and export-oriented industries could create zones that specialize in those sectors [62]. However, evidence from previous studies demonstrates that the success of comparative advantage requires an economic structure that encourages nations to take maximal advantage of their manufacturing and trade possibilities [63].

Revealed Comparative Advantage (RCA) is an economic concept employed to assess the competitiveness and comparative advantage of countries within particular industries or sectors. It aligns with Ricardo's notion that nations should focus on producing goods and services where they hold a comparative advantage [64]. The RCA index measures a country's export concentration in a specific product compared to global exports. It helps identify export strengths, weaknesses, and diversification potential, aiding in assessing global market competitiveness. Policymakers and businesses rely on RCA analysis to inform trade policies, investments, and industrial development decisions. Utilizing RCA can ensure African economies leverage their comparative advantages effectively in SEZ development aligned with strategic objectives [65]. Given Africa's unique socio-economic and demographic circumstances, the creation of the African Continental Free Trade Area (ACFTA) presents an opportunity to unlock economic prospects and capitalize on the agricultural and manufacturing capacities of the region. This endeavor has the potential to spur economic growth and advance industrial development across Africa [66].

Africa possesses several advantageous factors that position it well for industrialization and global competition. These include rapid urbanization, a growing labor force, an expanding domestic market, and advancements in digital and technological developments [3,67,68]. Additionally, Africa is rich in natural resources, giving it a strong position globally. It holds the top rank worldwide for reserves of various ores such as manganese, chromite, bauxite, gold, cobalt, and diamonds, among others. Additionally, it ranks second in reserves of copper, uranium, and graphite, and third in reserves of oil, gas, and iron ore. The continent also possesses significant

reserves of titanium, nickel, tantalum, and other minerals. Africa's agricultural potential is vast, with around a quarter of the world's fertile soil located within its borders. Moreover, Africa's forested area is the second-largest globally, trailing only behind Latin America and Russia [69].

To unlock Africa's manufacturing and industrial potential, concerted efforts are required from both the public and private sectors. There is a need to enhance Africa's economic complexity, diversity, competitiveness, and productivity. This entails implementing SEZs policies and initiatives that promote innovation, technological advancements, and skills development. The public sector plays a crucial role in creating an enabling environment through favorable regulations, investment in infrastructure, and the provision of quality education and healthcare. The private sector, on the other hand, needs to invest in research and development, adopt modern production techniques, and collaborate with local suppliers and stakeholders to foster value chains and increase competitiveness. By working together, the public and private sectors can drive the necessary changes and propel Africa towards achieving its manufacturing and industrial potential.

## 3. Methodology

This study is based on the idea that African countries, despite the increasing number of SEZs being established, are not fully maximizing the potential benefits of SEZ development. By aligning the specific comparative advantages of each country with their respective SEZ programs, it is believed that substantial economic benefits can be unlocked, contributing to sustainable industrialization across Africa. To accomplish this objective, a mixed-method approach comprising sample analysis and case studies is employed to examine African SEZs. The study brings forth a significant level of novelty by utilizing sources of information that have not been previously explored. The data for this study was obtained from the United Nations Conference on Trade and Development (UNCTAD) statistical database, and the relevant variables for each country have been calculated by the RCA matrix from 2011 to 2021 [70].

The research employs the Revealed Comparative Advantage (RCA) derived from Ricardian trade theory, which posits that the variations in productivity influence trade patterns among nations. The RCA measure is utilized to assess a country's competitive export capabilities using trade data. It is essential to recognize that while the RCA metric provides a general indication of competitiveness, it overlooks national factors affecting competitiveness, such as tariffs, non-tariff measures, and subsidies. The chosen countries for analysis are Ghana, Ethiopia, and South Africa, selected for their significant accomplishments in utilizing SEZ programs for economic growth and their diverse industrial environments supportive of industrialization. Selection criteria were based on factors like the number of firms within each zone, their employment impact, and SEZ policies, informed by existing literature on SEZ performance in Africa (e.g. Refs. [36,45,and71]]). Here, the RCA is employed to compare and identify industries or sectors where the selected countries possess comparative advantages and to highlight how these industries or sectors can be promoted within SEZs. This matching process can help align the comparative advantage of African countries with the opportunities provided by SEZs.

The Revealed comparative advantage data is sourced from UNCTAD statistic database (The RCA Matrix) and is defined as:

Country A is considered to have a revealed comparative advantage in a specific product (i) if its proportion of exports for product i, compared to its total exports of all products, surpasses the corresponding ratio for the entire world.

That is,

$$RCA_{Ai} = \frac{\frac{X_{Ai}}{\Sigma_{j\in P} X_{Aj}}}{\frac{Xw_i}{\Sigma_{j\in P} X_{wj}}} \geq 1 \quad (1)$$

Where.

- $P$ is the set of all products (with $i \in P$),
- $X_{Ai}$ is the country A's exports of product $i$,
- $X_{wi}$ is the worlds' exports of product $i$,
- $\Sigma_{j \in P} X_{Aj}$ is the country A's total exports (of all products $j$ in $P$), and
- $\Sigma_{j \in P} X_{wj}$ is the world's total exports (of all products $j$ in $P$).

When a country exhibits a revealed comparative advantage for a specific product (RCA >1), it indicates that the country is a competitive producer and exporter of that product. If a country's RCA for product i (denoted as $RCA_i$ in equation (1)) exceeds 1, it signifies the country's export prowess in that product. The greater the value of a country's RCA for product $i$, the stronger its export capability in that product [70].

The data derived from the RCA matrix [70] was analyzed and presented utilizing version 12 of EViews, which is an econometric software and statistical tool.

The sectors selected for application of the RCA matrix for Ghana are food and live animals (specifically cocoa), crude materials (ores and concentrates of base metals), commodities and transactions (Gold), and mineral fuel (petroleum and bitumen oils). These sectors were chosen based on the consistent comparative advantage exhibited by Ghana over the study period (2011–2021). Cocoa production is a key driver of Ghana's economy, and the country has maintained a strong comparative advantage in this sector. Additionally, Ghana has significant reserves of gold and petroleum, making these sectors important contributors to its economy. In the case of Ethiopia, the selected sectors are food and live animals (coffee), manufactured goods (leather), miscellaneous manufacturing (textile), and machinery and transport (engine motors). Ethiopia has demonstrated a consistent comparative advantage in coffee

production, making it a crucial sector for analysis. Leather, textile, and machinery industries also play significant roles in Ethiopia's economy, with the country exhibiting higher comparative advantage in these sectors over the study period.

For South Africa, the chosen sectors are manufactured goods (including silver and platinum, iron, and spiegeleisen), crude materials (ores and concentrates of base metals), and food and live animals (cereals and flour). South Africa's mining sector, especially in platinum, gold, and iron ore, plays a significant role in its economy and continues to demonstrate a robust comparative advantage. Additionally, the country's agricultural sector, particularly in cereals and flour production, has shown favorable comparative advantage over the study period. Overall, the selection of these sectors is based on the consistent comparative advantage exhibited by the respective countries over the study period. These sectors represent key areas of strength for each country's economy and are therefore suitable for analysis using the RCA matrix.

It is important to note that the RCA matrix forms the backbone of the methodology, as within the RCA framework, factors such as natural resources, labor skills, infrastructure, and market potential are implicitly considered. The RCA metric evaluates a country's competitive export strengths using trade data, which reflects underlying factors contributing to comparative advantage. For instance, abundant natural resources may lead to a country's specialization in resource-intensive industries, while a skilled labor force may drive competitiveness in knowledge-based sectors. Similarly, robust infrastructure and access to markets can enhance a country's export competitiveness. Therefore, while the RCA analysis may not explicitly assess these factors, they are reflected in the trade patterns analyzed, providing insights into a country's overall competitive position. Also, the integration of RCA framework with qualitative case studies enhances the depth and breadth of the analysis, providing a holistic understanding of the export strength of selected nations. This complementary approach allows for a more robust assessment of SEZ development potential and facilitates the alignment of comparative advantages with SEZ opportunities.

## 4. Analysis and findings

In line with the global trend, various countries in Africa have established SEZs as a means to drive industrialization and economic growth. These SEZs offer advantages such as streamlined administrative processes, favorable tax incentives, and modern infrastructure, which aim to attract investment and overcome obstacles to economic development [72,73]. However, the overall performance of SEZs in Africa has been largely disappointing, with few exceptions. According to a report by the African Development Bank, African firms are approximately 20 % less competitive compared to their counterparts in other regions [74]. This section examines the experiences of three African countries— Ethiopia, South Africa, and Ghana—that have made notable efforts in establishing SEZs and promoting industrialization. These countries offer diverse contexts and industries that can be analyzed using frameworks like Revealed Comparative Advantage (RCA) and SEZs. Through studying these cases, valuable insights can be gained into the dynamics of industrial development, comparative advantages, and the role of SEZs in driving economic growth.

### 4.1. Ghana

Special Economic Zones (SEZs) have emerged as a crucial strategy for many developing countries, including Ghana, to promote industrialization, generate employment, and drive export-led growth [75]. Ghana acknowledges the considerable potential of Special Economic Zones (SEZs) in attracting private sector investment and promoting export-driven growth. Indeed, the World Bank has praised Ghana's SEZ program as one of the most well-designed, adaptable, and inventive in Africa [76].

To capitalize on its strengths and promote economic growth, Ghana has adopted a two-tier system of SEZs, comprising enclave zones and single enterprise zones. The Ghana Free Zone Authority (GFA) has strategically established enclaves in urban areas with the objective of maximizing spillover effects and generating employment opportunities. A prominent example is the flagship enclave located in Tema, a port city, which currently hosts around forty companies operating within the zone. The introduction of SEZs in Ghana has facilitated significant market-driven transformations across various geographical regions, opening avenues for industries to engage in trade and export their products [71]. Ghana acknowledges that the establishment of Special Economic Zones (SEZs) is crucial for encouraging private sector investments, promoting export-driven expansion, and generating employment opportunities [77].

Ghana boasts several comparative advantages that contribute to its economic potential and trade opportunities. These include a stable political environment, abundant and diverse natural resources, agricultural production, cocoa processing, a favorable climate

**Table 1**
Selected sectors for Ghana and their annual RCA value from 2011 to 2021.

| S/N | GHANA | Revealed Comparative Advantage Value Per Year From 2011 to 2021 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SELECTED SECTOTRS | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| 1 | Food (Cocoa) and live Animal | 169.2 | 157.1 | 144.7 | 133.1 | 123.9 | 118.1 | 144.6 | 160.5 | 163.9 | 145.2 | 202.6 |
| 2 | Crude materials (ores and concentrates of base metals) | 13.5 | 10 | 12.1 | 8.5 | 7.1 | 10.1 | 11.6 | 14.8 | 23.8 | 16.4 | 14 |
| 3 | Commodities and Transaction (Gold, non-monetary excluding ores) | 12.6 | 15.4 | 11.7 | 16 | 18 | 19.3 | 20.2 | 21 | 20.2 | 14.9 | 18.2 |
| 4 | Mineral fuel (Petroleum, oil, bitumen, and minerals) | 2.4 | 2.5 | 3.1 | 3.7 | 3.5 | 2.5 | 4.6 | 5 | 5 | 6.7 | 6 |

Source: Author, extracted from UNCTAD data exploration

and fertile soil, a skilled workforce, and a strategic location that positions Ghana as a regional hub with access to global markets. These advantages enable Ghana to leverage its strengths and create favorable conditions for economic growth and trade expansion.

#### 4.1.1. The revealed comparative advantage of the selected sectors in Ghana

Table 1 highlights the sectors and sub-sectors with highest RCA value in Ghana between 2011 and 2021. The identified sectors include food and live animal (cocoa), crude materials (ores and concentrates of base metals), commodities and transaction (Gold), and mineral fuel (petroleum, bitumen oils).

The RCA values in Figs. 1 and 2 indicate that Ghana has shown a decreasing trend in RCA value for Cocoa and Cocoa-related products from 2011 to 2021. However, despite this decreasing trend, this sector maintained a higher comparative advantage compared to other sectors throughout the study period. Ghana, undergoing rapid urbanization at a rate of around 51 %, has become one of Africa's fastest-growing economies. With an average annual growth rate of 5.7 %, the nation has seen a considerable decline in poverty, particularly in the capital city of Accra, alongside a noticeable rise in industrial employment opportunities [78]. In this context, SEZs specializing in agro-processing, agricultural production, and the promotion of agricultural value addition have great potential to leverage Ghana's diverse agricultural sector and its comparative advantage in cocoa. SEZs located in key areas such as Dawa Industrial City in the greater Accra region, as well as those specifically dedicated to cocoa processing like the Tema Export Processing Zone and the Sekondi-Takoradi Industrial and Free Zone has the potential to significantly contribute to economic growth and the generation of employment opportunities. By capitalizing on Ghana's agricultural strengths and strategic positioning, these SEZs can contribute to the country's overall development and harness its comparative advantage in cocoa.

The establishment of SEZs in Ghana has contributed to a substantial increase in the country's GDP and urbanization. Zones in Ghana act as growth nodes that promote collaboration between local and foreign companies [45]. Similarly, the government's 10-point transformation agenda, with Free Zones as a key focus, has strategically targeted urban areas and regions where Ghana possesses a comparative advantage, such as port cities and manufacturing hubs, to establish SEZs and maximize their potential benefits. While Ghana has made commendable efforts in establishing SEZs as a means of promoting economic growth, the country still faces challenges in areas such as infrastructure, governance, and financing, which have hindered the progress of SEZ initiatives [79].

Apart from the Cocoa and Cocoa-related sectors, Ghana possesses comparative advantages in other sectors such as mineral fuel (petroleum, oil, bitumen and mineral), commodity transaction (Gold), and crude materials (ores/concentrates of base metal). Fig. 3 shows the (RCA) values for each sector.

As indicated in Fig. 3, Ghana boasts abundant natural resources, including gold, oil, and gas, positioning it as a significant player in these industries within Africa. As one of the continent's largest gold producers and with a growing oil and gas sector, the country possesses a comparative advantage in mining and energy-related activities. By establishing SEZs that focus on mineral processing and manufacturing, Ghana can leverage its natural resource wealth to add value to these commodities and create employment opportunities.

SEZs specializing in mineral processing can provide an opportunity for Ghana to enhance its competitive edge in these sectors. Concentrating expertise and resources in these zones can lead to increased specialization, fostering a critical mass of skilled professionals and enabling the production of higher-value outputs. For example, the Sekondi-Takoradi SEZ, strategically located near the country's oil and gas reserves in the Western Region, has the potential to attract investments and facilitate activities such as mining operations, oil exploration, and oil refining.

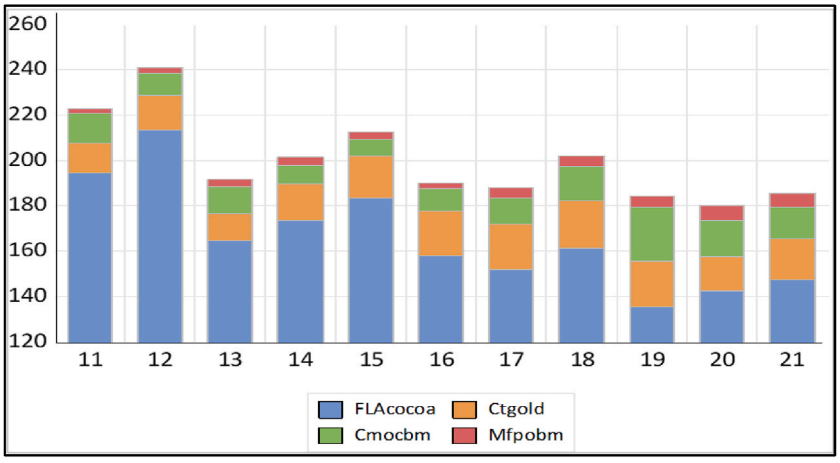


**Fig. 1.** Selected Variable for Ghana: FLA cocoa (Food and live animal, cocoa), Ct gold (Commodity transaction Gold), Mfpobm (Mineral fuel petroleum, oil, bitumen and mineral), Cmocbm (Crude materials, ores/concentrates of base metal) over time (2011–2021). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)
(Source, Author's production extracted from UNCTAD data exploration).

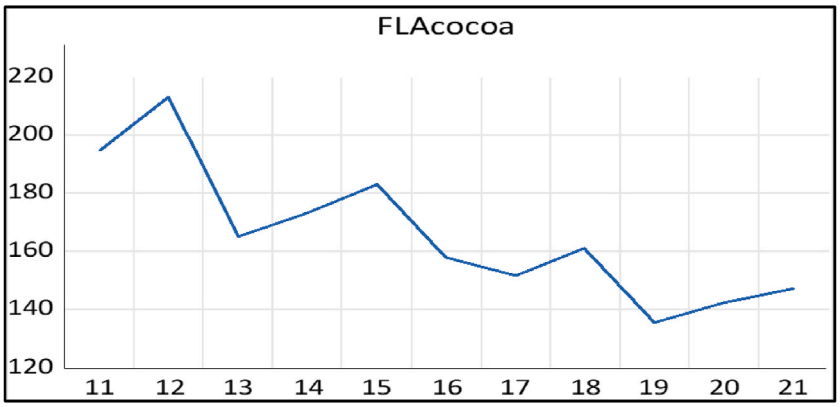


**Fig. 2.** Analyzed result of revealed comparative advantage (RCA) values for FLA cocoa (Food and Live Animals) in Ghana (2011–2021). (Source, Author's production extracted from UNCTAD data exploration).

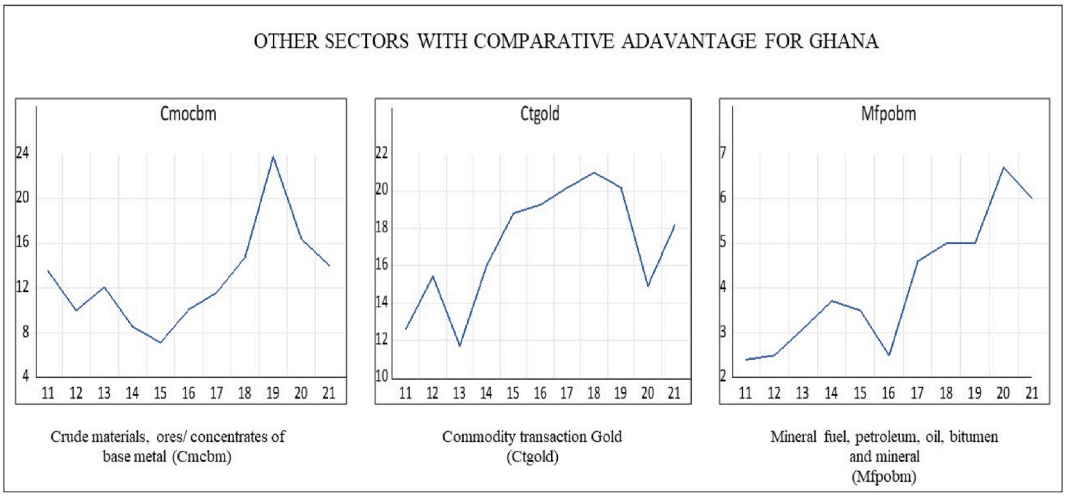


**Fig. 3.** Analyzed results of RCA values for Mfpobm (Mineral fuel, petroleum, oil, bitumen and mineral), Ctgold (Commodity transaction Gold), Cmocbm (Crude materials, ores/concentrates of base metal) over time (2011–2021). (Source, Author's production extracted from UNCTAD data exploration). (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

### *4.2. Ethiopia*

Ethiopia serves as an example that highlights the importance of interconnection of various factors, such as investment promotion, trade, customs regulations, and labor laws, in effectively developing and implementing Special Economic Zone (SEZ) policies. The Ethiopian SEZ models illustrate that the connection between these policy domains, typically managed by various government institutions and agencies, requires an efficient mechanism for institutional collaboration and coordination. This ensures that SEZ policies are integrated into comprehensive strategies and policy coherence [36].

Ethiopia's success in SEZ development can be attributed to various factors. Firstly, advantageous external factors, like the extension of the African Growth and Opportunity Act (AGOA) and affordable labor expenses, have been pivotal in attracting investments. Secondly, the country has implemented a well-targeted SEZ policy and actively promoted investment through dedicated efforts [45]. These factors have contributed to the growth and development of SEZs in Ethiopia, enabling the country to leverage its comparative advantages and create opportunities for economic expansion and trade. Similarly, the establishment of key institutions like the Ethiopian Investment Board (EIB) and the Ethiopian Investment Commission (EIC) has provided high levels of government support. These institutions are responsible for formulating policies and strategies, overseeing investment promotion, formulation of industrial park policies, managing day-to-day operations, attracting investors to targeted sectors, and regulating industrial park developers, operators, and firms [45]. Their concerted efforts have contributed to Ethiopia's progress in SEZ development.

Ethiopia possesses several advantages that have the potential to contribute to its economic growth and trade opportunities. These include its strategic geographical location, abundant agricultural resources, a thriving coffee production industry, a growing textile and garment sector, a skilled labor force, and favorable regional integration and market access.

#### 4.2.1. Revealed comparative advantage for selected sectors in Ethiopia

Table 2 shows the sectors and sub-sectors with highest RCA value in Ethiopia between 2011 and 2021. The identified sectors include food and live animal (coffee), manufactured goods (leather), miscellaneous manufacturing (textile), and machinery and transport (engine motors).

According to Figs. 4 and 5, Ethiopia has consistently maintained a significant comparative advantage in the Coffee sector compared to other sectors between 2011 and 2021. This highlights the country's strength and expertise in coffee production. To leverage this opportunity, current industrial parks in Ethiopia, like the Hawassa Industrial Park and the Bole Lemi Industrial Park near Addis Ababa, can indirectly support coffee-related industries by offering essential infrastructure and support services.

Additionally, Ethiopia shows potential in other sectors such as Machinery and Transportation (engine motors), Manufactured goods (Leather), and miscellaneous manufacturing (textile and garments). Fig. 6 highlights the RCA values for the sectors.

As indicated by Fig. 6, Ethiopia benefits from favorable agro-ecological conditions and diverse landscapes, which make it well-suited for agricultural production and create significant potential for export opportunities. The Eastern Industrial Zone (EIZ), located near Ethiopia's capital city of Addis Ababa, holds the potential to act as a strategic center for harnessing the country's agricultural sector. Its location offers several advantages, including proximity to major transportation routes such as the Addis Ababa-Djibouti railway and the Bole International Airport, providing access to regional markets. The EIZ's strategic positioning and infrastructure connectivity make it an ideal location for agricultural industries to establish their operations. With access to reliable transportation networks, businesses within the EIZ can efficiently transport agricultural products to regional markets and take advantage of export opportunities. This not only improves Ethiopia's agricultural value chain but also boosts the nation's economic growth and trade expansion. The establishment of the EIZ and its emphasis on harnessing Ethiopia's agricultural potential can advance the country's overarching industrialization objectives.

Additionally, Ethiopia has advanced considerably in building its textile and garment sector, leveraging its strengths such as cost-effective labor, ample cotton resources, and preferential trade deals with major markets like the United States and the European Union. These elements bolster Ethiopia's edge in the textile and apparel industry. The Hawassa Industrial Park, situated in the Southern Nations, Nationalities, and Peoples' Region, serves as a notable SEZ in Ethiopia, showcasing the nation's strategic vision. This industrial park is designed to align with Ethiopia's comparative advantage in agriculture by focusing on textile and garment manufacturing, taking advantage of the availability of cotton resources and the country's strong agricultural base. The Hawassa Industrial Park acts as a center for textile and garment manufacturing, offering infrastructure, utilities, and services to entice both domestic and international investors keen on tapping into Ethiopia's textile and apparel industry.

Hence, by leveraging its comparative advantages in the textile and garment sector, Ethiopia can advance its manufacturing capacity, generate job prospects, and boost its export potential worldwide [80]. The expansion of the textile and garment industry within SEZs such as the Hawassa Industrial Park fosters economic diversification, industrial growth, and trade amplification in Ethiopia.

### 4.3. South Africa

The Coega Industrial Development Zone (Coega IDZ) in South Africa, founded near Port Elizabeth in 2001, stands as a prominent illustration of how SEZs can facilitate connections with local small, micro, and medium-sized enterprises (SMMEs). Coega IDZ has implemented specific initiatives to create an environment conducive to the participation and benefit of local firms in its industrial activities. These efforts encompass the formation of an SMME Development Unit tasked with overseeing the SMME Development Program. This program aims to promote the establishment of local businesses by compiling a supplier database, offering customized training and development initiatives, and providing technical mentorship to assist local companies in competing for more lucrative tenders [81,82]. This arrangement allows for close collaboration and interaction between companies operating within the SEZ and the surrounding SMMEs, leading to the development of strong sourcing linkages.

South Africa enjoys various comparative advantages that greatly contribute to its economic progress and competitiveness. The country possesses abundant natural resources, a stable infrastructure, a strong manufacturing and industrial base, and a reputation as a financial hub. Additionally, South Africa has access to a skilled workforce, and boasts strong institutional frameworks.

#### 4.3.1. Revealed comparative advantage for selected sectors in South Africa

Table 3 highlights the sectors and sub-sectors with highest RCA value in South Africa between 2011 and 2021. The identified sectors include manufactured goods (silver and platinum, iron, and spiegeleisen), crude materials (ores and concentrates of base metals), food and live animals (cereals and flour).

**Table 2**
Selected sectors for Ethiopia and their RCA value between 2011 and 2021.

| S/N | Ethiopia | REVEALED COMPARATIVE ADVANTAGE VALUE PER YEAR FROM 2011–2021 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SELECTED SECTOTRS | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| 1 | Food and live Animal (Coffee) | 169.2 | 157.1 | 144.7 | 133.1 | 123.9 | 118.1 | 144.6 | 160.5 | 163.9 | 145.2 | 202.6 |
| 2 | Manufactured goods (Leather) | 45.4 | 31.7 | 31.2 | 25.5 | 26.5 | 24.7 | 22.7 | 27.7 | 27.1 | 13.2 | 20.5 |
| 3 | Miscellaneous manufacturing (Textile) | 1.3 | 1.1 | 1.5 | 1.5 | 1.5 | 2.1 | 3 | 3.5 | 5.9 | 5.4 | 4.5 |
| 4 | Machinery/Transport (Engine motors) | 1.2 | 1.9 | 2 | 0 | 3.6 | 4.3 | 3.7 | 2.3 | 3.5 | 11 | 3.5 |

Source: Author, extracted from UNCTAD data exploration

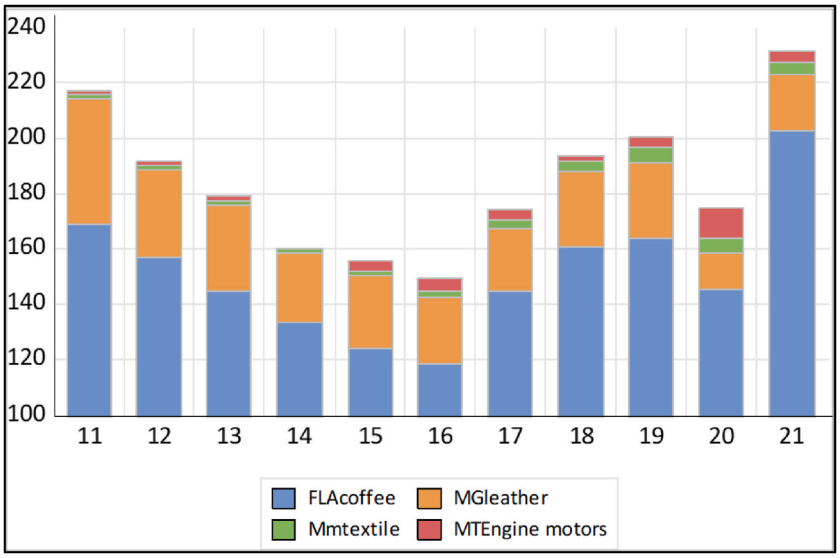


**Fig. 4.** Selected Variable for Ethiopia: FLA coffee (Food and live animal coffee and coffee substitute), MGleather (Manufactured goods, Leather), Mmtextile (miscellaneous manufacturing, textile and garments), and MTengine motors (Machinery and Transportation engine motors), over time (2011–2021). (Source, Author's production extracted from UNCTAD data exploration).

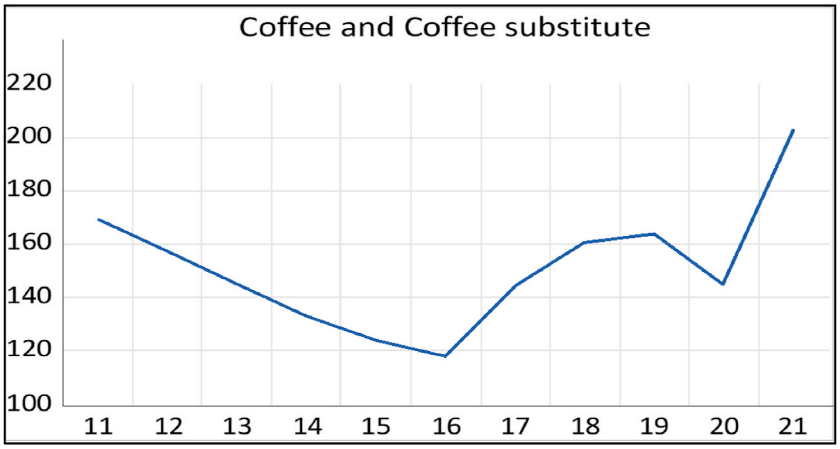


**Fig. 5.** Analyzed result of revealed comparative advantage (RCA) values for FLA coffee (Food and Live animal coffee) in Ethiopia (2011–2021). (Source, Author's production extracted from UNCTAD data exploration).

Figs. 7 and 8 shows that South Africa demonstrated a consistent and substantial comparative advantage in the mineral ores and concentrates sector compared to other sectors from 2011 to 2021. This comparative advantage highlights the country's strength in mineral exploration and processing. SEZs that specifically target mineral exploration and processing, such as the Richards Bay Industrial Development Zone (RBIDZ), can effectively leverage this advantage to drive economic development and foster inclusive growth. The RBIDZ, located in the Richards Bay area of KwaZulu-Natal, is strategically positioned to harness South Africa's mineral resources and maximize their value through processing and beneficiation activities [83]. Given its comparative advantage in the mineral ores and concentrates sector, the RBIDZ can attract investments and facilitate activities such as mining operations, mineral processing, and export-oriented production.

By establishing SEZs that focus on mineral exploration and processing, South Africa can create a conducive environment for companies to capitalize on the country's abundant mineral resources and leverage advanced technologies and expertise in the sector. This can lead to increased value addition, job creation, and enhanced export opportunities, ultimately contributing to economic development and promoting inclusive growth. Therefore, it is important for South Africa to continue developing and supporting SEZs like the RBIDZ, providing necessary infrastructure, incentives, and regulatory frameworks to attract investments and foster a vibrant mineral processing industry. This strategy can empower the nation to unleash the complete potential of its mineral wealth, promote economic diversification, and enhance its standing in the global marketplace.

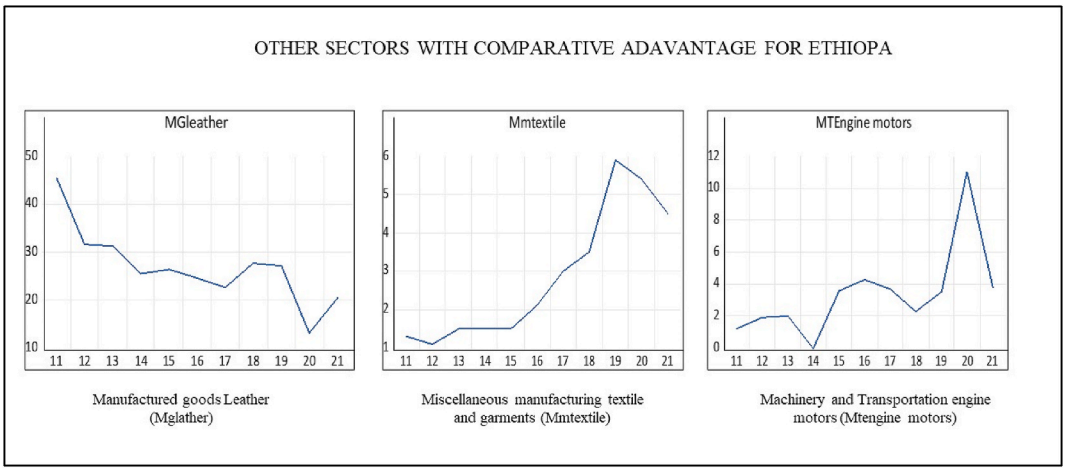


**Fig. 6.** Analyzed results of RCA values for MGleather (Manufactured goods Leather), Mmtextile (miscellaneous manufacturing textile and garments), and MTEngine motors (Machinery and Transportation engine motors) between 2011 and 2021. (Source, Author's production extracted from UNCTAD data exploration).

**Table 3**
Selected sectors for South Africa and their RCA value from 2011 to 2021.

| S/N | SOUTH AFRICA | REVEALED COMPARATIVE ADVANTAGE VALUE PER YEAR FROM 2011–2021 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SELECTED SECTOTRS | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 |
| 1 | Manufactured Goods (Silver Platinum etc.) | 25.7 | 22.3 | 28.8 | 26.6 | 33.5 | 31.5 | 27.8 | 31.8 | 30 | 24.4 | 31.5 |
| 2 | Crude materials (ores and concentrates of base metals) | 21.8 | 23.9 | 29.4 | 28 | 29.8 | 33.3 | 37.3 | 38.5 | 41.3 | 39.7 | 50.2 |
| 3 | Food and live Animal (cereal/flour) | 12 | 15.3 | 17.9 | 16.4 | 15.8 | 18.4 | 14.3 | 12.6 | 16.5 | 19.5 | 2.6 |
| 4 | Manufactured Goods (Iron, Spiegeleisen, powder) | 18.9 | 18 | 22.4 | 22.8 | 26.7 | 28.8 | 22.2 | 19.9 | 19.1 | 16.6 | 23.7 |

Source: Author, extracted from UNCTAD data exploration

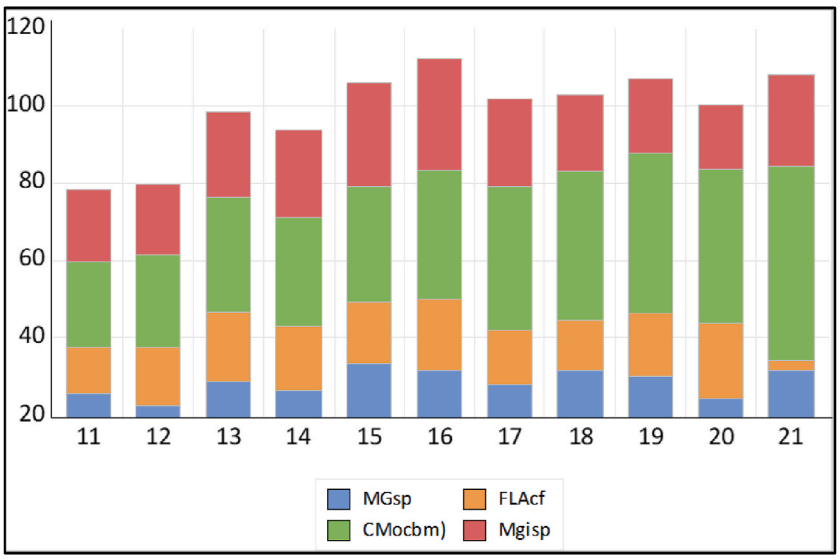


**Fig. 7.** Selected Variable for South Africa: MGsp (Manufactured Goods, silver, platinum etc.), FLAcf (Food and live animals (cereal and flour), CMocbm (Crude materials ores and concentrates), and Mgisp (Manufactured goods, iron spiegeleisen, powder) between 2011 and 2021. (Source, Author's production extracted from UNCTAD data exploration).

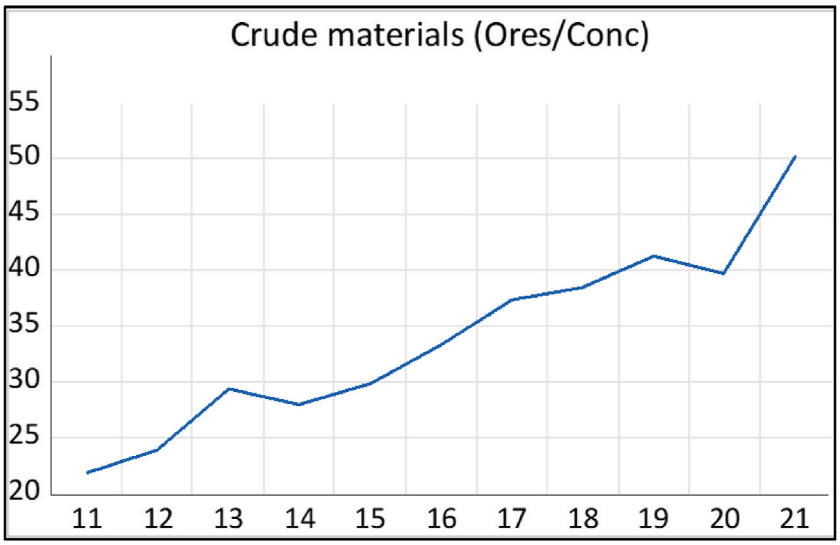


**Fig. 8.** Analyzed result of revealed comparative advantage (RCA) values for CMocbm (Crude materials, ores and concentrates) in South Africa from 2011 to 2021. (Source, Author's production extracted from UNCTAD data exploration).

Furthermore, South Africa shows high comparative advantage in other sectors such as Manufactured Goods (Silver, platinum etc.), Food and live animal (Cereal and flour), and other Manufactured goods (iron, spiegeleisen, granulated powder), as highlighted in Fig. 9 below.

Fig. 9 highlights the reveal comparative advantage of other sectors in South Africa. By establishing SEZs that focused on manufacturing, agro-processing and provision of a platform for collaboration and knowledge exchange, such as those implemented in SEZs like Coega IDZ for the above-mentioned sectors across the entire country, several opportunities will be created for domestic firms to expand their market reach, access finance, and receive training and mentoring. These initiatives will enable SMMEs to integrate into larger value chains, enhance their competitiveness, and seize growth opportunities [45]. The success of these initiatives in Coega IDZ highlights the crucial role of SEZs in promoting economic development and fostering linkages between different actors in the economy by facilitating collaboration, knowledge sharing, value chain integration, and the growth and development of both large enterprises and smaller domestic firms.

Table 4 presents a summary of the identified sectors with highest RCA values for Ethiopia, Ghana and South Africa and other sectors for potential diversification and recommended types of SEZs that aligns with each of the identified sector.

## 5. Discussion

The revealed comparative advantage (RCA) provides valuable insights into a country's regional specialization by identifying the

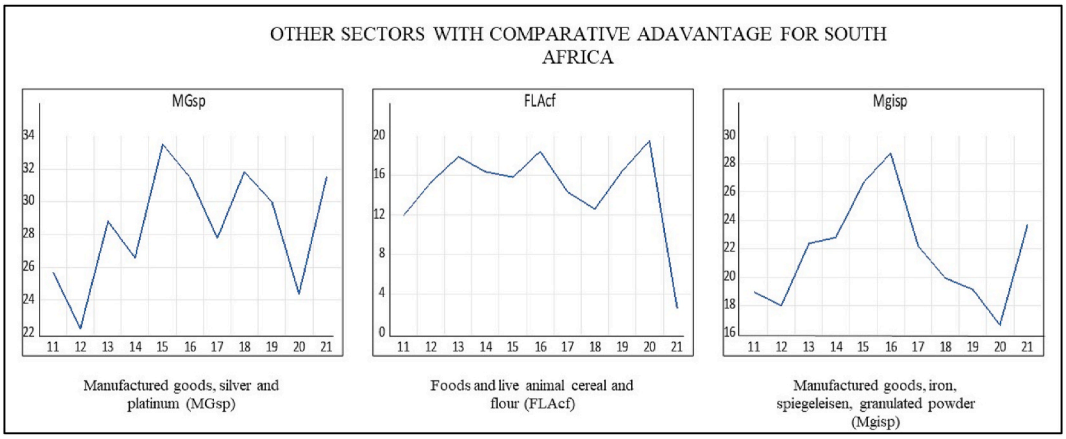


**Fig. 9.** Analyzed result of revealed comparative advantage (RCA) values for MGsp (Manufactured goods, silver and platinum), FLAcf (Foods and live animal cereal and flour), and Mgisp (Manufactured goods, iron, spiegeleisen, granulated powder) in South Africa from 2011 to 2021. (Source, Author's production extracted from UNCTAD data exploration).

**Table 4**
Identified comparative advantages of selected countries and recommended zone types.

| S/N | COUNTRIES | SECTORS | MEAN ITEM SCORE FOR SECTORS | SECTORS WITH HIGHEST COMPARATIVE ADVANTAGE | SECTORS WITH POTENTIAL | RECOMMENDED SEZ TYPES |
|---|---|---|---|---|---|---|
| 1 | Ethiopia | 1. Food and live animals (Coffee and Coffee substitutes)<br>2. Manufactured Goods (Leather)<br>3. Miscellaneous Manufacturing (Textile and Garments)<br>4. Machinery and Transport (Engine motors). | 151.172<br>26.927<br>2.845<br>3.363 | Food and live animals (Coffee and Coffee substitutes) | 1. Manufactured Goods (Leather).<br>2. Miscellaneous Manufacturing (Textile and Garments).<br>3. Machinery and Transport (Engine motors). | 1. Agro-processing zone.<br>2. Manufacturing processing zones, |
| 2 | Ghana | 1. Food and live animals (Cocoa)<br>2. Commodity transaction (Gold)<br>3. Mineral fuel (petroleum, oil, bitumen and mineral)<br>4. Crude materials (ores/ concentrates of base metal) | 165.909<br>17.045<br>4.09<br>12.9 | Food and live animals (Cocoa) | 1. Commodity transaction (Gold).<br>2. Mineral fuel (petroleum, oil, bitumen and mineral).<br>3. Crude materials (ores/ concentrates of base metal). | 1. Agro-processing zone.<br>2. Mineral exploration and processing zone |
| 3 | South Africa | 1. Crude materials (Ores and concentrates of base metals)<br>2. Food and live animals (cereal and flour)<br>3. Manufactured goods (iron spiegeleisen, powder)<br>4. Manufactured Goods (silver, platinum etc.) | 33.927<br>14.663<br>28.536<br>21.736 | Crude materials (Ores and concentrates of base metals) | 1. Food and live animals (cereal and flour).<br>2. Manufactured goods (iron spiegeleisen, powder).<br>3. Manufactured Goods (silver, platinum etc.) | 1. Mineral exploration processing zone.<br>2. Agro-processing Zone |

Source: Author, extracted from UNCTAD data exploration

products that represent strengths and weaknesses for international trade within that country in a particular field [84]. According to the RCA matrix, a value exceeding 1 for a specific product implies that a country possesses a comparative advantage in that product, signifying that it exports a greater proportion of that product compared to the global average. Conversely, a value below 1 indicates a comparative disadvantage. However, the country is neither at an advantage nor a disadvantage if the RCA value is 1. Hence, this study revealed that each of the analyzed countries consistently maintained a comparative advantage in specific sectors compared to the others. For example, Ghana displayed the greatest comparative advantage in cocoa and cocoa-related products from 2011 to 2021, peaking at an RCA value of 213.1 in 2012. Similarly, Ethiopia exhibited a significant comparative advantage in coffee throughout the same period, reaching its highest RCA value of 202.6 in 2021. South Africa demonstrated a substantial comparative advantage in the mineral ores and concentrates sector, achieving its peak RCA value of 50.2 in 2021.

Establishing SEZs tailored to the comparative advantages of African nations offers a promising path toward sustainable industrialization. Research, such as [2], emphasizes the importance of targeting labor-intensive industries and locally sourceable raw materials as key investment opportunities in Africa. This suggests that SEZs can strategically utilize these resources by situating industrial zones near areas abundant in specific resources. For example, countries like South Africa possess significant reserves of minerals such as gold, platinum, and diamonds (as indicated by this study). SEZs specializing in mineral processing and beneficiation can leverage these resources to stimulate industrial growth and value addition. Similarly, Africa boasts extensive agricultural potential, with fertile lands conducive to cultivating various crops. SEZs focusing on agro-processing can capitalize on this advantage, promoting value addition and export-oriented production. This aligns with [85]'s endorsement of leveraging the agro-industry as the next natural stage to aid the continent in achieving structural transformation and advancing along the global value chain.

Echoing the recommendation from Ref. [86] to customize SEZs according to local skills and innovation capabilities, Africa boasts a diverse pool of human capital with a range of skills and expertise. Tailoring SEZs to match local skills ensures the optimal utilization of available talent. For instance, countries with a robust agricultural workforce can establish SEZs focused on agro-processing, tapping into the agricultural value chain. Similarly, nations with skilled labor forces in sectors like manufacturing or technology can develop SEZs specializing in high-value-added industries, fostering innovation and competitiveness. Furthermore, the proposition underscores the importance of nurturing innovation within SEZs. Africa's burgeoning ecosystem of startups and entrepreneurship offers opportunities for SEZs to function as innovation hubs. By providing conducive environments for research and development, SEZs can cultivate local innovation ecosystems and bolster the growth of knowledge-based industries. Moreover, adapting SEZs to align with Africa's innovation capacities entails investment in infrastructure and technology. Access to dependable energy, transportation, and

telecommunications infrastructure is crucial for facilitating business operations and attracting investment.

A study by Ref. [66] emphasizes Africa's potential for growth and integration into global value chains through industrialization and ICT. The findings underscore the importance of integrating digital technologies and Industry 4.0 principles to areas of comparative advantage such as agriculture to enhance productivity, efficiency, and competitiveness, thereby driving economic development and positioning Africa as a key player in the global economy. Similarly, Africa's economic development is contingent upon robust connectivity infrastructure, including transportation networks, telecommunications systems, and digital platforms. SEZs situated in areas with access to reliable infrastructure can leverage digital technologies to streamline logistics, facilitate trade, and enhance market connectivity. Moreover, the deployment of smart infrastructure within SEZs, such as intelligent transportation systems and digital ports, can improve efficiency and competitiveness, enabling seamless integration into global supply chains. Additionally, according to Ref. [87], an analysis of the revealed comparative advantage for certain products based on the Standard International Trade Classification (SITC) by the World Trade Organization compared Ghana and China. The study found that Ghana holds a more advantageous position in the global market for three products, including minerals, wood, and food, among the seven products examined. These findings underscore the pivotal role of these sectors in propelling Ghana's economic growth and enhancing its export competitiveness. The country's comparative advantage in these sectors offers potential for establishing SEZs that can drive innovation and serve as hubs for processing, packing and export of wide range of high-quality products, aligning with findings of [88].

Foreign Direct Investment (FDI) plays a vital role in maximizing the influence of comparative advantage by stimulating economic growth and promoting sustainable development. However, according to studies by Ref. [31], deviating from comparative advantage is seen as a successful method for integrating into global value chains. Insights from Ref. [89] underscore the role of SEZs in attracting FDI, particularly in labor-intensive sectors such as textiles and leather, aligning with Ethiopia's comparative advantage. Therefore, within the African context, FDI can be utilized to leverage natural resource advantages for industrialization and bolster competitiveness. Consequently, policymakers should enact favorable investment policies, enhance infrastructure, and fortify institutions to effectively attract and retain FDI.

From the practical standpoint, Matching SEZs with comparative advantage holds significant potential to support various stakeholders, including small and medium-sized enterprises (SMEs), entrepreneurs, and local communities in Africa. For SMEs and entrepreneurs, SEZs tailored to local comparative advantages offer a conducive ecosystem for business expansion and innovation. These zones provide SMEs with access to specialized infrastructure, support services, and market linkages, enabling them to capitalize on their strengths and improve skill development [89]. Additionally, SEZs aligned with comparative advantages can serve as incubators for entrepreneurship and innovation, creating a vibrant ecosystem that nurtures new ventures and startups. By providing access to mentorship, financing, and networking opportunities, these zones enable aspiring entrepreneurs to translate their ideas into viable businesses and contribute to economic diversification, thereby fostering a culture of entrepreneurship within local communities [89].

Local communities also stand to benefit significantly from SEZs matched with comparative advantages. These zones generate employment opportunities, both directly through job creation within SEZ enterprises and indirectly through the multiplier effect on supporting industries and services [36]. By prioritizing local hiring and procurement, promoting inclusive growth and socioeconomic development within surrounding communities the zones can contribute to poverty reduction, income generation, and improved living standards for local residents. Also, when matched with comparative advantage, SEZs can stimulate infrastructure development and urbanization, spurring investment in roads, utilities, housing, and social amenities in host regions. This infrastructure investment can support community development initiatives, such as education, healthcare, and skills training programs, fostering human capital development and social empowerment, thereby laying the foundation for long-term sustainable development [90]. Therefore, matching SEZs with comparative advantages serves as a point of departure for promoting economic prosperity and social inclusion. By leveraging the unique strengths of each region, SEZs create synergies between businesses, government, and local communities, driving sustainable growth and shared prosperity. Policymakers should prioritize the development of SEZs that maximize value creation, innovation, and inclusivity, ensuring that the benefits accrue equitably to all stakeholders and contribute to the overall well-being of society.

Comprehensively addressing challenges in logistics, transport, and stakeholder engagement is essential for the success of matching SEZs to comparative advantage. By investing in infrastructure, implementing supportive policies, building capacity, and fostering stakeholder collaboration, policymakers can create an enabling environment that maximizes the potential of SEZs to drive economic growth, promote industrialization, and enhance competitiveness while ensuring that the benefits are shared equitably among all stakeholders. Also, the establishment of high-polluting industries, like leather manufacturing, can present notable environmental obstacles that must be meticulously tackled to guarantee sustainable development. Therefore, it is crucial to implement robust environmental policies and regulations such as Effluent Treatment Regulations, Pollution Prevention Measures, Air Quality Standards, Waste Management Regulations, and Environmental Monitoring and Enforcement to mitigate the environmental impact of contaminant industries while leveraging the comparative advantage they offer.

## 6. Conclusion

This study underscores the significance of matching comparative advantage to SEZs as a strategic approach for fostering sustainable industrialization in African countries using RCA matrix. By identifying the specific sectors where Ghana, Ethiopia, and South Africa have a comparative advantage—cocoa and cocoa-related products, coffee, and mineral ores and concentrates, respectively—the study advocates for the establishment of dedicated SEZs to promote these industries. Furthermore, the study highlights the importance of exploring additional sectors with potential for each country beyond their primary comparative advantages. For Ghana, this includes mineral fuel and commodity transactions, for Ethiopia, machinery and transportation, and for South Africa, manufactured goods and

foods. Diversifying into these sectors can contribute to economic growth, employment generation, and enhanced competitiveness. While the RCA matrix provides valuable insights into export competitiveness, it may overlook other critical factors such as global demand trends, domestic supply constraints, and non-tariff barriers. Therefore, future research should conduct a more detailed analysis that incorporates these factors to better inform SEZ development strategies.

The study recommends that policymakers should develop targeted policies and incentives to support the establishment and operation of SEZs aligned with comparative advantages. This involves investing in infrastructure, providing access to finance, facilitating technology transfer, and promoting collaboration between public and private sectors. Additionally, policymakers should prioritize integrating supply chain management principles into the core of SEZ operations. This entails fostering linkages between SEZ enterprises, domestic suppliers, and global markets to enhance value addition, efficiency, and resilience. Moving forward, it is imperative for future research to expand its scope to include a comprehensive assessment of the socio-economic impacts of SEZs tailored to comparative advantages across a broader array of African countries. This entails evaluating their efficacy in fostering inclusive growth, reducing poverty, and promoting sustainable development. Also, ongoing monitoring and evaluation are essential to track the performance of SEZs over time and identify areas for improvement. Matching comparative advantage to SEZs offers a promising pathway for African countries to achieve diversified economic growth and sustainable industrialization. By leveraging their unique strengths and exploring sectors with potential, countries can unlock new opportunities for development and prosperity. However, success requires a holistic approach that addresses logistical challenges, fosters stakeholder engagement, and integrates supply chain management principles into SEZ operations. Through strategic planning, targeted policies, and continuous innovation, African countries can realize the full potential of SEZs as engines of economic transformation and drivers of sustainable development.

## CRediT authorship contribution statement

**Isah Ibrahim Danja:** Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Xingping Wang:** Writing – review & editing, Supervision, Conceptualization.

## Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Xingping Wang reports financial support was provided by Social Science Foundation of China. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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